

# The Gold Report

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## Beware of False Claims About Rare Earth Metals: Bob Wolf

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Bob Wolf, Alliance LLC vice president, doesn't believe everything he reads. Manufacturers claim they can swap out rare earth elements for cheaper, more accessible materials, while some miners insist they can fill every gap in the rare earth supply chain. In this exclusive interview with *The Critical Metals Report*, Wolf explains why rare earth elements are irreplaceable in many applications and outlines the patenting and permitting hurdles that producers must overcome to realize mine-to-magnet production.

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**The Critical Metals Report:** Bob, at the [Asian Metal Conference](#) in San Francisco, you spoke about rare earth elements (REE) used in magnets. Are magnets the most important application driving REE demand?

**Bob Wolf:** No. If you look at total supply of all REEs, magnets make up about 5% of the total usage by weight. If you mine 100,000 pounds (lbs) of REEs, 5% might be used in magnets. REE usage in magnets is a very small, but essential percentage of the total REE supply. For example, without lanthanum, there would be no flat-screen TVs. However, without the REEs in neodymium iron boron (NdFeB) magnets, your laptop would become the size of a small room, because REE magnets are required for small disk drives.

**TCMR:** Are REE magnets dramatically smaller and lighter than alternatives?

**BW:** Yes. The volume of an NdFeB magnet is about one-tenth the size of a ferrite magnet. Wind power generation is a large user of permanent magnets. The typical permanent magnet windmill generator uses approximately 600 lbs of REEs in magnets. The alternative is 2,500 lbs of ferrite magnets. Without REEs in that application, the engineering is a headache.

**TCMR:** Do REE magnets perform better than other magnet designs?

**BW:** Yes, REE magnets have better performance than any of the others. However, magnet design can be complicated. Some older designs, like alnico 5, have some properties that are equivalent to REE magnets. But they have drawbacks, such as sensitivity to vibration and demagnetization. Even with the drawbacks, they serve a very specific purpose in some applications involving extreme temperatures.

**TCMR:** It sounds like there's a lot of design that goes into choosing the appropriate magnet for an application.

**BW:** Oh yes. I'm starting to see more awareness of magnet choice by end users. People ask, "Can I change back from REE magnets to something else?" Sometimes the answer is no. One example is the very tiny micro-motors—I call them "roto rooters"—that are used in medical applications. These motors are used in medical devices inside arteries, where they clean out plaque. These devices wouldn't exist without neodymium magnets. With a ferrite magnet, the motor size increases by a factor of 10 and there is no way it's going to fit in an artery. That's an application where you can't possibly switch.

**TCMR:** If the magnet is that small, is cost no object?

**BW:** In many respects. People will look at the cost and compute the cost per pound (lb). It all depends on the material grade, size, shape, geometry and application. For example, those magnets may cost \$3,000/lb. But you could put 100,000 of them in a coffee cup. Some individual magnets are priced to three decimal places. On a cost/lb basis it's astronomical, but on a cost per unit basis it's nothing.

**TCMR:** There is a wide variation in price between rare earth elements. To what extent can less-expensive REEs substitute for more expensive REEs?

**BW:** Substitution is possible in some circumstances, but it depends on the application. Operating temperature is one of the more important factors. For example, a neodymium magnet is available in many grades based on dysprosium and cobalt content. The more expensive magnets perform better at higher temperatures. It is all about the application. An automotive sensor will usually not exceed a service temperature of 100 degrees Celsius. A hand tool will generally not exceed 60 degrees Celsius. The application determines the magnet materials and therefore the cost.

**TCMR:** Is there ongoing research that examines new REE magnet formulations?

**BW:** In the past, the Crucible Research Center in Pittsburgh, the GM Research Center in Detroit and Bell Laboratories in New Jersey were actively trying to find new materials. None of those organizations exist anymore. Very few universities conduct research on permanent magnets. Many Chinese companies have scientists looking into new materials. However, I haven't seen anything commercialized from that research.

**TCMR:** In the past, how have new magnet technologies entered the market?

**BW:** If a company developed a commercially viable new material, that company would surely want to protect it. In the past, the industry has licensed technology. When NdFeB magnets were invented in December 1983, Sumitomo, Crucible and General Motors all filed patents. Sumitomo holds the patent for making sintered magnets and licensed the technology to five firms in the United States, five in Europe and five in China. GM, which became Magnequench, has the patents for bonded magnets. Magnequench does not license its technology. If you want to make a bonded magnet, you have to buy material from Magnequench. However, now all the licensed companies in the U.S. are gone and I am only aware of one left in Europe, so China really owns the magnet fabrication industry.

That is just the manufacturers that take REEs or REE alloys and create magnets. There are a lot of processes between the mine and the manufacturer. You've got to separate the material into the metals. Then you've got to alloy the metals. Eventually, you get to the magnet manufacturer.

**TCMR:** You just mentioned the mine-to-magnets integration concept. [Molycorp Inc. \(MCP:NYSE\)](#) promotes that type of vertical integration, wherein the company can produce REEs at each step of the supply chain, from extraction, to oxides, metals, alloys and the magnets themselves. Have Chinese REE producers already accomplished this strategy?

**BW:** Not totally. The Chinese government owns many mines, but there are a large number of mines outside its control. There are also many companies in each of the refining, alloying and manufacturing businesses. It is not integrated into a single company.

**TCMR:** Where does your company fit in?

**BW:** Alliance LLC is similar to a distributor. Beyond that, we're also engineers. We have long-standing relationships in China with companies that are extremely reputable. We hold inventory in Valparaiso, Indiana, so a customer is not dependent on manufacturing and shipping across the world to get a part. We even hold some parts in inventory because we know customer ordering patterns and we'll hedge by a month or so just to make sure it's available.

