Volcanos and Extinctions: Erupting of the Impact Idea?

Two researchers argue that intense volcanic activity, not an asteroid impact, wiped out many plant and animal species 65 million years ago. But among other scientists, belief in the impact theory appears to be stronger than ever.

By STEFI WEISBURD

If there's one idea that's geologically tantalizing, it's the theory that an asteroid bombarded the earth 65 million years ago with a forceful impact, causing a riot of dust and debris and the demise of about three-quarters of the plant and animal species, including perhaps the dinosaurs (SN: 6/2/79, p. 356). Over the last six years, a wealth of geochemical, fossil and other data have brought a number of geologists into the "impact" camp.

But like much of geology, the clues found in the boundary layer between the Cretaceous and Tertiary periods, which marks the mass extinctions, are open to interpretation and reevaluation. And so, in the March 8 SCIENCE, Charles B. Officer and Charles L. Drake at Dartmouth College in Hanover, N.H., took the existing evidence and wove a tapestry in support of another proposed cause: an intense bout of volcanic eruptions. Moreover, says Officer, "We've shown conclusively that what occurred was not of extraterrestrial origin." This does not sit well with some impact proponents, who charge that Officer and Drake ignored strands of data that strongly support the impact theory, in favor of results that could fall either way. And so the debate goes on.

One tack taken by geologists studying the Cretaceous-Tertiary (K/T) boundary is to look at the distribution of elements in geologic sections. In fact, it was the 1979 finding of a peak in the boundary's concentration of iridium — an element thought at the time to be rare on the earth's surface but plentiful in asteroids — that motivated Walter Alvarez at the University of California at Berkeley and his colleagues to suggest the impact hypothesis in the first place. Officer and Drake point out, however, that more recent studies of particles emitted by the Kilauea volcano in Hawaii have shown that high levels of iridium from the inner earth can reach the surface, so that the K/T layer's iridium is not necessarily extraterrestrial in origin.

Frank Asaro, one of Alvarez's co-workers at Berkeley, agrees that had this finding been known six years ago, it might have given them some concern. But since that time, he says, many other geochemical data have fortified the impact hypothesis. For example, he cites studies in which the ratios of gold to iridium and platinum to iridium come within 5 percent of what would be expected from a meteoric source. Officer and Drake, on the other hand, have found values for these ratios that they say more closely resemble those of mantle material. They also refer to papers in which the ratios of arsenic and antimony to iridium reflect values found in the Kilauea particles but are about 1,000 times greater than what is found in a chondrite meteorite. This, they feel, strongly points to volcanos rather than asteroids as the culprits of mass extinction.

Asaro says he is puzzled by their analysis: "Officer and Drake do not seem to consider that there is also a terrestrial component to the elements they're looking at." Officer counters that such background levels of arsenic and antimony are about 100 times lower than that found at the boundary and so couldn't really contribute to the high values in the K/T layer.

The two groups also seem to disagree in their interpretations of the distribution of elements in the boundary layers. Officer and Drake argue that iridium and other elements are scattered over many centimeters above and below the boundary. If peaks in concentration are found, they say, those peaks occur in sections that are not complete. After taking into account the smearing of sediments due to the movement of organisms, they conclude that iridium was deposited in a flux that lasted 10,000 to 100,000 years—a duration far too long to be explained by just one asteroid impact.

While some impact supporters have considered the possibility that more than one asteroid hit the earth, others feel that the extended distribution of elements does not necessarily mean there was more than one impact. A few scientists are now focusing on how materials thrown up into the air by one impact would segregate as they settle down in sedimentary layers, and once settled, how they might move in a section over time. For example, says Bruce Bohor of the U.S. Geological Survey in Denver, Colo., the distribution of iridium in coal might depend on plants that took up the element in their roots. And in marine sediments, the iridium profile might reflect how it mixed with the preexisting material in the water column, he adds.

Another bit of evidence used to support impacts is the finding of shocked quartz—quartz grains containing crystals aligned in a pattern indicative of an impulse of high pressure—at K/T boundary layers in Montana and Europe (SN: 3/31/84, p. 197). "The important question," says Officer, "is whether those features are diagnostic of an extraterrestrial origin or if they could also be formed by internal [in the earth] shock pressures." He and Drake cite one example of a granitic intrusion that they say resulted in quartz patterns quite similar to those found near impact craters. But Bohor, who originally found the K/T shocked quartz, and others maintain that the K/T quartz features are very distinct from those produced by terrestrial processes.

Impact supporters also note that a wide distribution of the relatively heavy shocked quartz grains and other K/T material over the globe speaks well for the impact theory. Material spewed up from an impact, they say, would be more widely dispersed than that erupted from a volcano because the impact-generated particles would be ejected above the atmosphere and travel greater distances than if their movement depended just on atmospheric transport.

The case for an asteroid bombardment would be greatly bolstered, if not clinched, if someone found a large impact crater dating back 65 million years (Myr), but so far no such direct evidence has been unearthed. In support of the volcanic theory, on the other hand, Officer and Drake believe there is direct evidence for large-scale movement of magma to the surface around K/T time.

They say that the Deccan trap in India, one of the largest continental lava fields in the world, shows that a million cubic kilometers of magma were expelled over a very short time period in geologic terms—400,000 years. While the trap indicates that the area was volcanically active from 30 to 100 Myr ago, the major episode of volcanism is dated at 60 to 65 Myr ago. What's more, another major trap in Siberia is thought to have formed 240 Myr ago, a time corresponding to the preceding mass extinction event. Officer acknowledges that the Deccan trap resulted from a relatively calm upwelling of lava, not an explosive eruption requisite to expel massive amounts of particles into the air. But he says there is other evidence of explosive eruptions at that time.

Since both the asteroid and volcano theories have loyal supporters, it is likely that the discussion, and the disagreements, will continue for some time. The suggestion has also been made that both parties are partially correct: Perhaps an asteroid that shook the world also triggered massive volcanic eruptions. □