



Written Testimony

**Mark A. Smith
Chief Executive Officer, Molycorp Minerals, LLC**

**House Science and Technology Committee
Subcommittee on Investigations and Oversight**

“Rare Earth Minerals and 21st Century Industry”

March 16, 2010

Introduction

Chairman Miller, Ranking Member Broun, and Members of the Subcommittee, I want to thank you for the opportunity to share my observations, experiences, and insights on the subject of rare earths, the critical role they play in the technologies that will shape our future, the looming supply challenges that are ahead of us, and the work we are doing at our facility at Mountain Pass, California. This is the first Committee to hold a hearing specifically on this important topic, and I want to commend you for your leadership and forethought.

I'm the CEO of rare earths technology company Molycorp Minerals, LLC. Molycorp owns the rare earth mine and processing facility at Mountain Pass, California, one of the richest rare earth deposits in the world, and we are the only active producer of rare earths in the Western Hemisphere. I have worked with Molycorp and its former parent companies, Unocal and Chevron, for over 25 years, and have watched closely the evolution of this industry over the past decade. It has been remarkable to watch the applications for rare earths explode. However, as rare earth-based technologies have become more and more essential, the U.S., which invented rare earth processing and manufacturing technology, has become almost completely dependent on China for access to rare earths and, more specifically, the metals, alloys and magnets that derive from them.

On its face it may not seem any more disconcerting than any other material dependency. However, it is the combination of three key factors that make this situation one of urgent concern to policymakers: 1) the indispensability of rare earths in key clean energy and defense technologies; 2) the dominance of rare earth production by one country, China, and 3) China's accelerating consumption of their own rare earth resources, leaving the rest of the world without a viable alternative source.

The development of clean energy technology is a top national priority, as these innovations are key to our broader national objectives of greater energy security and independence, reduced carbon emissions, long term economic competitiveness, and robust job creation. Yet all of these crucial national objectives become less achievable if we lack access to rare earth resources.

Our company has produced rare earths for 57 years, and we are in the process of restarting active mining and down-stream processing at Mountain Pass. We are redeveloping our facilities to dramatically increase our production, and we are executing a strategy to rebuild the rare earth metal and magnet manufacturing capabilities that our country has lost in the past decade. This effort will help to address rare earth access concerns and may help to catalyze clean tech manufacturing, but the lingering question is how quickly we can make this happen, as the looming supply concerns seem to accelerate every day.

Below I offer my perspective on rare earths and their applications, America's rare earth capability gap, the global supply concerns and their implications, our work at Molycorp to expand our domestic rare earth access, and the role the federal government can play to help address the looming supply concerns.

Rare Earth Elements and Key Applications

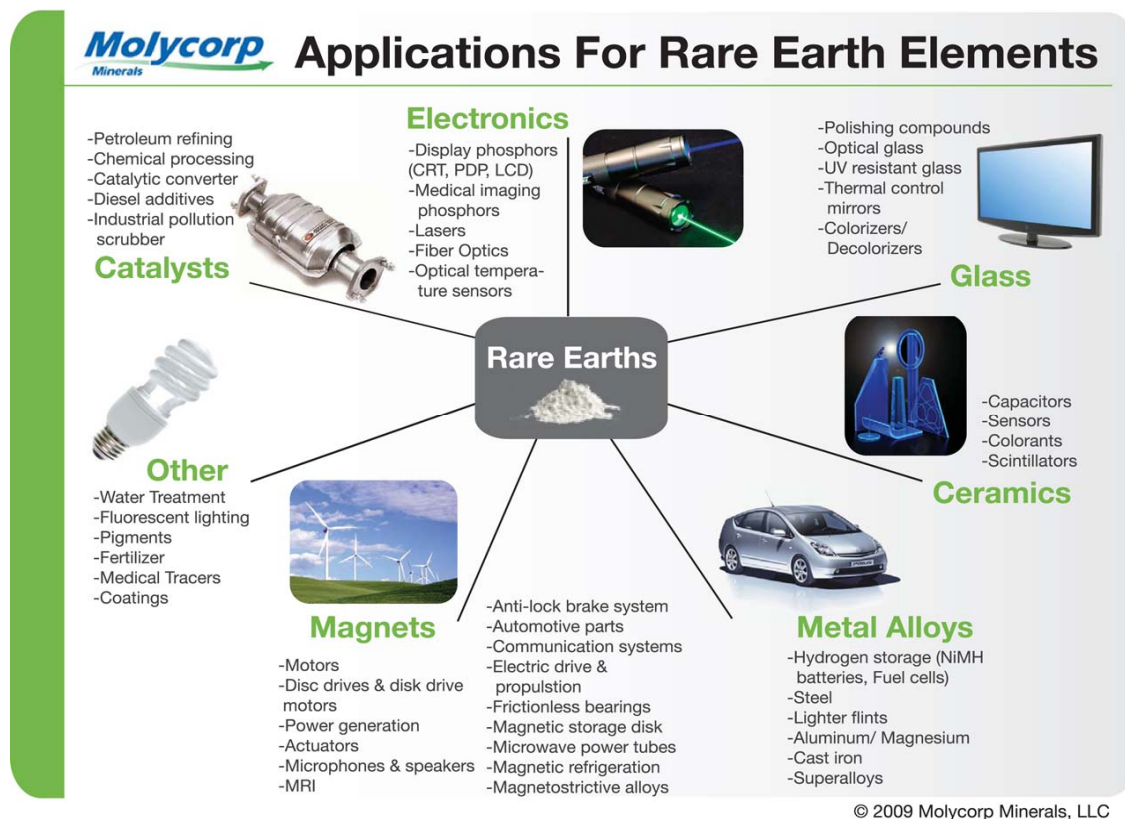
Rare earths are a group of 17 elements (atomic numbers 57-71 along with Sc and Y) whose unique properties make them indispensable in a wide variety of advanced technologies. One rare earth in particular – neodymium (Nd) – is used to create the very high powered but lightweight magnets that have enabled miniaturization of a long list of consumer electronics, such as hard disk drives and cell phones. While high-tech applications such as these have dominated the usage of rare earths over the past decade, it is their application in clean energy technologies and defense systems that has brought heightened attention to rare earths.

