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STRATEGIC AND CRITICAL MINERALS POLICY: DOMESTIC MINERALS SUPPLIES AND DEMANDS IN A TIME OF FOREIGN SUPPLY DISRUPTIONS

OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND MINERAL RESOURCES

OF THE

COMMITTEE ON NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES

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OVERSIGHT HEARING ON THE "STRATEGIC AND CRITICAL MINERALS POLICY: DOMESTIC MINERALS SUPPLIES AND DEMANDS IN A TIME OF FOREIGN SUPPLY DISRUPTIONS."

Tuesday, May 24, 2011
U.S. House of Representatives
Subcommittee on Energy and Mineral Resources
Committee on Natural Resources
Washington, D.C.

The Subcommittee met, pursuant to call, at 9:07 a.m. in Room 1324, Longworth House Office Building, Hon. Doug Lamborn, [Chairman of the Subcommittee] presiding.

Present: Representatives Lamborn, Coffman, Benishek, Rivera, Duncan of South Carolina, Gosar, Flores, Johnson, Holt, and Markey [ex-officio].

Also Present: Representative Labrador.

Mr. LAMBORN. The Chairman notes the presence of a quorum, which under Rule 3[e] is two Members. The Subcommittee on Energy and Mineral Resources is meeting today to hear testimony on an oversight hearing on Strategic and Critical Minerals Policy: Domestic Minerals Supplies and Demands in a Time of Foreign Supply Disruptions.

So, please have a seat, and I will be introducing you all shortly, and at the appropriate time explaining how the testimony process works for those of you who may not have done this before. But it will be a few minutes before we get there and so I wanted to make sure that you are comfortable.

Under Rule 4[f], opening statements are limited to the Chairman and Ranking Member of the Subcommittee. However, I ask for unanimous consent to include any other Members opening statements in the hearing record if submitted to the Clerk by close of business today. Hearing no objection, so ordered.

Mr. LAMBORN. I also ask for unanimous consent that the Gentleman from Idaho, Mr. Raúl Labrador, a Member of the Full Natural Resources Committee, be allowed to join us on the dais, and participate in the hearing when he arrives. Without objection, so ordered. Now I will recognize myself for five minutes, and then the Ranking Member.

STATEMENT OF HON. DOUG LAMBORN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF COLORADO

Mr. LAMBORN. We are here today to discuss the Nation's Strategic and Critical Minerals Policy and opportunities for improvement so the United States can better meet domestic needs, create jobs, and strengthen our economy and national security by decreasing our foreign dependence on mineral materials.

Today, we will gain valuable insight from the mining industry, users of mineral commodities, an American Resources advocate, and the Chairman of two National Research Council Reports published in 2008, and a 2011 report, issued by the American Physical Society and the Materials Research Society.

Rare-earth elements are important components for renewable energy technologies, telecommunications, medical devices, and maybe most importantly, military technology. They are used to make very small and powerful magnets.

In fact, if you will allow me to demonstrate. I have two such magnets in my hands here today, neodymium, and these are very powerful and are difficult to pull apart, and you should be careful when you do so because you can squeeze your finger when they let loose.

So, this is an example of a very small, but powerful, magnet that is not found in normal magnetic minerals that we just use in everyday use. Magnets like these can be used in the military drones that have played an important part in the war on terrorism.

The industrialization of China and India is driving demand for non-fuel mineral commodities, sparking a period of resource nationalism.

Steps taken by China to restrict exports of mineral commodities needed for the industrialization of their country highlights the need for the United States to assess the state of our Nation's mineral policies, and the opportunities to produce these and other strategic and critical minerals domestically.

According to the National Resource Council, one of the primary advantages the United States possesses over our strongest industrial competitors is our domestic resource base. In other words, we have a lot of mineral resources that could be developed.

The United States is among the world's largest producer of many important metals and minerals, particularly copper, gold, lead, molybdenum, silver, and zinc, and we still have substantial domestic reserves for these metals and rare earth elements.

Yet, domestic mineral exploration stagnated or declined during most of the 1990s and 2000s, even though global mineral exploration trends were strongly positive. In 1993, we attracted 20 percent of the worldwide minerals exploration budget. Today, we attract about 8 percent.

