ergy product reported to date, 45 MGOe, with its Crumax material. "We think we can probably tap up to 54 MGOe in two or three years," says Narasimhan. Even at 45 MGOe, the researchers are doing well; this is 1.5 times better than the best cobalt-based magnet and over 11 times greater than levels achieved by conventional ferrites.

Both Crucible and the Sumitomo company in Japan, which has obtained 38 MGOe, make their magnets by grinding an amorphous chunk of the material down to a powder, aligning the micron-size particles in a magnetic field and then bonding the particles together with heat.

GM took another approach called melt-spinning, in which a stream of molten material is directed on to a spinning wheel to produce a thin, brittle ribbon. According to John Croat of GM, the researchers have achieved 14 MGOe with their Magnequench material and believe they can obtain 34 MGOe. However, Croat would not discuss how they plan to do this or, for that matter, how they will make actual magnets.

Electron microscopy reveals that the new magnets are made up of tiny particles. Part of the trick of making high energy products is to align these particles, or orient the crystal axis that is easiest to magnetize, with a magnetic field during the manufacturing process.

What causes high coercivity, however, is still subject to debate. Researchers agree that the anisotropic crystalline structure contributes. But more importantly, perhaps, is how the larger metallurgical arrangement of the particles — as determined by the processing technique — influences the formation of regions, called domains, inside which all the magnetic moments point in the same direction.When an external magnetic field is turned on, the domain walls sweep through the magnet, changing the orientation of the moments along the way in order to minimize the magnetic energy of the system.

In materials made by the powder method, microscopy shows the formation of large grains of the $R_2Fe_{14}B$ phase surrounded by areas of different composition and rich in neodymium and iron. Some scientists argue that the high coercivity in these materials results because the domain walls get stuck, or pinned, at the boundary between the two phases, making it difficult for an external field to change the direction of magnetization within the grain.

Microscopy of GM's rapidly quenched ribbons, on the other hand, reveals much smaller particles and mostly one phase. Herbst says that the coercivity of these samples is due to an optimum size of the particles, about 600 angstroms. (One angstrom equals one ten-billionth of a meter.) Below this size, he says, one would expect particles to have only one magnetic domain. *—S. Weisburd*

Reducing the risks at university reactors

Fears that terrorists could steal highly enriched uranium fuel from university nuclear reactors to make nuclear weapons have prompted the Nuclear Regulatory Commission (NRC) to set new regulations for these reactors. Last week, NRC staff completed work on a draft rule that requires research reactors to switch from using highly enriched uranium to a nuclear fuel with a much lower proportion of the uranium isotope U-235.

The uranium fuel currently in use contains 93 percent U-235. NRC would like to see this level reduced to less than 20 percent. The idea is to make it more difficult to build a bomb from the material. Highly enriched uranium can be fabricated into a bomb simply by chemically separating the uranium from the aluminum alloy that holds a fuel rod or plate together. No additional enrichment is necessary.

A 1982 NRC policy statement outlines the commission's intentions. The statement says, "U.S. research reactor operators have shown little interest in converting to low-enrichment fuels, and as part of a policy to strongly encourage conversion by foreign operators, the commission will take steps to encourage similar action by U.S. research reactor operators." The United States provides the bulk of the highly enriched uranium used in research, training and test reactors and every year exports about 600 kilograms of the material for this purpose. About 500 kilograms are used domestically.

The new rules will affect 25 university reactors, three reactors belonging to government agencies such as the National Bureau of Standards and five private reactors. "We feel that it's technically feasible to replace our existing fuel ... with fuel plates of identical dimensions containing 20 percent enriched uranium," says Thomas J. Parkinson, who heads the reactor program at the Virginia Polytechnic Institute and State University in Blacksburg. "The big problem facing university reactors is who's going to pay." Conversion requires new studies and calculations to ensure that the reactor is still safe and functioning properly. Parkinson points out that it may take a long time for manufacturers to change their products to the new specifications. The reactor conversion may take as long as 10 years, he says, and cost a total of $15 million for all the reactors. Recently, a congressional committee added $1.25 million to the Energy Department budget to start this process.