Rare earths are indispensable in a wide variety of clean energy technologies. Rare earth metals are used in the advanced nickel-metal hydride (NiMH) batteries that are found in most current model hybrids; powerful rare earth magnets enable next generation wind turbines, electric vehicle motors, and hybrid vehicle motors and generators; and rare earth phosphors are what illuminate compact fluorescent light bulbs. On the defense side, missile guidance systems, military electronics, communications and surveillance equipment all require rare earths. None of these technologies will work without rare earths, and yet each of these technologies is tied closely to some of the nation's highest national priorities, our energy and national security.

The list of rare earth applications is long and varied, but there are additional applications that are worth noting specifically. The automotive sector is a big user of rare earths. Cerium is used to polish glass and provides protection from UV rays. In the 1970s, rare earths replaced palladium for use in catalytic converters, and if palladium were still used today, cars would be significantly more expensive. They are also used in petroleum refining and as diesel additives.

At Molycorp, we have also found a use for cerium in water filtration. We have developed proprietary water filtration technology that has applications in industrial wastewater treatment, clean water production in the developing world, and the recreation and backpacking market.

The diagram below offers a broader view of rare earths' applications:



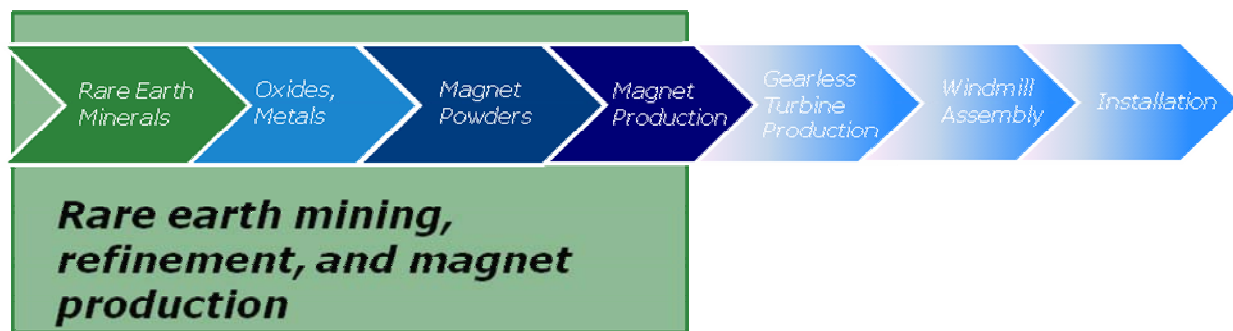
Despite their name, rare earths are not rare. If you were to go outside right now and grab a handful of dirt from the ground, it would contain rare earths. However, it is far more difficult to find rare earths in a concentration high enough to be mined and separated economically. When rare earths are extracted from the ground, the ore contains all of the rare earths, and it is through highly complex separation processes that each individual rare earth oxide can be produced. It is this separation process that largely drives the cost of rare earth production. Ore bodies that contain rare earths at percentages in the low single digits cannot be mined economically under current prices for rare earths.

Thus, today, there are only 3 known and verified locations where a sufficiently high concentration of rare earths exists: Baotou, China; Mountain Pass, California, where Molycorp's mine is located; and Mt. Weld, Australia, which has a rich ore deposit but none of the infrastructure necessary to begin extraction, separation, and distribution to market. Given these circumstances, Molycorp's mine at Mountain Pass is clearly one of the only rare earth resources in the world that is immediately minable, economically viable, and can provide a near-term source of rare earth materials. With supply concerns becoming increasingly imminent, the

greatest challenge facing Molycorp is the speed at which we can bring these needed resources online. I will discuss this in further detail later in this testimony.