Without increased domestic exploration, significant declines in United States mineral production are unavoidable as present reserves are exhausted. We will continue to ship American jobs overseas and forfeit our economic competitiveness unless we take steps to develop our own mineral resources.

The lack of exploration expenditures and other factors have led to an increased dependence on foreign imports. For example, 25 years ago, the United States was dependent on foreign sources for 30 non-fuel mineral materials, 6 of which were entirely imported to meet the Nation's requirements, and another 16 of which were imported to meet more than 60 percent of the Nation's needs.

By last year our import dependence for non-fuel minerals more than doubled from 30 to 67 commodities. Eighteen of those commodities were imported entirely to meet the Nation's requirements,

and another 25 of those were imported to the tune of 50 percent or more.

You can see on the screen to your right and left a breakdown of some of these key 67 commodities, and how much is imported. While much of the focus has been on rare earth elements because of China's restrictions on exports, they currently produce about 96 percent of the world's rare earth elements.

These metals are not the only ones that should be of concern to us. For example, at a 2006 Subcommittee hearing on the energy and mineral requirements for renewable and alternative fuels used for transportation and other purposes, Robyn Storer stated that by 2016 less than half of the world demand for copper mine supply can be met from production from existing mines, and that the world needs the equivalent of 30 new major mines by 2016 to meet the projected demand growth.

The worldwide economic downturn in 2008 and 2009, and the slow recovery has stayed that dire projection, but has not eliminated it. The United States has abundant copper resources, and could benefit greatly from development of projects like Resolution Copper in Arizona.

Developing our Nation's mineral resources is not only an integral part of an all-of-the-above energy plan, but it will create long-term family wage jobs, stimulate our economy, and reduce our foreign dependence on mineral resources.

I look forward now to hearing from our witnesses. I will explain the procedures shortly, but now I would like to recognize the Ranking Member for five minutes for an opening statement. Mr. Holt.

[The prepared statement of Chairman Lamborn follows:]

Statement of The Honorable Doug Lamborn, Chairman, Subcommittee on Energy and Mineral Resources

We are here today to discuss the Nation's Strategic and Critical Minerals Policy and opportunities for improvement so the United States can better meet domestic needs, create jobs and strengthen our economic and national security by decreasing our foreign dependence on mineral materials.

Today we will gain valuable insight from the mining industry, users of mineral commodities, an American Resources advocate and the Chairmen of two National Research Counsel Reports published in 2008 and a 2011 report issued by the American Physical Society and the Materials Research Society.

Rare-earth elements are important components for renewable energy technologies, telecommunications, medical devices and maybe most importantly military technology.

They are used to make very small and powerful magnets—if you allow me to demonstrate with these two small magnets here—magnets that are used in the military drones that have played an important role in the war on terrorism.

The industrialization of China and India is driving demand for non-fuel mineral commodities, sparking a period of resource nationalism.

Steps taken by China to restrict exports of mineral commodities needed for the industrialization of their country highlights the need for the Unites States to assess the state of our Nation's mineral policies and the opportunities to produce these and other strategic and critical minerals domestically.

According to the National Research Council, one of the primary advantages the United States possesses over our strongest industrial competitors is our domestic resource base—in other words we have a lot of mineral resources that could be developed.

The United States is among the world's largest producer of many important metals and minerals, particularly copper, gold, lead, molybdenum, silver, and zinc; and we still have substantial domestic reserves of these metals including rare earth elements.

Yet, domestic mineral exploration stagnated or declined during most of the 1990's and 2000's even though global mineral exploration trends were strongly positive. In 1993 we attracted twenty percent of the world-wide minerals exploration budget, today we attract about eight percent.

Without increased domestic exploration, significant declines in U.S. mineral production are unavoidable as present reserves are exhausted. We will continue to ship American jobs overseas and forfeit our economic competitiveness unless we take steps to develop our own mineral resources.

The lack of exploration expenditures and other factors has led to an increased dependence on foreign imports. For example, 25 years ago the United States was dependent on foreign sources for 30 non-fuel mineral materials, 6 of which were entirely imported to meet the Nation's requirements and another 16 of which were imported to meet more than 60 percent of the Nation's needs.

By last year our import dependence for non-fuel mineral materials more than doubled from 30 to 67commodities, 18 commodities were imported entirely to meet the Nation's requirements, and another 25 commodities required imports of more than 50 percent (figure 1—on screen).