For the high-performance reactors at the Massachusetts Institute of Technology in Cambridge and at the University of Missouri in Columbia, the situation is more serious because no adequate alternative fuel exists. Missouri's Robert Brugger says, "Our reactor was designed to take advantage of the best technologies that were known at the time to make the best research reactor that could be made." This meant designing it around a compact core of highly enriched uranium. "If we were required to go to low-enriched uranium, it would dim our [neutron] source," says Brugger, "and it would not be an effective research reactor."

NRC's Charles N. Kelber says that the proposed rule allows some leeway by calling for the use of uranium fuel with an enrichment as close to 20 percent "as is available and acceptable to the commission." Kelber says that the Department of Energy has an extensive research program to develop new nuclear fuels that pack a larger amount of uranium into a given volume of fuel. Thus, although the uranium contains a lower percentage of U-235, more uranium is present in the fuel, so that the overall effect should be the same. However, these fuels are far from being commercially available.

Reactor operators are also worried that the fuel changeover will require them to seek an amendment to their reactor operating licenses. This procedure could involve public hearings, extra expense and long delays. The battle over renewing the license for the reactor at the University of California in Los Angeles is often cited as an example. UCLA's Neill C. Ostrander reports that the struggle has taken four years so far and cost about $250,000, and "the end is not yet in sight." At the moment, the UCLA reactor is shut down for maintenance and will remain closed until the end of the Olympic Games this summer.

—I. Peterson

Abundant Ir marks a third boundary

In a finding sure to enhance the debate about impacts of the earth with extraterrestrial bodies and their effect on the earth, Chinese scientists now report high iridium levels at the boundary between the Permian and Triassic periods. This boundary formed about 248 million years ago, at a time when 90 percent of species then living on earth became extinct. At least five other boundaries are marked by the relatively sudden extinction of many kinds of life. The Permo-Triassic boundary is the third where high iridium levels have been found, though one of these was not a time of major mass extinction.

Iridium, like other rare earth metals, is abundant in extraterrestrial bodies such as asteroids and comets, but normally is scarce on the planet's surface. It has been suggested that high levels of iridium indicate that the earth collided with an asteroid or a comet, and that after the impact, the element was carried around the world in a vast cloud of dust (SN: 3/31/84, p. 197). This debris became the clay that marks

the boundaries between several geologic periods.

Iridium now has been found at more than 50 sites around the world where rocks span the boundary between the Cretaceous, which ended 65 million years ago when 75 percent of species became extinct, and the subsequent period, the Tertiary. The Eocene-Oligocene boundary formed 38 million years ago. It was a time of higher than normal extinction, but is not considered one of the major extinction events. At that boundary, high iridium levels have been found in sediments containing glassy particles called microtektites. These are believed to be droplets of earth, melted by the energy of an impact, rapidly cooled, and strewn over great expanses of the planet.

The finding at the Permo-Triassic boundary was described to a group of scientists participating in the International Geological Correlation Project. The geologists met in Beijing, China, to consider sites proposed as the type section—the standard against which all other rocks of a given period are measured — for the Permo-Triassic boundary. Some of the best samples of this boundary are in China, preserved in rocks formed by sediments from the ancient Tethys Sea. The researchers are Xu Dao-Yi of the State Seismological Bureau, and colleagues from Academia Sinica in Beijing, the Chinese Academy of Geological Sciences, and the Beijing Astronomical Observatory. They have found abundant iridium and other trace elements at the boundary at two locations—Baoqing Quarry, near Changxing in Zhejiang province, and in the Shansi section, Guangyuan, Sichuan province. They conclude that mass extinctions coincident with the iridium anomaly at the Shangsi site, abundance of trace elements, and similarities with evidence for an impact 65 million years ago imply an extraterrestrial event at the end of the Permian.

