Global scramble looms for vital 'clean energy' minerals

Katie Howell, Environment & Energy Publishing, 4-12-10

During the Cold War, the U.S. government kept a close watch on supplies of rare earth minerals deemed critical for maintaining military readiness.

Then the Soviet Union crumbled, and so did U.S. interest in rare earths.

"Slowly but surely, we've lost our mineral base in the United States," said Daniel Kish, senior vice president for policy at the nonprofit Institute for Energy Research.

But those minerals are now seen as critical to creating a new "clean energy" economy. Rare earths are vital for making rechargeable batteries for hybrid cars, high-performance magnets for wind turbines and fluorescent light bulbs.

So the United States is scrambling to mine, acquire and manage rare-earth minerals.

But getting them won't be easy. Only a fraction of the world's rare earths are produced in the United States. And the world's largest rare-earth producer, China -- home to half of the globe's minable rare-earth deposits -- is about to lock up its supplies to meet surging domestic demand.

Researchers and industry representatives are urging the United States to mobilize quickly for what many warn could be the most critical energy imports of the 21st century.

"We understand that the primary purpose of putting hybrid electric vehicles on the roads of our country is to lower the consumption and dependence on foreign crude oil," said Mark Smith, CEO of Molycorp Minerals, the only U.S. rare-earth producer. "But as we're lowering our dependence of one commodity, aren't we trading that dependence on another, namely rare earths?"

There are 17 rare-earth elements -- scandium, yttrium and 15 lanthanides -- and they are found grouped together in the periodic table. But despite being called "rare," they are relatively abundant. In fact cerium, the most common member of the group, is more prevalent in the Earth's crust than copper.

"If you were to go outside right now and grab a handful of dirt from the ground, it would contain rare earths," Smith said.

But some science behind rare earths remains a mystery. For one, geologists do not agree on how the ores that contain the elements were formed, with theories ranging from volcanic activity to meteorites.

"If I talk to 40 different geologists," Smith said, "I'll get 40 different answers."

But one thing is for certain: Rare earths' unique properties -- they are catalytic, chemical, electrical, metallurgical, nuclear, magnetic and optical -- make them indispensible to many modern technologies.

So important are they that Kish is warning that the Obama administration's ambitious long-term energy agenda may hinge on rare earths.

"If you're going to go on a 30-mile day hike, you need to make sure you have water and something to eat," Kish

said. "In this case, we're talking about going on a lengthy hike to a green energy future without considering what it takes to go on the hike."

The administration appears to be paying attention. The Energy Department announced last month that it was preparing a rare-earth strategy aimed at ensuring U.S. access to supplies. Meanwhile, lawmakers have introduced legislation (H.R. 4866) aimed at heading off supply problems.

And due soon is a Government Accountability Office report on the importance of rare earths in Pentagon supply chains.

Why the urgency? Smith said China is not far from limiting exports as it needs rare-earth minerals to meet its booming domestic energy needs.

"I believe there's a two- to three-year window in which things need to occur," Smith said in an interview. "And that window is getting shorter every day."

Mojave Desert mine

Molycorp is preparing to resume production at its Mountain Pass mine in California.

The open-pit mine -- found in the Mojave Desert between Los Angeles and Las Vegas -- is 57 years old. First discovered in the 1940s by uranium prospectors, Mountain Pass is now cited by the U.S. Geological Survey as containing the world's greatest concentration of rare-earth minerals.

Active mining at Mountain Pass ended in 2002 because of a combination of economics and environmental concerns, but the facility has been processing stockpiles of ore since 2007, and the company plans to start work this summer on refurbishing the mine so active mining can begin again.

Currently, Mountain Pass is producing about 2,000 metric tons of rare earths a year. By 2012, Molycorp hopes to increase that output to 20,000 tons.

But the mine has had a troubled environmental past. For years, tainted wastewater from rare earth processing was pumped to unlined evaporation ponds, and chemicals leached into groundwater. And ruptures of a pipeline carrying wastewater to evaporation ponds spilled thousands of gallons of radioactive and other hazardous waste onto the desert floor, environmental groups say.

A cleanup is ongoing. A group of U.S.-based investors, including Smith, bought the mine in late 2008 and plans to use what it says are state-of-the-art technologies for water treatment and mineral recovery to avoid the mistakes of the past.

Mountain Pass produces a type of rock called bastnäsite, a yellowish-brown ore that tends to occur in "hard rock" igneous formations and is mined using traditional open-pit techniques.

Rare earths are unique in that all the elements tend to occur together in deposits, so all 17 rare-earth elements can be found in each lump of bastnäsite.

