



The tech crisis that isn't: China controls the world's rare earth supply chains

Is it a crisis when a country holds a commanding lead in supplying a critical global market successfully manages to avoid disrupting that market amid a pandemic, and doesn't have "United" in its name?

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They're called either the Diaoyu Archipelago or the Senkaku Islands -- eight rocks just a few miles wide, if that, situated about 125 miles southwest of Okinawa. They're uninhabited, and generally so strategically unimportant that during negotiations for the Treaty of San Francisco in 1951 that established Japan's territorial borders, diplomats forgot to mention them. They remained "occupied" by the US until 1972. Today, Japan claims them, but so does China and so does Taiwan. From a distance, they look like the tops of old furniture floating just above the waterline after a flood.

Submerged reefs make for wonderful fishing. During the first week of September 2010, several unlicensed Chinese trawlers were spotted operating in what Japan calls the Senkaku. Depending on who tells the story, there may have been as few as one, and as many as 160. Japan's Coast Guard was dispatched to escort the vessels out of disputed waters. Most complied. One did not. Trawler Minjinyu 5179, with a crew of 15 and a Quanzhou registry, rammed a patrol vessel, twice. One account says the captain and his entire crew were inebriated at the time. At any rate, the Coast Guard boarded the vessel and detained the captain.

China protested, demanding an official apology. Its press portrayed the captain as a hostage of Japan. The Japanese Ministry of Foreign Affairs issued a statement, which included the sentence, "There exists no issue of territorial sovereignty to be resolved concerning the Senkaku Islands." Its inclusion of the Japanese name merely underscored the ludicrousness of the claim. As initial retaliation, China stepped up its detention of Japanese tourists for what its officials described as indecent behavior.

What happened next is visible in the graph above: China imposed an embargo on shipments of so-called *rare earth elements* (REE) to Japanese ports. It effectively pinched the neck of one of the world's critical supply chains, driving worldwide prices for the types of elements and compounds found in industrial magnets and consumer electronics higher by over 700%.

For the manufacturers of IT components and devices that had taken great steps to reduce their reliance upon single sources and diversify their supply chains, one pinched-off shipping route should not have been a problem. But China had already grown its REE industry from effectively nothing at the turn of the century, to the supplier of over three-fourths of the world's rare compounds. Due to a set of circumstances that had played out billions of years ago, as the Earth's crust was cooling and tectonic plates were beginning to shear away from each other, China was to find itself the world's principal source for the stuff strong magnets are made of. Even a globally diverse group of parts makers and materials suppliers would be reliant upon a single source, for reasons that mostly couldn't be helped.

"You think you're diversifying, but you're not," commented Dr. Sherman Robinson, senior fellow with the Peterson Institute for International Economics. Manufacturers dependent upon the parts that are themselves dependent upon REE, he said, are well aware of this situation. "The last thing they need is to have a tsunami, or something having to do with climate change, wreck some crucial, irreplaceable link."

Or perhaps a pandemic.

The resource advantage

"People have no idea where their stuff comes from," remarked David S. Abraham, senior fellow with the Resource Security Program with Washington, D.C.-based public policy institute New America. "They don't realize the complexity of what's in their iPhone, their laptop, or their refrigerator. Countries like Japan and China have a greater sense of what it takes to make material products, because that's where production is done -- just like people in Colorado have a better appreciation of what mining is, than people in Connecticut."

Improve the development and application of rare earth, and change the resource advantage into economic superiority. -

— *Bullet point from the Twelfth Five-Year Plan, 1999, Jiang Zemin, President, People's Republic of China*

In 2017, the White House issued an executive order, calling upon all federal agencies to devise a cohesive strategy for responding to rare earths and critical minerals supply chain disruptions. The following May, the Interior Dept. published a list of 35 "mineral commodities that are vital to the Nation's security and economic prosperity." They included more common elements such as aluminum, cobalt, and graphite; the somewhat radioactive uranium; plus all 17 members of the REE group: scandium, yttrium, and the 15 metallic chemical elements called lanthanides.

