reported a prolonged period of change around the boundary, as recorded in marine microfossils at El Kef, Tunisia, and the Brazos River of Texas. At El Kef, species extinctions began 20 to 30 centimeters or more than 30,000 years before the boundary and ended 15,000 years after the boundary, she said. As many species became extinct before or after as at the boundary.

Keller's conclusions from her marine studies sum up much of what these and other studies seem to suggest, that there may well have been a confluence of causes that created the K-T mass extinction. That does not argue against a large impact at the precise boundary; the evidence for such an impact grows steadily stronger (*Science*, 8 May 1987, p. 666). Most recently, the first really promising candidate for the K-T impact crater has appeared. Michael Kunk of the U.S. Geological Survey in Reston, Virginia, and his colleagues have dated the Manson crater in Iowa as 67 ± 2 million years old. The K-T boundary is dated at 65 to 66 million years. In addition, the debris found globally at the boundary seems most abundant in North America. "Manson is in the right place and is certainly quite close in age," says Kunk. "It's certainly tantalizing." One problem with Manson, however, is its small size, which would require other, simultaneous impacts (*Science*, 21 August 1987, p. 856).

The chore now is to tease apart the sources of all the important environmental changes that led to extinctions while distinguishing between regional and truly global events. Given the demonstrated influence of the Milankovitch cycles on the past couple hundred million years of climate on time scales of 20,000 to 100,000 years, a background of changing climate seems inevitable. Did this background play a role? Sea level was indeed falling, reducing habitats such as the inland sea of North America that the dinosaurs found so congenial. A huge volcanic outpouring was forming the Deccan Traps of India, possibly increasing atmospheric carbon dioxide and turbidity even if it were not the boundary event.

Given these and other terrestrial influences, the great impact at the boundary could indeed have sent a destabilized ecological system over the brink. Even the prelude to the K-T event might have been extraterrestrial, a million-year swarm of smaller comets punctuated by the knockout punch. Or, perhaps the "prelude" was little more than a pulse in a background of climatic and biological change usually blurred beyond recognition in less detailed studies. Researchers will be taking quite some time considering all the possibilities. ■

RICHARD A. KERR

Superconductors Hotter Yet

It is almost a year since the discovery of a 90 K (90° above absolute zero) superconductor touched off an explosion of laboratory research and media interest in an area of enormous—but still elusive—technological potential. Within the past few weeks Japanese and American scientists have independently discovered a new material that is superconducting at temperatures up to 120 K, thus keeping alive the notion that superconductivity at practicable temperatures will one day soon transform activities ranging from microelectronics, to high speed trains, to high energy physics research.

The new material, a compound of bismuth, copper, strontium, calcium, oxygen, and (optionally) aluminum, has the potential for being dramatically cheaper and easier to work with than the other known high-temperature superconductors, which begins to address some of the practical issues of the technology. It was identified only weeks ago by Paul C. Chu and his colleagues at the University of Houston; its properties have since been confirmed by several other U.S. laboratories. Meanwhile, an apparently similar material has been reported by a team working under Hiroshi Maeda at the National Research Institute for Metals in Tsukuba, Japan. The Japanese team announced their discovery on 22 January, just 3 days before that of Chu and his colleagues.

It was Chu's team that last year discovered superconductivity at 90 K in a class of yttrium–barium–copper oxides—the so-called "1-2-3" compounds. That discovery, in turn, had followed close on the heels of 40 K superconductivity in lanthanum–barium–copper oxide, which had been announced in the fall of 1986 by Georg Bednorz and Karl Alexander Mueller of IBM's Zurich Research Laboratory, an achievement that earned them the 1987 Nobel Prize in Physics, the fastest-ever recognition of a discovery by the Nobel committee.

The new 120 K material thus represents a third fundamentally distinct class of high-temperature superconductors. As such it may well shed new light on the still mysterious mechanism of high-temperature superconductivity. In a telephone interview with *Science*, Chu said he was reluctant to discuss the exact formula of the new material before the discovery is published in the scientific literature, which should occur within the next few months. However, he did say that at the atomic level the new material is similar to the 40 K and 90 K superconductors in that it seems to have a layered structure—although it is not yet clear exactly what the arrangement of the layers is. Like the other two materials it also seems to have copper and oxygen atoms arrayed in long chains, a feature that many theorists think is central to the superconductivity.

In terms of practical applications, said Chu, the new material seems to have a number of potential advantages. Cost, for example: unlike the 40 K and 90 K compounds, which incorporate a variety of rare-earth elements, the new substance can be made from common and inexpensive raw materials. By the same token the new superconductor seems much more tolerant of variations in the precise ratio of its constituents.

Or consider stability: unlike the 1-2-3 compounds, in which oxygen can all too easily escape from the crystal lattice and destroy the superconductivity, the new compound retains its oxygen even when heated near its 900°C melting point.

On the other hand, said Chu, it has so far proved very difficult to make the material into a single, pure chemical phase. This is a problem that will certainly have to be overcome before the material can be useful. Also, there are still some major unknowns about the substance, the most notable being its critical current capacity—that is, the maximum current it can carry before losing its superconductivity. Practical large-scale applications will require critical currents on the order of 1 million amperes per square centimeter.

In short, it is still too early yet to say just what this new material will mean in practical terms. Nonetheless, as Chu pointed out, it will definitely provide "scope for flexibility": a new arena for studying the mechanism of high-temperature superconductivity, for exploring the effect of new variations in composition, and—who knows?—perhaps even for making the leap to still higher critical temperatures. ■

M. MITCHELL WALDROP