While much of the focus has been on rare earth elements because of China's restrictions on exports—they currently produce about ninety-six percent of the world's rare earth elements. These metals are not the only ones that should be of concern to us.

For example, at a 2006 subcommittee hearing on "*The Energy and Mineral Requirements for Renewable and Alternative Fuels Used for Transportation and Other Purposes*" Robyn Storer stated that "by 2016 less than half of world demand for copper mine supply can be met from production from existing mines". . .and that. . ."the world needs the equivalent of 30 new major mines by 2016 to meet the projected growth in demand."

The world-wide economic downturn in 2008 and 2009 and slow recovery has stayed that dire projection but not eliminated it.

The United States has abundant copper resources and could benefit greatly from development of projects like Resolution Copper in Arizona. Developing our Nation's mineral resources is not only an integral part of an all-of-the-above energy plan but it will create long-term family wage jobs, stimulate our economy and reduce our foreign dependence on mineral resources.

I look forward to hearing from our witnesses today.

STATEMENT OF HON. RUSH D. HOLT, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW JERSEY

Mr. HOLT. Thank you, Mr. Chairman. In recent years, the issue of rare earth elements and critical minerals has come to widespread attention, and we have witnessed, I think, a growing realization that allowing our domestic rare earth supply chain to disintegrate over the past couple of decades may be a threat to both our national security and our economic competitiveness.

It was nearly 20 years ago that Chinese President Deng Xiaoping famously noted that while the Middle East has its oil, China has its rare earths. So, China's march to monopoly of 97 percent of the world's rare earth minerals, ores, and oxides began.

At the same time, the United States has gone from the world's leading producer to near total reliance on imports of rare earths. This has serious repercussions for the military. These minerals are essential for guidance systems, and lasers, and satellite communication, and radar, and sonar, and all sorts of other things.

And the Department of Defense is currently working on a report on its plan to ensure near-term availability, and I am not sure that anybody is really looking at long-term availability. So, I look forward to that report from the DoD. But it is more than a national security concern. There are implications for the development of clean energy. Over the next couple of decades, the global market

for sustainable energy products and equipment is going to be a multi-multi-trillion dollar industry.

And if American companies and workers are to participate in this rapidly growing sector for access to rare earths, and the ability to domestically refine and process reliable supplies will be critical.

A hybrid vehicle, for example, contains a couple of pounds of neodymium in its motor, and nearly 25 pounds of lanthanum in its battery. Those are just two of the 17 minerals categorized as rare earths.

Several hundred pounds of these might be used for advanced magnets for the large wind turbines, for example. So, China has the ability to shut down the production of almost all of these products if it wishes, and based on current Chinese exports quotas and tariffs, as well as the unofficial earth embargo to Japan last fall, relying completely on China for these critical minerals is clearly not a sound approach for our country.

It is clear that China is acting as they see it strategically to dominate the entire clean energy supply chain, from mine to solar module, and it is vital to America's economic competitiveness that we, too, develop a long-term strategy for competing in this and other high tech sectors.

The strategy must include a plan for securing reliable supplies of critical minerals. So, we need the United States Geological Survey, and Geological Surveys from around the world, too provide the best and most transparent data on critical mineral resources in the ground.

We need the Department of Energy researching mineral and material substitutes, developing reuse and recycling methods, and improving technologies for critical mineral extraction and refining.

We need the Department of Defense to develop a plan for securing adequate supplies to meet national security requirements now and into the future. So, let us be clear. An over-simplified "Mine, Baby, Mine" mantra will not create a domestic supply chain.

It will not develop substitute materials, and it will not enhance in the long run our national security and economic competitiveness. Moreover, since rare earths—maybe at some point we should make it clear that rare earths aren't rare—just difficult to acquire.

But since rare earth deposits are typically found associated with radioactive elements, haphazard and imprudent mining can leave us with contaminated water supplies, and radioactive superfund sites around the country.

So, it is an important hearing, and I hope the first of many on this subject. As the Chairman said, I think it is possible to find some common ground, and this need not be a partisan issue. I thank the witnesses for being here today, and I look forward to your testimony.