Industrial Supply Chain and America's Capability Gap

One of the biggest challenges in raising awareness and understanding about rare earths is that they are found so early in the industrial supply chain that it is difficult to contemplate their usage in products that we see every day. To illustrate this point, consider the example of the new generation of wind turbines, which employ rare earth-based permanent magnet generators with reliability and efficiency improvements of 70% over the current industry standard. Below is a simplified supply chain:



Once the rare earths are mined, they are separated and converted to oxides and then converted into metals. The metals are then manufactured into alloys and magnet powders. The powders are then bonded or sintered to form the magnets required for turbine production. The turbine, in turn, is included in the windmill assembly, and the final product is installed. All of the functions within the green box are necessary to be able to produce the magnets required for this clean energy technology and so many others. However, other than the rare earth mineral extraction and conversion to oxides, the other manufacturing capabilities in the green box no longer exist in the United States. The U.S. did at one time possess all of these capabilities, and in fact, these technologies largely originated here. However, over the past decade as American manufacturing has steadily eroded, the U.S. has ceded this technological ground to competitors in China, Japan and Germany.

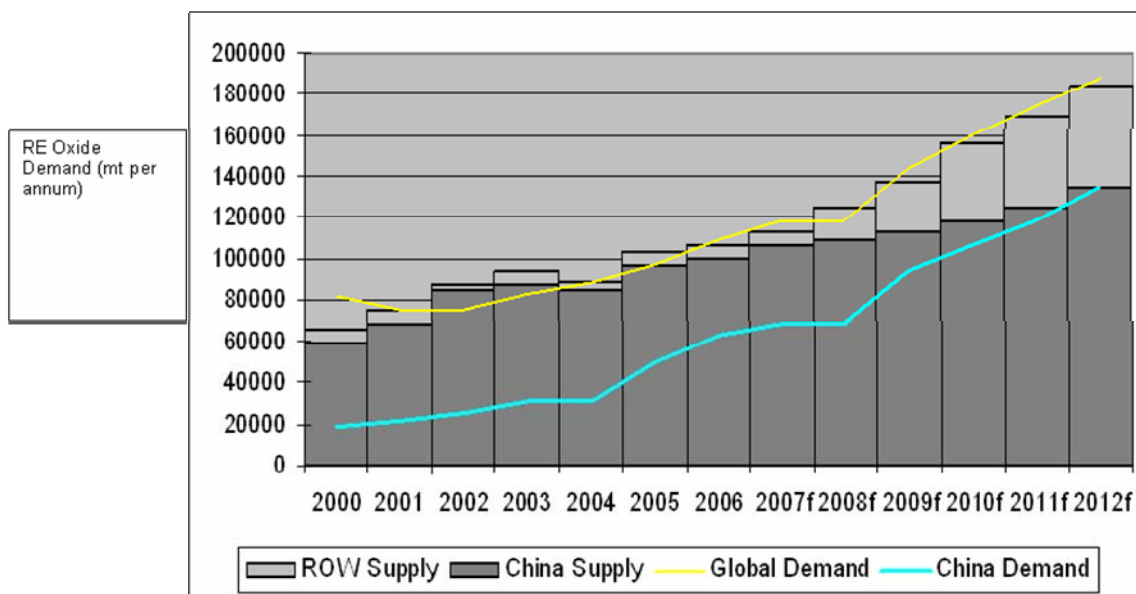
China has become particularly dominant, and some would contend that it has been by design. In the early 1990s, China's Deng Xiaoping was quoted as saying, "There is oil in the Middle East; there is rare earth in China."¹ China realized that it had a significant natural resource advantage, and through the development of new applications in an ever-expanding number of advanced technologies, China helped to grow the market for rare earths from 40,000 tons in the early 1990's to roughly 125,000 tons in 2008. It is over that same period that, due to a variety of factors, the U.S. ceased active mining of rare earths.

¹ Cox, Clint. (2006, October 10). *Rare earth may be China's checkmate*. Retrieved from the Anchor House web site on February 5, 2010 at <http://www.theanchorsite.com/2006/10/>.

While the U.S. still possesses the technical expertise, we have lost the necessary infrastructure to manufacture the rare earth metals and magnets that fuel next generation technologies. The last rare earth magnet manufacturer in the U.S. was a company called Magnaquench, formerly located in Valparaiso, Indiana, and owned by General Motors. Magnaquench and all of its U.S. assets were sold to a Chinese company in the early 2000s in an effort to help GM gain access to the Chinese market.² Two domestic companies can produce small quantities of rare earth based alloys but none can convert the rare earth oxides to metal. The result is a significant rare earth “capability gap” in the U.S. that has the potential to quickly become a major strategic and economic disadvantage.