But the key is separating rare-earth elements from one another.

"Mining is -- believe it or not -- the absolute easiest thing we do," Smith said. "Once we pull it out of the ground, that's when things get complicated."

Molycorp -- and most rare-earth producers -- use a solvent-extraction process to separate elements from each other. That process involves immersing the processed ore into different chemical solutions to separate individual elements. But the atomic weights of each of the rare-earth metals are so similar that the process involves multiple stages to complete the separation process.

"It's not like putting [the ore] in a tank and watching the solids settle out," Smith said. "These are like 1,000 tanks to get that separation."

And that is where the process gets expensive. Smith said Molycorp can affordably produce nine of the 17 rare earths at today's prices.

"We know how to get those [other ones]. We know how to do it," he said. "But it costs too much money. The amount of the element in the ore body as you get into some of these rare earths is down to such small levels that you're talking about several thousand cells to pull the element out individually."

Molycorp is not alone in scaling up U.S. production. Ed Cowle, CEO of U.S. Rare Earths, said his company is sitting on some of the nation's largest rare earth resources outside Mountain Pass.

The company is not mining those reserves -- in Idaho, Montana and Colorado -- yet. But it plans to do so, Cowle said.

"I feel like I'm in the middle of a tsunami coming over us," Cowle said. "We have a deposit that's exponentially getting attention and gaining value as the weeks go by."

He added, "I don't know who will help us develop our properties, or when, but if everything that is said about this industry -- the prices, supply and demand -- are correct, then I believe some entity will help us develop these properties."

Flight to China

The U.S. government made its first big rare-earth push in the later stages of World War II, when it established a rare-earth division at the Ames National Laboratory at Iowa State University.

"The time span of the 1950s through the 1970s was the golden age of rare-earth research at the Ames Laboratory," Karl Gschneidner, a senior metallurgist at Ames and a professor at Iowa State, told a House Science and Technology subcommittee last month.

But federal funding started to dry up in the 1980s, and now Gschneider's program gets by on about $4 million a year from the Energy Department. His lab is the only federally funded rare-earth research program.

As the Cold War ended and federal monitoring of rare earth supplies tailed off, China became dominant in rare-earth mining and production.

The Chinese in the 1990s flooded global markets with low-priced, rare-earth products, shutting out remaining U.S. rare-earth producers and sending the nation's technical rare-earth experts scrambling for jobs in other industries, said Gschneidner.

And with the shift of rare-earth mining to China has gone production of metals and manufacture of products derived from rare earths, including neodymium magnets crucial for building wind turbines.

"If you control the minerals, you've got the cheap manufacturing," Kish said.

In 2003, the last U.S. manufacturer of neodymium magnets was sold to a Canadian company that shifted production from Indiana to China.

All this happened, Kish said, with little response from the United States.

"It seems as though nobody is looking up," Kish said. "The left hand doesn't know what the right hand is doing, and the policies in the United States, if anything, have been making it harder to mine, whether it's for uranium, copper or rare earths."

He compared the flight of the rare-earth production to the demise of the U.S. auto industry. "At the height of Detroit's problems, why didn't automakers think about what it would mean for the industry when the price of gasoline reached $3?" Kish said. "Everybody said they didn't do any planning, and now they find themselves whipsawed by this."

Meanwhile, Molycorp's Smith said his company has a front-row seat for seeing China's market control.

"When I sell neodymium oxide to Japan, the major manufacturers there take that oxide and ship it to China to convert it to metal, and then China ships it back to Japan," Smith said. "There's a complete gap in whole processing of these oxides into metals."

U.S. comeback?

Smith maintains his company can lead a rebirth of the U.S. rare-earth supply chain.

"As part of our mining-to-magnets development, we will build out the metals, alloying and magnet-powder manufacturing capabilities," Smith said. "We would also establish the production of rare-earth permanent magnets, all here in the United States."

Research is critical to develop alternatives to and recycling of rare earths, said Steven Duclos, chief scientist and manager of material sustainability at General Electric Global Research.

"An optimal solution is to develop technology that either greatly reduces the use of the at-risk elements or eliminates the need for the element altogether," Duclos said. "While there are cases where the properties imparted by the element are uniquely suitable to a particular application, I can cite many examples where GE has been able to invent alternate materials, or use already existing alternate materials to greatly minimize our risk."

All and all, Smith said rising attention being paid now to rare earths is coming not a moment too soon.

"Is the sky falling today? Absolutely not," Smith said. "But we're heading toward serious consequences."