[The prepared statement of Mr. Holt follows:]

Statement of The Honorable Rush D. Holt, Ranking Member, Subcommittee on Energy and Mineral Resources

Over the past year, the issue of rare earth elements and other critical minerals has jumped to the front burner. We have witnessed a collective realization—rightly I believe—that allowing our domestic rare earth supply chain to disintegrate over the past two decades may be a threat to both our national security and economic competitiveness.

In 1992, the Chinese president Deng Xiaoping [shou-ping] famously noted that "the Middle East has its oil, but China has rare earth." So began China's march to monopoly producer of 97 percent of the world's rare earth mineral ores and oxides. At the same time, the U.S. has gone from the world's leading producer to near total reliance on imported rare earths.

This has serious repercussions for our military. Rare earth minerals are essential to our missile guidance systems, lasers for enemy mine detection, satellite communications, and radar and sonar systems. The Department of Defense is currently working on a report on its plan to ensure near-term availability of rare earth minerals, and I look forward to that report.

But this is more than a national security concern. It also has significant implications for the development of clean energy. Over the next two decades, the global market for sustainable energy products and equipment is estimated to be worth more than $12 trillion. If American companies and workers are to participate in this rapidly growing sector, access to rare earths and the ability to domestically refine and process reliable supplies of these minerals will be absolutely critical.

Today, a hybrid vehicle contains 2 pounds of neodymium in its motor and nearly 25 pounds of lanthanum in its battery. Those are just two of the 17 minerals categorized as rare earths. Several hundred pounds of these minerals may be used to make the advanced magnets needed in a large wind turbine. Today, China has the ability to shut down production of all of these products if it wishes. Based on current Chinese export quotas and tariffs, as well as the unofficial rare earth embargo to Japan last fall, relying completely on China for these critical minerals is clearly not a sound approach.

It is clear that China is acting strategically to dominate the entire clean energy supply chain, from mine to solar module. It is vital to America's economic competitiveness that we too develop a long-term strategy for competing in this and other high-tech sectors. This strategy must include a plan for securing reliable supplies of critical minerals.

So we need the U.S. Geological Survey, and geological surveys from around the world, providing the best and most transparent data on critical mineral resources in the ground. We need the Department of Energy researching material substitutes, developing reuse and recycling methods, and improving technologies for critical mineral extraction and refining. We need the Department of Defense to develop a plan for securing adequate supplies to meet national security requirements in the near-term. But let's be clear. An over-simplified "Mine Baby Mine" mantra will not create a domestic supply chain, it will not develop substitute materials, and it will not enhance our national security or economic competitiveness. Moreover, since rare earth deposits are typically found among radioactive uranium, thorium, and radon, a haphazard "Mine, Baby, Mine" strategy could leave us with contaminated water supplies and radioactive Superfund sites across the country.

This is a very important hearing and, I hope, the first of more on the subject.I thank the witnesses for being here today and look forward to their testimony.

Mr. LAMBORN. OK. Thank you, Representative Holt. At this point, I would like to have a moment of silence. Our Chairman, Doc Hastings, unfortunately lost his mother in the last day or so. So, if we could have a moment of silence, it would be appreciated.

[Pause.]

Mr. LAMBORN. Thank you. So, the Chairman of the Full Committee is not with us. We are graced with the presence of our Ranking Member of the Full Committee. So, if you have an opening statement, Mr. Markey, we would like to hear it.

STATEMENT OF HON. EDWARD J. MARKEY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MASSACHUSETTS

Mr. MARKEY. Thank you, Mr. Chairman, very much. And I also appreciate your foresight in using the word strategic in the title of today's hearing. It underscores the importance of dealing with this resource challenge with a long-term national purpose in mind.

We can mine every last rare earth molecule from the National Mall to the California coast, but if we are shipping all that ore

back across the Pacific to be refined and processed into valuable alloys in China, and assembled into solar panels, i-Pods, and missile guidance systems in China, then we have completely missed the opportunity.

Against all odds, American manufacturing is charging back, anchored by a strong domestic auto industry that has reoriented around technology and innovation. United States manufacturing has now expanded for 21 consecutive months.

I know that all of us are happy to see this recovery happening, but it is time to take stock of how we are going to maintain this growth. Our workers are competitive globally, not because they will work for the lowest wages, but because they are the most productive because they innovate.