Global Supply Concerns and Implications for the U.S.

Today, the production of rare earths, and the metals and magnets that derive from them, is overwhelmingly dominated by China. At present, China produces 97% of the world’s rare earth supply, almost 100% of the associated metal production, and 80% of the rare earth magnets. Complicating this picture even further, China’s national consumption of rare earth resources is growing at an intense pace, consistent with their meteoric GDP growth, and it is leaving the rest of the world with less of these critical materials just as the clean energy economy is beginning to gain momentum. As the chart below from rare earths research firm, the Industrial Minerals Company of Australia (IMCOA) demonstrates, China’s massive production has been able to satisfy both their own internal needs and those of the rest of the world. However, as the blue line indicates Chinese demand for its own rare earths will soon match, if not eclipse, its own internal supply, and with global demand (in yellow) growing at a parallel pace, there is a significant production gap – around 60,000 tons – that must be filled in a very short timeframe.



Source: Industrial Minerals Company of Australia, 2008

² Moberg, David. (2004, January 23). *Magnet Consolidation Threatens Both U.S. Jobs and Security*. Retrieved from the In These Times web site on February 5, 2010 at <http://www.inthesetimes.com/article/685/>.

IMCOA's previous forecasts concluded that this critical shortage for the rest of the world outside of China would occur by 2012, but China has recently said that it intends to be the world's largest producer of wind energy and electric vehicles and has committed \$150 billion and \$29 billion to these two respective clean technology sectors (by comparison, the entire amount of stimulus funding under the American Recovery and Reinvestment Act directed at all areas of clean energy deployment was \$60 billion). The new, more efficient wind turbines that use rare earth permanent magnet generators require around 2 tons of rare earth magnets per windmill. The rare earth industry has never seen this level of demand. To date, rare earth producers like Molycorp have filled orders by the pound or kilogram, not by the ton. If China's commitment holds true, this will vastly accelerate their consumption of rare earths and speed up the date when the rest of the world will find its access to rare earths severely limited.

Around the same time that China was outlining its clean energy investments, it also began to consider steps to reduce the availability of its rare earths to the rest of the world. As if the demand forecasts weren't disconcerting enough, China heightened international supply concerns last fall when its Interior Ministry signaled that it would further restrict its exports of rare earth resources. China has been steadily decreasing its exports by an average of 6% per year since 2002, but these new restrictions portend a more aggressive effort to use its own resources domestically. This critical issue was featured on the front page of the New York Time's business section on August 31, 2009, and I've included the article for the Committee's record.

Finally, in late December, China announced that it will begin to stockpile rare earths. It is our estimation that if they are announcing it officially to the rest of the world, it is highly likely that the stockpiling has been occurring for some time. Regardless, it will have a further depressive effect on global supply.

Energy Security and Global Competitiveness

Disruption in the global supply of rare earths poses a significant concern for America's energy security and clean energy objectives, its future defense needs, and its long-term global competitiveness. Rare earths may not be familiar to most people, hidden deep in the industrial supply chain, but they are absolutely indispensable for so many of the advanced technologies that will allow us to achieve critical national objectives.

Efforts to decrease U.S. dependence on foreign oil and develop a clean energy economy, as well as the jobs that come with it, have received broad bipartisan support, and few would disagree that the U.S. must diversify its sources of energy and slow the demand for fossil fuels. Wind power and electric vehicles (EVs) have emerged as technologies that will play important roles in these efforts, and the U.S. has indicated it intends to be a leader in both. As noted above, the most efficient wind turbines require multiple tons of rare earths, and as the U.S. moves to increase the percentage of power that comes from wind, there will be a commensurate increase in domestic demand for rare earths. The American automotive industry is expanding the number of hybrid, plug-in hybrid (PHEV), and full electric vehicle (EV) models in an effort to produce far more fuel efficient products, and yet many of the advanced batteries that power hybrids and PHEVs utilize several kilograms of rare earth metals in each unit. The motors and generators in

these new vehicles also use several kilograms of rare earth permanent magnets. Similar implications exist for our national defense capabilities. From military communications equipment to missile guidance systems, rare earths enable a long list of advanced defense technologies. We have had extensive discussions with the Department of Defense (DoD), and they are paying far greater attention to this concern. In fact, the FY2011 DoD Authorization signed into law last October included a provision requiring the Department to submit a report to Congress no later than April 1, 2010, assessing the usage of rare earth materials in DoD's supply chain, looking at projected availability for use by DoD, the extent to which the DoD is dependent on rare earth materials, steps that the Department is taking to address any risks to national security, and recommendations for further action.

Access to rare earths is obviously essential, but without rebuilding the manufacturing capacity to produce rare earth metals and magnets, the U.S. could find itself dependent on China for key technological building blocks. But even this scenario presumes that the U.S. has the manufacturing capabilities to put Chinese rare earth materials to use in final products. Right now, given the current state of U.S. manufacturing, it is unfortunately more likely that we would become a raw material supplier to Chinese manufacturers.