- **Scandium (Sc)** is a soft, lightweight element which, compounded with iodine, produces an agent added to arc-discharge lights to increase their intensity, as well as tint them slightly yellow, like sunlight.
- **Yttrium (Y)** is used in several inorganic compounds to produce warmer-temperature superconductive ceramics, such as yttrium barium copper oxide (YBCO). Last January, as part of an effort to compensate for trade imbalances, China agreed to purchase

scandium and yttrium from US mines, even though no US mines presently produce yttrium or scandium.

- Among the lanthanides: **Samarium (Sm)**, an inexpensive rare earth element, combined with cobalt, produces a small, strong, permanent magnet (SmCo), albeit one that's susceptible to chipping.
- **Neodymium (Nd)** isn't a particularly expensive element, selling for about \$70 per kilogram. You may recall, Apple got into some trouble in 2015 over the neodymium magnets used for the "taptic feedback" in its Apple Watches and iPhones, for degrading over a shorter time than anticipated.
- **Dysprosium (Dy)** is a very rare, highly magnetic, heavy rare earth element (HREE). It first found its use in coolants for nuclear reactor rods. Since then, it became a go-to ingredient for producing the magnets in earbud speakers, as well as some lithium-ion batteries to help prevent loss of power at high temperatures.

In his 2015 book *The Elements of Power: Gadgets, Guns, and the Struggle for a Sustainable Future in the Rare Metal Age*, Abraham tells the story of a Fujitsu researcher named Masato Sagawa, who was working on a way to add other elements to compounds to help space out the neodymium atoms, amping up the magnetism. He accomplished this in 1983 by adding iron, boron, and to counteract the loss of conductivity at high temperatures, between 3 and 6% of dysprosium. The resulting NdFeB compound is easily among the world's strongest, and that tiny bit of dysprosium proved invaluable.

Until 2018, when Australia re-invested in the rare earths market, China was the world's sole source of dysprosium. Myanmar entered the market last year, ironically exporting its product to China. Earlier this year, the Defense Dept. began backing efforts to build mines for dysprosium and other rare earths in Texas and California. In addition, the Pentagon had begun advocating legislation that would raise the budgetary spending caps for REE under the Defense Production Act to \$1.75 billion.

Sen. Ted Cruz (R – Texas) co-authored this legislation. In a May 12 statement on the Senate floor, Cruz remarked, "Our ability as a nation to manufacture defense technologies and support our military is dangerously dependent on our ability to access rare earth elements and critical minerals mined, refined, and manufactured almost exclusively in China. Much like the Chinese Communist Party has threatened to cut off the US from life-saving medicines made in China, the Chinese Communist Party could also cut off our access to these materials, significantly threatening US national security."

Yet unbeknownst even to the people reporting the Pentagon news in May, according to a letter obtained by Reuters, their efforts had already been halted in April, awaiting "additional research."

That research finally received \$122 million in funding from the Dept. of Energy in September, after being combined with an initiative to spur the nation's production of more conventional materials. "These projects have an important role," stated Energy Sec. Dan Brouillette. "They

will help develop a viable domestic supply of these resources, while creating new market opportunities for coal."

Command and control

In a brief published last March by the Center for Strategic and International Studies, Tobin Hansen (now a junior fellow at the Carnegie Endowment for International Peace), opened his brief for the Pentagon, "Securing US Access to Rare Earth Elements," with this sentence: "Control over the production of critical minerals necessary for advanced defense and commercial manufacturing processes is a new feature of the escalating tensions between the United States and China over trade and security." It's the type of language a Pentagon analyst relishes.

Is command and control over the rare earth supply chain absolutely necessary for there to be a strategically secure relationship between the producers of these minerals and the manufacturers who rely on them?

"No!" emphatically responded Dr. Eugene Gholz, an adjunct scholar with the Defense & Foreign Policy Dept. at the Cato Institute.

"There certainly doesn't have to be a command or a control relationship," Dr. Gholz continued. "That's what the market is: lots of contractual relationships between independent entities, to get supply of all the things you need -- whether they're critical minerals, or the cup of coffee I drank a few minutes ago. I don't have to own the farm in order to have coffee."