**TCMR:** What's your view on China's REE export quotas?

**BW:** What's happened in China is common to all emerging economies. China's population wants new color TVs, cellphones, electric cars and windmills. China's government is using quotas to save resources for domestic use. Lately, it hasn't been raising the quotas, which only apply to REEs shipped as raw materials. The quotas don't necessarily apply to a finished product, like a magnet. China's government is trying to protect its economy. However, the quotas had a side effect of rising prices. As the prices rose, small manufacturers couldn't get credit and their customers suffered. Larger manufacturers were protecting their existing customers before taking new customers, which created some stability. Alliance foresaw the

upcoming crisis and used its resources to purchase adequate inventory for its customers. In doing this, some customers had no or modest price increases.

**TCMR:** Which REEs do you follow? Do you have any views on pricing for the light rare earth elements (LREEs) versus the heavy rare earth elements (HREEs)?

**BW:** I follow the REEs used in the magnet sector, which includes praseodymium, neodymium, samarium (LREES), gadolinium, terbium and dysprosium (HREEs). I also watch the aluminum and cobalt markets. I am watching not so much for absolute price, but overall market trends.

**TCMR:** What are some current trends in REE markets?

**BW:** Lately, the price is trending down. It may be stabilizing or perking up. I don't know yet whether that's going to be a continuing trend or whether it was just a one-week perk. If it continues for more than two weeks in a consistent direction, I will let my customers know. I could forewarn my customers and advise that they put in a blanket order.

**TCMR:** There's a lot of talk about potential production coming online from new North American sources of REEs. Are there companies that you keep your eye on?

**BW:** I read the news releases. However, there is usually more to the story. Consider what would happen if a vertically integrated rare earth producer was able to start producing NdFeB magnets tomorrow. That could be a problem, because they may not have a license from the patent holders. As far as I know Hitachi is not currently issuing any new licenses.

**TCMR:** Is Chinese patent infringement in the magnet space an issue?

**BW:** Making magnets and shipping within China is not a problem. However, if they're shipping to the United States or Japan, then the magnets must be made with licensed material, which includes a royalty to Neomax.

**TCMR:** Do you see that as a deal breaker for non-Chinese companies entering the magnet manufacturing business, or just an added cost?

**BW:** It will probably end up being an added cost. There are only five licensed sources for NdFeB magnets in China. Verification of the royalty payment to the patent holder can be tough if you purchase magnets from manufacturers outside the licensed sources. Even licensed Chinese producers are not permitted to export magnets to Japan.

**TCMR:** Have you seen any new or underappreciated uses for REE magnets?

**BW:** You never use magnets by themselves, but REE magnets are in the vibratory motor in your cellphone and in the hard drive of your laptop. There are over 100 applications for permanent magnets in your car. Airbag triggers, loudspeakers, anti-lock brake sensors, windshield wiper motors, power window motors—they all use magnets. I can go on and on and on with all the applications.

**TCMR:** What are your biggest customers right now?

**BW:** Motors and generators make up the largest sector, because they're so widely used. After that, the sensor market is probably the most significant. Hall effect sensors [sensors that adjust wattage in response to a magnetic field] are a growth area. But the sensors are a small component in any application.

**TCMR:** What about investing in the mining companies for the minerals that make the magnets?

**BW:** Keep in mind that REEs are quite plentiful. Permitting is more of an issue than finding and mining REEs. One of the biggest REE deposits in the United States is on the North Carolina coast. No mine will be built because of hotel development. But the REEs are there. Separating into oxides and metals is an intensive chemical process. Permitting these types of plants in the U.S. will be very difficult. Then you need to build an alloying plant. There are a lot of parts of the business.

I wish all the best to Molycorp, [Lynas Corp. \(LYC:ASX\)](#), [Great Western Minerals Group Ltd. \(GWG:TSX.V; GWMGF:OTCQX\)](#) and [Matamec Explorations Inc. \(MAT:TSX.V; MRHEF:OTCQX\)](#). The competition they bring to the resource market is good. I expect that if they all came online and all started producing REEs and magnets it would stabilize prices. However, I doubt if it would reduce prices for magnets. It will be very difficult to compete based on price with China in the REE industry.

**TCMR:** So, why didn't you start a magnet manufacturing company?

**BW:** I suppose I could have. However, it is more fun to sell magnets rather than make magnets. But the people who actually know how to make a magnet fall into three categories: retired, senile and dead. Only about six chief application engineers are still around. A lot of research was not written down. China was able to copy many of those technologies, but many have not been duplicated well and some have never been duplicated at all because they are lost. The last U.S.-based REE magnet manufacturing plant closed in 1999. In general, the trade secrets from those manufacturing processes have been lost. New plants, whether in the U.S. or in China, will have quite a learning curve.

**TCMR:** Thank you for taking the time to talk to us today.

*Bob Wolf has over 25 years of experience in the permanent magnet industry. He has served as product manager for rare earth magnets at Crucible Materials Corp., manager of North American marketing of permanent magnets for Philips Corp. and vice president of neodymium iron boron sales for Ugimac Corp. He was on the board of directors of the Magnetic Materials Producers Association. Currently, he is the vice*

*president of sales and marketing for Alliance LLC. He is also an instructor in mathematics at Purdue University North Central. Wolf is a graduate of Loyola University, where he earned a Bachelor of Science degree in physics. He earned a Master of Science in physics at DePaul University. Wolf has authored over a dozen articles.*

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