Viewed through this lens, the domestic development of rare earth resources and manufacturing capabilities is not only a strategic necessity but also a potential catalyst for job growth in the clean energy and advanced technology manufacturing sectors. If these resources and capabilities were built up domestically, it could have a multiplier effect on downstream, value added manufacturing. Consider China's experience. It has to create 10-15 million jobs a year just to accommodate new entrants into its job market, and it has viewed the rare earths industry as a "magnet" for jobs. China repeatedly attracted high-tech manufacturers to move to its shores in exchange for access to rare earths among other enticements. The U.S. could experience a similar jobs boost by making a concerted effort to rebuild the clean energy supply chain, beginning with rare earths, within its borders.

Molycorp Minerals' Mining to Magnets Strategy

Molycorp Minerals has been in the rare earths business for 57 years, and while the company and its facilities have changed ownership over the years, it has remained one of the world's only viable sources of rare earth minerals. On October 1, 2008, a group of U.S. based investors, including myself, formed Molycorp Minerals, LLC, and we acquired from Chevron its rare earth assets at Mountain Pass, which the U.S. Geological Survey has deemed "the greatest concentration of rare earth minerals now known." From the outset, we have sought to combine this world-class rare earth deposit with a "mining to magnets" strategy. Our redevelopment of Mountain Pass is the starting point of a broader effort to reestablish domestic manufacturing of the rare earth metals, alloys and magnets that enable and are indispensable to the clean energy economy and advanced technology manufacturing.

Our work at Mountain Pass provides a timely, well-planned, and economically viable means to address the rare earth access challenges on the shortest timeline possible. While Molycorp has been processing existing rare earth stockpiles since 2007, it has invested \$20 million to begin the restart of active mining. Our team matches this remarkable natural resource

with 57 years of rare earth mining, milling, and processing experience. We have obtained the necessary 30-year mine plan permit, and the Environmental Impact Report for the mining-to-oxides portion of the redevelopment has been reviewed and approved by all applicable federal, state, and local agencies. Molycorp's footprint will be limited to its privately-held land, using state-of-the-art technologies for water treatment and mineral recovery. Through new advances in our production processes, Molycorp will produce 20,000 tons, or 40,000,000 pounds, of rare earth oxides per year, and our increased production and capabilities can potentially create 900 new jobs for the hard hit San Bernardino-Riverside and Henderson-Las Vegas regions of California and Nevada. Molycorp is the only domestic rare earth provider that stands "shovel-ready" to create jobs and commence the mining-to-magnets work required to meet multiple customer-specific product demands.

Access to the raw, rare earth minerals is obviously essential, but as noted earlier, it resolves only part of the challenge. As part of our mining to magnets development, we will build out the metals, alloying and magnet powder manufacturing capabilities. We would also establish the production of rare earth permanent magnets, all here in the United States. Our company is uniquely well-positioned to rebuild these early steps in the clean energy supply chain and fully extend the value and capabilities of the rare earth resources at Mountain Pass.

Environmental Stewardship as a Source of Cost-Competitiveness

Many industry observers question how a U.S. producer of rare earths can ever compete with the Chinese, when the possibility always lingers that the Chinese could flood the market and dramatically depress rare earth prices, a practice they have demonstrated previously. We have spent the better part of the past 8 years developing the answer to this question. We changed the orientation of our thinking and discovered that by focusing principally on energy and resource efficiency, we could make major improvements in our cost competitiveness while at the same time advance our environmental stewardship.

We will incorporate a wide variety of manufacturing processes that are new to the rare earth industry, which will increase resource efficiency, improve environmental performance, and reduce carbon emissions. Specifically:

- Our overall processing improvements will almost cut in half the amount of raw ore needed to produce the same amount of rare earth oxides that we have produced historically. This effectively doubles the life of the ore body and further minimizes the mine's footprint;
- Our extraction improvements will increase the processing facility's rare earth recovery rates to 95% (up from 60-65%) and decrease the amount of reagents needed by over 30%;
- Our reagent recycling, through proprietary technology that Molycorp has developed, could lead to even greater decreases in reagent use;
- Our new water recycling and treatment processes reduce the mine's fresh water usage from 850 gallons per minute (gpm) to 30 gpm — a 96% reduction;
- Finally, the construction of a Combined Heat and Power (CHP) plant — fueled by natural gas — will eliminate usage of fuel oil and propane. This will significantly reduce the

facility's carbon emissions, reduce electricity costs by 50%, and improve electricity reliability.

These process improvements fundamentally reverse the conventional wisdom that superior environmental stewardship increases production costs. At the same time, we significantly distinguish ourselves from the Chinese rare earth industry that has been plagued by a history of significant environmental degradation, one that it is just beginning to recognize and rectify.

