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## The Secret Ingredients of Everything

From smart phones to hybrid vehicles to cordless power drills, devices we all desire are made with a pinch of rare earths—exotic elements that right now come mostly from China.

By Tim Folger

Most of us would be hard-pressed to locate Inner Mongolia, Jiangxi, or Guangdong on a map. Yet many of the high-tech devices we depend on—cell phones, laptops, and hundreds of others—would not exist without an obscure group of elements mined, sometimes illegally, in those three and other regions of China.

Rare earths, as the elements are called, were discovered beginning in the late 18th century as oxidized minerals—hence "earths." They're actually metals, and they aren't really rare; they're just scattered. A handful of dirt from your backyard would probably contain a smidgen, maybe a few parts per million. The rarest rare earth is nearly 200 times more abundant than gold. But deposits large and concentrated enough to be worth mining are indeed rare.

The list of things that contain rare earths is almost endless. Magnets made with them are much more powerful than conventional magnets and weigh less; that's one reason so many electronic devices have gotten so small. Rare earths are also essential to a host of green machines, including hybrid cars and wind turbines. The battery in a single Toyota Prius contains more than 20 pounds of the rare earth element lanthanum; the magnet in a large wind turbine may contain 500 pounds or more of neodymium. The U.S. military needs rare earths for night-vision goggles, cruise missiles, and other weapons.

"They're all around you," says Karl Gschneidner, a senior metallurgist with the Department of Energy's Ames Laboratory in Ames, Iowa, who has studied rare earth elements for more than 50 years. "The phosphors in your TV—the red color comes from an element called europium. The catalytic converter on your exhaust system contains cerium and lanthanum. They're hidden unless you know about them, so most people never worried about them as long as they could keep buying them."

Now a lot of people are worried.

China, which supplies 97 percent of the world's rare earth needs, rattled global markets in the fall of 2010 when it cut off shipments to Japan for a month during a diplomatic dispute. Over the next decade China is expected to steadily reduce rare earth exports in order to protect the supplies of its own rapidly growing industries, which already consume about 60 percent of the rare earths produced in the country. Fears of future shortages have sent prices soaring. Dysprosium, used in computer hard drives, now sells for \$212 a pound, up from \$6.77 eight years ago. Over just two months last summer, prices on cerium jumped more than 450 percent. World demand will probably exceed supply before the end of 2011, says Mark A. Smith, president and CEO of Molycorp, an American company that reopened a rare earth mine at Mountain Pass, California, last year.

"We're in a supply crunch right now, and it's a pretty severe one," says Smith. "This year the demand will be 55,000 to 60,000 tons outside of China, and everyone's best guess right now is that China will be exporting about 24,000 tons of material. We'll survive because of industry inventories and government stockpiles, but I think 2011 will be a very, very critical year in terms of supply and demand."

The demand shows no signs of abating. In 2015 the world's industries are forecast to consume an estimated 185,000 tons of rare earths, 50 percent more than the total for 2010. So with China holding tightly to its reserves, where will the rest of the world get the elements that have become so vital to modern technology?

Although China currently monopolizes rare earth mining, other countries have deposits too. China has 48 percent of the world's reserves; the United States has 13 percent. Russia, Australia, and Canada have substantial deposits as well. Until the 1980s, the United States led the world in rare earth production, thanks largely to the Mountain Pass mine. "There was a time we were producing 20,000 tons a year when the market was 30,000 tons," says Smith. "So we were 60-

plus percent of the world's market."

American dominance ended in the mid 1980s. China, which for decades had been developing the technology for separating rare earths (not easy to do because they're chemically so similar), entered the world market with a roar. With government support, cheap labor, and lax or nonexistent environmental regulations, its rare earth industries undercut all competitors. The Mountain Pass mine closed in 2002, and Baotou, a city in Inner Mongolia (an autonomous region of China), became the world's new rare earth capital. Baotou's mines hold about 80 percent of China's rare earths, says Chen Zhanheng, director of the academic department of the Chinese Society of Rare Earths in Beijing. But Baotou has paid a steep price for its supremacy. Some of the most environmentally benign and high-tech products turn out to have very dirty origins indeed.

Rare earth mines often also contain radioactive elements, such as uranium and thorium. Villagers near Baotou reportedly have been relocated because their water and crops have been contaminated with mining wastes. Every year the mines near Baotou produce about ten million tons of wastewater, much of it either highly acidic or radioactive, and nearly all of it untreated. Chen maintains that the Chinese government is making an effort to clean up the industry.

"The government has already made strict regulations to protect the environment and weed out the backward techniques, equipment, and products," Chen wrote in an email. "Those factories without abilities of environmental protection will be closed or merged with bigger companies."

The Chinese government may eventually be able to regulate the large rare earth mining industry around Baotou. But some of the smaller mines in southern China will be more difficult to control—because they're operating outside the law to begin with. Violent criminal gangs run dozens of heavily polluting—and profitable—rare earth mines in Jiangxi and Guangdong Provinces. Xinhua, the official Chinese news agency, has reported that criminals smuggled 20,000 tons of rare earths from the country in 2008, nearly a third of the total rare earth exports for that year. If you own a smart phone or a flat-screen television, it may contain contraband rare earths from southern China.

"People don't understand how totally corrupt the system in China is, with local party people aiding and abetting criminals in a very substantial way," says Alan Crawley, CEO of Pacific Ores Metals & Chemicals, a trading company in Hong Kong. Crawley speaks from experience. One of his colleagues was murdered 11 years ago by Guangdong gangsters. "The Hong Kong police can't do anything," he says. "The killers fled back to the mainland."

The world is now scrambling to find other sources of supply; the development of rare earth mines in the U.S., Australia, Russia, and other countries may eventually cut into the smugglers' business. Molycorp intends to produce 3,000 to 5,000 tons of rare earths from stockpiled ore at its Mountain Pass mine this year and has big expansion plans. "The current U.S. demand is somewhere between 15,000 and 18,000 tons per year," says Smith. "In principle, Mountain Pass could eventually make the United States independent in rare earths." According to Chen, China's present dominance of the market is not in its own long-term interests. "This situation is obviously not sustainable," he noted, "for China's rare earth industry and for the world's high-tech industry."

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