"One of the things that interested me about the occurrences that we are witnessing is that they resemble very closely what we have seen at Stevns Klint in Denmark," says Norman Newell of the American Museum of Natural History in New York. The Denmark formation is one of the best samples of rocks spanning the Cretaceous-Tertiary boundary, and contains very high levels of iridium. "The rock is very distinctive clay that is different from the rocks above and below," he says. Newell, who attended the meeting, believes that the iridium levels may be due to a cosmic source, but is not persuaded that it has anything to do with mass extinctions. He suggests that both the rocks from the Permo-Triassic boundary in China, and at Stevns Klint, show signs that there was a lapse in sedimentation. Such a gap could accentuate any faunal changes, he says. He urges geochemists also to look for iridium in parts of the geologic record where mass extinction did not occur.

— C. Simon

Volcanic ash takes stressful toll

On the morning of May 18, 1980, Washington state's Mount St. Helens erupted violently, spewing about 1.3 billion cubic yards of ash and other material into the air. By noon, in the small town of Othello, Wash., about 140 miles from the volcano, the sky had clouded over and it was pitch black. Over two inches of ash fell on the Othello area that day and business virtually ground to a halt for several weeks.

"Enormous plumes of dust 20 to 30 feet in the air trailed moving cars," says Paul R. Adams, a counselor at a mental health clinic in Othello. "If the wind blew, you couldn't see to the end of your car."

Adams and colleague Gerald R. Adams (no relation) of Utah State University in Logan, Utah, did see their way clear, however, to conducting one of the few sound "before-after" studies of natural disaster victims. They report in the March AMERICAN PSYCHOLOGIST that there was an extensive "disaster stress reaction" among the 7,000 people in and around Othello that lasted for at least seven months.

USGS

Mount St. Helens sits quietly in 1978, two years before it erupted.

The researchers compared community data from June through December for the years before and after the ashfall. Changes were tallied for statistics related to psychosomatic illness, family problems, alcohol abuse, aggression and general adjustment. After the ashfall, calls to a mental health crisis line doubled, police reports of domestic violence increased by two-thirds, and mental health clinic appointments, hospital emergency room visits and clients served by a community alcohol center all increased by about one-third. District court cases filed went up 25 percent and the total number of arrests increased 17 percent.

The investigators also found that diagnoses of mental illness, psychosomatic illness and stress-aggravated illness made by local mental health counselors and physicians doubled in the seven months following the eruption.

The findings suggest that small communities exposed to a disaster need intensive mental health support for at least several months, says Paul Adams. With threats of further eruptions by Mount St. Helens, the Othello community may be undergoing renewed stress, he adds.

Traumatic reactions to disasters have been documented anecdotally, says Calvin J. Frederick, chief of psychology services at the Brentwood VA Hospital in Los Angeles, "but statistically we've been up a tree." Frederick participated in a recent study that found significantly more psychological symptoms among Three Mile Island residents than among residents of other towns near nuclear reactors.

Considering the problems in gathering data that predate a disaster, he says the Othello investigation "is about the best you can do."

A similar project is underway with residents of the Times Beach, Mo., area who were beleaguered by massive flooding and concern about dioxin. Many of them happened to take part in a survey of mental disorders just before the disasters in 1982. They will be reinterviewed by psychologist Lee Robins and co-workers at Washington University in St. Louis to determine psychological reactions to either or both events.

Some reactions are harder to pin down with interviews. "A lot of babies were born about nine months after the [Mount St. Helens] eruption," says Othello resident Jeni Wilcox. "'Ashley' has become a popular name for newborns in the last few years."

She says her husband Lon, a nurse at the local hospital, noticed a marked increase in problem pregnancies and Caesarian sections about one year after the eruption. "It's been rather strange, although we can't really tell what caused the problems," Wilcox adds.

Ironically, most of the police officers, alcohol counselors and physicians who participated in the Othello study told Paul Adams they did not see any behavioral changes after the ashfall. "But when we looked at the data, we saw significant changes that they hadn't recognized," says Adams.

Othello residents recognize that what happened before could happen again. "Within a few days of the first eruption, the grocery stories were emptied out," says Wilcox. "We've started a food storage program now and we're learning to be better prepared."

Her memories of the ashfall are vivid. "The Bible says the sky became dark when Christ was on the cross," she recalls. "I gained an understanding of what the crucifixion was like the day the volcano erupted."

—B. Bower