Need for Federal Leadership

Over the past year, I have spent a significant amount of time in Washington meeting with Members of Congress and their staffs as well as officials in a variety of federal agencies to direct greater attention to this issue. I'm pleased to report, just over one year since we began our efforts, that the federal government is beginning to take meaningful steps toward understanding and addressing our rare earth vulnerabilities. The question remains, however, if it will be able to make its assessments, determine the required actions, and execute them within a timeline that seems to be accelerating daily.

In each of these meetings, and as this Committee has also inquired, I am asked what role the federal government should play in tackling this pressing concern, and I believe that there are 4 areas where it can have the greatest near- and long-term impact: 1) federally based financing and/or loan guarantee support for highly capital intensive projects like ours; 2) assistance rebuilding America's rare earth knowledge infrastructure (university-based rare earth research, development of academic curricula and fields of study, training and exposure to the chemical and physical science related to rare earths, etc.); 3) increased interagency collaboration at the highest levels on the impact of rare earth accessibility on major national objectives; and 4) funding competitive grants for public and private sector rare earth research. I'll explore each in greater depth below:

- **Financing support:** Given the size, scale, ambition, and necessity of Molycorp's redevelopment efforts, we submitted an application for the Department of Energy's Loan Guarantee Program (LGP). We believed that the program was well-suited for our project, particularly given that the project's substantial implications closely match the program's paramount objectives. Traditional bank financing in the current climate – with very short repayment periods and interest rates near double digits – is not economically feasible. The LGP offers longer term financing and lower interest rates and would allow Molycorp to accelerate development in the near-term while ensuring rare earth resource availability in the long term. However, the DOE summarily rejected our application in December, saying that the project did not qualify as a “New or Significantly Improved Technology.” We reviewed the relevant portion of the Rule, Section 609.2, and our project meets every one of the stated criteria. We requested further discussion with the DOE to understand how it came to its conclusion and how Molycorp might proceed. After almost two months, the DOE finally responded to our request. During the meeting, the DOE contended that this project goes “too far upstream” and that the program was not intended to cover mining projects. We have yet to find the legislative or regulatory language that provides such a limitation. However, it appears we may need to ask

Congress for legislative direction or possibly new legislative language specifically authorizing the use of loan guarantees for strategically important projects like this. Our frustrations with the loan guarantee notwithstanding, I still believe that this kind of financing support is exactly what a project like ours needs. We will be in a very strong position to both raise our portion of the capital to execute the project and repay the loan well-within the required timeline. We will continue to pursue this financing support despite the DOE's current position.

- **Rebuilding the rare earth knowledge infrastructure:** The United States used to be the world's preeminent source of rare earth information and expertise, but it has ceded that advantage over the past decade, as its position in the industry has become subordinate to China and other countries in East Asia. The federal government, and the House Science and Technology Committee in particular, can play a pivotal role in reestablishing that institutional knowledge and expertise and sharing it with a wider audience of researchers, scholars, and practitioners here in the U.S. and abroad. At Molycorp, we are fortunate to have a team of 17 rare earth researchers and technologists who are second to none in the world, but almost all of them had no previous expertise in rare earths prior to joining Molycorp. It will be difficult for the U.S. to reestablish its preeminence without a concerted effort to attract the brightest scientists and researchers to the field of rare earths. Rebuilding the knowledge infrastructure and the research support will go a long way toward that goal. Dr. Gerschneidner, who I'm honored to testify with today, is regarded as the father of rare earths, and his work at Ames Laboratory and Iowa State University as well as the great work being done by Dr. Eggert and his colleagues at the Colorado School of Mines can serve as the foundation on which to expand America's rare earth expertise. As a reminder of the rest of the world's interests and actions in this regard, the Korea Times recently reported that Korea is developing rare earth metals for industrial use at a government-funded research center.
- **Interagency Cooperation:** Over the past several months, we have been very pleased to learn about efforts within many federal agencies to direct specific attention to rare earth issues. We have been in direct contact with the Departments of Defense, Commerce, and State, and each is examining this issue within the unique context of their agencies' work. It is also worth noting that the Commerce Department convened a group of stakeholders from both the government and the private sector in December, 2009, which included representatives from DoD, GAO, USTR, and OSTP. We have also had multiple discussions with the Office of Science and Technology Policy directly and have been very appreciative of their engagement on this issue. In fact, OSTP, along with Commerce, is facilitating interagency collaboration going forward. While we are encouraged by these recent efforts, it is our hope that the agencies and the White House recognize that the global supply-demand challenges are approaching at an increasingly rapid pace and that their efforts should reflect the requisite urgency.
- **Funding support for rare earth research:** Part of China's success in growing and dominating the market for rare earths can be attributed to their efforts to find and commercialize new applications for rare earth materials. Federal funding support for competitive grants specifically directed at rare earth research will help to expand the

U.S.'s ability to do the same. This has the potential to broaden the economic impact of rare earths, and contribute to the goal mentioned above of reestablishing America's superior expertise in rare earth research.