Maybe it would be premature, Gholz told ZDNet, to declare the rare earths supply chain "just fine." But at each stage of the value chain, between the mining of the ores and the polishing of the touchscreen, there are multiple stages. There is already, he asserts, an appreciable degree of flexibility there. "In general," he said, "if governments would stay out, things would work great." As Gholz continued:

"The fear is, because a number of suppliers, including the larger ones, are located in China, a country with which several of the consumers, including the United States, have a relatively adversarial relationship, Chinese political interference in the rare earth market would hurt us. So the question is, if you think Chinese political interference is possible, and would hurt us, is the best response American political interference in the market as well? I would question all three of those requirements. I don't think that the Chinese capability to interfere in the rare earths market is very high. I don't think that, if China did intervene, it would cripple consumers like the United States, or cripple national security in particular. And I don't think that, even if that risk existed, US government intervention in the rare earths market is the best response."

For Hansen's part, his report does advise US policy makers that China would be working against its own interests if it were to impose a Minjinyu 5179-style embargo on the US, for some offense or another. But he goes on to advise that policy makers should seize on the rare, bilateral spirit of disdain towards China in Congress, by pushing legislation. "The United States must take advantage of the opportunity created by China's explicit REE threats to undermine the near-monopoly it faces," wrote Hansen. "For now, the leverage China holds is undeniable, though this leverage is unlikely to remain effective indefinitely."

Yet during the global pandemic -- easily the greatest test of the strength of the global economy in a century -- the REE supply chain appears to have remained strong, and may have even solidified. There's a case to be made that, had the supply chain been more diverse, and more customers relied upon supplies from outside China -- which has largely recovered from the pandemic's first wave -- the situation would have been more critical.

Put another way, if the world won't accept American tourists right now, there's a chance they might not want American rocks either.

China's management of this supply chain, asserted David Abraham, "has been a boon to tech companies." He went on:

"They have reliable supplies of materials at inexpensive prices. They didn't have to be concerned about where these rare materials were coming from. They could just be happy that their screens could light up, and their phones have very powerful magnets and batteries in them. It's been enabling for them. The fact that China produced them cheaply, because they cared less about the environment or had lower labor costs, enabled them to pass things over. They don't think about things that don't necessarily cost too much."

Amid the geopolitical and the macroeconomic debates, and the policy issues pitting the long-term virtues of globalization versus the short-term gains of nationalism, there is one striking, and somehow oft-overlooked, fact that should, if we'd just shut up and listen to someone else a moment, be the chief reality of our discussion: The formation of our solar system, which left Earth somewhat wobbly, tilted, and imperfectly shaped, gave China a natural advantage in rare earths several billion years before the first vibrations of muted iPhones.

The magnificent sandstone pillars of Zhangjiajie in southern China are so tall and deep that you would think they'd have to have been hoisted up by a huge crane. Billions of years ago, the land in that area was the floor of the ocean. Tremendous tectonic activity left quartzite deposits on the surface that were carved into by millions of years of receding ocean tides, leaving behind natural mineral skyscrapers, to be further shaped by erosion.

Settling at the base of these towers, geologists discovered, is a bright white, silicate clay mineral called kaolinite, or $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$. It's a common enough mineral as to have been found in what's now southern Iran, in fragments of the pottery of ancient Sumerians, who evidently appreciated its brightness. In the case of Zhangjiajie, these geologists now believe, kaolinite deposits formed when naturally acidic rain washed between these towers, mixing with granite and settling into wet pools. These pools formed a kind of stew called *ion absorption clays* that, amazingly, collected rare earths.

As a result, you can think of the Zhangjiajie towers as colossal fingers pointing right to where the rare earths are. High mountains elsewhere in China may also serve as natural waypoints. And because these rare earths were deposited by rainwater in sandstone, "mining" them can conceivably be accomplished with a pail and shovel, and is historically known to have happened by coincidence. Indeed, portions of the Mutianyu Great Wall, built in the 6th century A.D. using locally available materials, are said to actually contain dysprosium.

In the inner Mongolian region of northern China, the world's largest rare earth mine, is a giant open pit called Bayan Obo -- the source of easily one-half of the world's REE. It is ostensibly an iron ore mine. Rare earths are pulled up from the ground along the way, and their subsequent sale helps offset some of China's iron production costs. As Cato Institute's Eugene Gholz told us, there's essentially no costs involved in producing REE that were not already allocated for iron ore mining. "Mining costs are a trivial fraction of the cost of rare earths," he told us.