Conclusion

The global rare earth supply concerns facing the U.S. and all other countries outside China are obviously disconcerting, but they are not insurmountable. A combination of geologic good fortune and an accelerated effort to ramp up domestic production and rebuild lost manufacturing capabilities could provide a solution for the U.S. and ensure that our leading national objectives are not jeopardized. At Molycorp, our "mining to magnets" strategy is far more than an approach to a new business, it is a cause with far reaching implications. If executed effectively, it could prove to be catalytic for our development of a clean energy economy and the resurgence of domestic manufacturing. This project will have meaningful and significant impact on leading national priorities, and as such, we stand ready to work with Congress and the Administration to find ways to accelerate our work at Mountain Pass and bring these needed capabilities online as soon as possible.

Thank you once again for the opportunity to share my perspective on rare earths, and I look forward to working with the Committee in the weeks and months to come as it continues to examine this important topic and determine potential actions.

Business

China Tightens Grip on Rare Minerals

By KEITH BRADSHER

HONG KONG - China is set to tighten its hammerlock on the market for some of the world's most obscure but valuable minerals.

China currently accounts for 93 percent of production of so-called rare earth elements - and more than 99 percent of the output for two of these elements, dysprosium and terbium, vital for a wide range of green energy technologies and military applications like missiles.



Juergen Bauer/www.smart-elements.com

China is cutting exports of elements like terbium, pressuring manufacturers to open factories there.

Deng Xiaoping once observed that the Mideast had oil, but China had rare earth elements. As the Organization of the Petroleum Exporting Countries has done with oil, China is now starting to flex its muscle.

Even tighter limits on production and exports, part of a plan from the Ministry of Industry and Information Technology, would ensure China has the supply for its own technological and economic needs, and force more manufacturers to make

their wares here in order to have access to the minerals.

In each of the last three years, China has reduced the amount of rare earths that can be exported. This year's export quotas are on track to be the smallest yet. But what is really starting to alarm Western governments and multinationals alike is the possibility that exports will be further restricted.

Chinese officials will almost certainly be pressed to address the issue at a conference Thursday in Beijing. What they say could influence whether Australian regulators next week approve a deal by a Chinese company to acquire a majority stake in Australia's main rare-earth mine.

The detention of executives from the British-Australian mining giant Rio Tinto has already increased tensions.

They sell for up to \$300 a kilogram, or up to about \$150 a pound for material like terbium, which is in particularly short supply. Dysprosium is \$110 a kilo, or about \$50 a pound. Less scarce rare earth like neodymium sells for only a fraction of that.

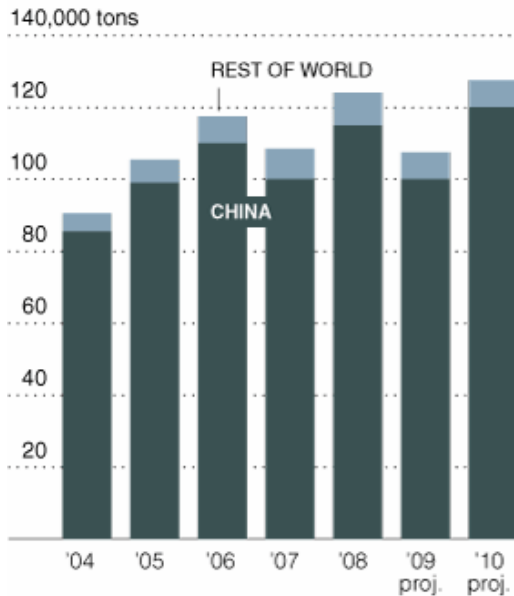
(They are considerably less expensive than precious metals because despite the names, they are found in much higher quantities and much greater concentrations than precious metal.)

China's Ministry of Industry and Information Technology has drafted a six-year plan for rare earth production and submitted it to the State Council, the equivalent of the cabinet, according to four mining industry officials who have discussed the plan with Chinese officials. A few, often contradictory, details of the plan have leaked out, but it appears to suggest tighter restrictions on exports, and strict curbs on environmentally damaging mines.

Rare Wealth

China accounts for the vast majority of the world's production of rare earths — 17 elements — which are used in a wide array of products.

RARE EARTH MINERAL PRODUCTION



Source: Dudley J. Kingsnorth (production)

RARE EARTHS	ATOMIC NO.	COMMERICAL USE
Scandium	21	Stadium lights
Yttrium	39	Lasers
Lanthanum	57	Electric car batteries
Cerium	58	Lens polishes
Praseodymium	59	Searchlights, aircraft parts
Neodymium	60	High-strength magnets
Promethium	61	Portable X-ray units
Samarium	62	Glass
Europium	63	Compact fluorescent bulbs
Gadolinium	64	Neutron radiography
Terbium	65	High-strength magnets
Dysprosium	66	High-strength magnets
Holmium	67	Glass tint
Erbium	68	Metal alloys
Thulium	69	Lasers
Ytterbium	70	Stainless steel
Lutetium	71	None

THE NEW YORK TIMES

Beijing officials are forcing global manufacturers to move factories to China by limiting the availability of rare earths outside China. "Rare earth usage in China will be increasingly greater than exports," said Zhang Peichen, the deputy director of the government-linked Baotou Rare Earth Research Institute.

Some of the minerals crucial to green technologies are extracted in China using methods that inflict serious damage on the local environment. China dominates global rare earth production partly because of its willingness until now to tolerate highly polluting, low-cost mining.

The ministry did not respond to repeated requests for comment in the last eight days. Jia Yinsong, a director general at the ministry, is to speak about China's intentions Thursday at the Minor Metals and Rare Earths 2009 conference in Beijing.

Until spring, it seemed that China's stranglehold on production of rare earths might weaken in the next three years - two Australian mines are opening with combined production equal to a quarter of global output.

But both companies developing mines - Lynas Corporation and smaller rival, Arafura Resources - lost their financing last winter because of the global financial crisis. Buyers deserted Lynas's planned bond issue and Arafura's initial public offering.

Mining companies wholly owned by the Chinese government swooped in last spring with the cash needed to finish the construction of both companies' mines and ore processing factories. The Chinese companies reached agreements to buy 51.7 percent of Lynas and 25 percent of Arafura.

The Arafura deal has already been approved by Australian regulators and is subject to final approval by shareholders on Sept. 17. The regulators have postponed twice a decision on Lynas, and now face a deadline of next Monday to act.

Matthew James, an executive vice president of Lynas, said that the company's would-be acquirer had agreed not to direct the day-to-day operations of the company, but would have four seats on an eight-member board.

Expectations of tightening Chinese restrictions have produced a surge in the last two weeks in the share prices of the few non-Chinese producers that are publicly traded. In addition

to the two Australian mines, Avalon Rare Metals of Toronto is trying to open a mine in northwest Canada, and Molycorp Minerals is trying to reopen a mine in Mountain Pass, Calif.

Unocal used to own the Mountain Pass mine, which suspended mining in 2002 because of weak demand and a delay in an environmental review. State-owned CNOOC of China almost acquired the mine in 2005 with its unsuccessful bid for Unocal, which was bought instead by Chevron; Chinese buyers tried to persuade Chevron to sell the mine to them in 2007, but Chevron sold it to Molycorp Minerals, a private American group.

A single mine in Baotou, in China's Inner Mongolia, produces half of the world's rare earths. Much of the rest - particularly some of the rarest elements most needed for products from wind turbines to Prius cars - comes from small, often unlicensed mines in southern China.

China produces over 99 percent of dysprosium and terbium and 95 percent of neodymium. These are vital to many green energy technologies, including high-strength, lightweight magnets used in wind turbines, as well as military applications.

To get at the materials, powerful acid is pumped down bore holes. There it dissolves some of the rare earths, and the slurry is then pumped into leaky artificial ponds with earthen dams, according to mining specialists.

The Ministry of Industry and Information Technology has cut the country's target output from rare earth mines by 8.1 percent this year and is forcing mergers of mining companies in a bid to improve technical standards, according to the government-controlled China Mining Association, a government-led trade group.

General Motors and the United States Air Force played leading roles in the development of rare-earth magnets. The magnets are still used in the electric motors that control the guidance vanes on the sides of missiles, said Jack Lifton, a chemist who helped develop some of the early magnets.



Yuriko Nakao/Reuters

Toyota's Prius hybrids use several pounds of neodymium, a rare earth, in their electric motors.

But demand is surging now because of wind turbines and hybrid vehicles.

The electric motor in a Prius requires 2 to 4 pounds of neodymium, said Dudley Kingsnorth, a consultant in Perth, Australia, whose compilations of rare earth mining and trade are the industry's benchmark.

Mr. Lifton said that Toyota officials had expressed strong worry to him on Sunday about the availability of rare earths.

Toyota and General Motors, which plans to introduce the Chevrolet Volt next year with an electric motor that uses rare earths, both declined on Monday to comment.

Rick A. Lowden, a senior materials analyst at the Defense Department, told a Congressional subcommittee in July that his office was reviewing a growing number of questions about the availability of rare earths.

China is increasingly manufacturing high-performance electric motors, not just the magnets.

"The people who are making these products outside China are at a huge disadvantage, and that is why more and more of that manufacturing is moving to China," Mr. Kingsnorth said.

Correction: September 4, 2009

An article on Tuesday about China's tightening control over the production of rare earth minerals misidentified the country in which Avalon Rare Metals, a non-Chinese producer, was trying to open a new mine. It is Canada, in the northwest area, not Australia.