Meanwhile, in southern China where all the colossal pointing fingers are, "mining" -- if it can be called that -- takes place on an astoundingly small scale. As *The New York Times* first reported in *2010*, illegal dysprosium mines pop up regularly in folks' back yards. At least one-third of HREE mining in China, states Gholz, is illegal and unlicensed. What's more, according to a recent Yale University report, these small-scale mines are collectively creating large-scale environmental disasters. You see, rare earths can be separated from sandstone the way Walter Huston panned for gold in "Treasure of the Sierra Madre." But the wastewater from what are essentially garden hoses, flows downstream into local rivers, taking with it whatever REE miners don't need or want -- for instance, uranium.

"Those are the people," said Gholz, "who just go out, dig a hole in the ground, dump acid in the hole, wait for the acid to react with the soil and draw out the rare earths, which float to the top, then skim it off and leave pools of acid in the ground. . . Families go out, they do it over the course of a day or two at any given site. They dig a hole, they dump the acid, and they're gone before any enforcement people can show up."

Aerial photographs reveal the damage these secret groups leave behind. But by the time these photos get printed, the perpetrators have already left the scene.

"It's cheap," said Gholz, "if you're willing to put up with bad worker conditions, environmental devastation, buying from organized crime -- all of that other crap that goes with it."

For a variety of reasons -- some geopolitical, some cultural, and others unavoidably geological -- China has attained a natural advantage in rare earths production. For Australia, the US, or any other country, artificially jump-starting a competitive market in REE would require an investment in mining processes, skills, and equipment that would be more environmentally respectful. They would also, however, have to account for the fact that they would likely be drilling through limestone, not sandstone. The quantitative value of such investment, by rule, would be above zero. That there would be costs involved at all, will make any challenger a higher-cost producer.

That signal alone, as PIIE's Dr. Sherman Robinson told us some weeks back, puts any new player in a global market at an automatic disadvantage. A high-cost producer, he said, can't export. The jobs go away, and customers route their supply chains to bypass it. Sustaining a market that can't contain itself, like tobacco, would require government subsidies -- perhaps permanent ones.

"I think there's a risk," stated Eugene Gholz, "that government intervention in the market could make things worse. That does not mean it necessarily will." For example, he proffered, if the US

Government were to use some of that \$122 million the Energy Dept. was touting to subsidize the entry of new players into the REE market, that subsidy would certainly disadvantage other players. But with multiple countries struggling for relevance in a rapidly re-nationalizing world, where American leadership is best symbolized by a question mark, those other players may not necessarily include China.

So the question becomes, to what extent is China's lucky draw in the rare earths market, to coin a phrase, sustainable?

The chart at the front of this article seemed notable at the time for its spike, like one of the giant pillars of Zhangjiajie. Perhaps its most important feature now is how that peak collapsed. Once the Japan embargo was lifted, China began a process of stockpiling REE, building up an inventory so rich as to have fully weathered the demand shocks of the pandemic once cities and economies were reopened. There is no rare earths supply crisis today. The trick that politicians have tried to pull off has been to convince people the reason there's no crisis today is the same reason there could be one tomorrow. As David Abraham asserted, when the cost for something is next to nothing or even nothing, it isn't really a line item anymore.

At the same time, however, China's position may be untenable for China itself, and not too long from now. While its strategy puts it in the leadership position that Deng Xiaoping and Jiang Zemin dreamed of, at the moment, it's a kind of sandstone castle. REE only commands high trading values when there's a crisis China can control, like an inebriated, off-course fishing trawler triggering an international *tête-a-tête*. In a pandemic, on the other hand, the country's hand is forced: It has to keep prices low to maintain market stability in a global economic crisis, as well as to discourage more people from listening to Ted Cruz.

"I think history will tell you things have been relatively stable," remarked Abraham. "The fear is that, at some point, China could make a decision and say, 'We don't want to export.' That's the risk: that it's arbitrary and capricious on the outside. But that's been the risk the whole time."