They find ways to work smarter instead of harder, and that is why this hearing is so important. This is all about building blocks of the high-tech economy. A Nation that wishes to compete in high-tech, value-added manufacturing, in the 21st Century must have a reliable source of critical minerals.

One agency which this Committee has jurisdiction over that I believe must be more fully utilized to help solve the critical minerals challenge is the United States Geological Survey.

This is why I have introduced a bill, along with Representative Hank Johnson, that directs the United States Geological Survey to work with other Geological Surveys to identify and quantify global rare earth deposits, improve our understanding of the distribution and formation of these deposits, analyze the state of the rare earth supply chain, and recommend steps to ensure supply.

I believe that H.R. 1314, the Resource Assessment of Rare Earths, or RARE Act, is an important first step that this Committee could take to bring valuable government resources and expertise to bear on this problem.

I hope to work with the Majority on this and other legislation that address the critical mineral challenge. I thank you, Mr. Chairman, for holding this hearing.

[The prepared statement of Mr. Markey follows:]

Statement of The Honorable Edward J. Markey, Ranking Member, Committee on Natural Resources

I thank the Chairman.

And I also appreciate his foresight in using the word "strategic" in the title of today's hearing. It underscores the importance of dealing with this resource challenge with a long-term national purpose in mind.

"Drill, Baby, Drill" or "Mine, Baby, Mine" doesn't really capture the type of solutions we need in this area. We can mine every last rare earth molecule from the National Mall to the California coast. But if we're shipping all that ore back across the Pacific to be refined and processed into valuable alloys in China and assembled into solar panels, iPods, and missile guidance systems in China, then we will have completely missed the opportunity.

Against all odds, American manufacturing is charging back. Anchored by a strong domestic auto industry that has re-oriented around technology and innovation, U.S. manufacturing has now expanded for 21 straight months.

I know all of us are happy to see this recovery happening. But it's time to take stock of how we're going to maintain this growth. Our workers are competitive globally not because they'll work for the lowest wages, but because they are the most productive. They innovate. They find ways to work smarter, instead of harder.

That's why this hearing is so important today. This is all about the building blocks of the high-tech economy. A nation that wishes to compete in high-tech,

value-added manufacturing in the 21st Century must have a reliable source of critical minerals.

One agency which this committee has jurisdiction over that I believe must be more fully utilized to help solve the critical minerals challenge is the U.S. Geological Survey. That is why I have introduced a bill along with Representative Hank Johnson that directs the USGS to work with other geological surveys to identify and quantify global rare earth deposits, improve our understanding of the distribution and formation of these deposits, analyze the state of the rare earth supply chain, and recommend steps to ensure supply. I believe H.R. 1314—the Resource Assessment of Rare Earths, or RARE Act—is an important first step that this committee could take to bring valuable government resources and expertise to bear on this problem.

I hope to work with the majority on this and other legislation that address the critical mineral challenge.

Mr. LAMBORN. OK. And thank you, Representative Markey. I look forward now to hearing from our witnesses. Let me introduce them. From our left to right, Hal Quinn, President and CEO of the National Mining Association; Dr. Roderick Eggert, Director and Professor of the Division of Economics and Business at the Colorado School of Mines in our State, myself and Representative Coffman here; Dr. Robert Jaffe, Morningstar Professor of Science at the Massachusetts Institute of Technology; Robert Latiff, President and Consultant, R. Latiff Associates; Ed Richardson, President of the Magnetic Materials Association, and Vice President of Thomas and Skinner; and Daniel McGroarty, President of the American Resources Policy Network.

Like all of our witnesses, your written testimony will appear in full in the hearing record. So, I ask that you keep your oral statements to five minutes as outlined in the invitation letter that we sent you and under Committee Rule 4[a],

Our microphones are not automatic, and so you have to push the button in front of you, and you will see a timer that counts down from five minutes to zero, and that is when your time has run out.

After four minutes a yellow light will come on for the last minute. Then I would ask that you stop and we go on to the next witness. Then we will alternate between the Majority and the Minority to ask questions of any one of you for up to five minutes per Representative, and if your schedule allows, it would be nice to have a second round of questions.

In any case, we do have to be out of here sometime before 11 o'clock, because at that point, we need to be over at the House, and I assume that all of us are interested, and need, and want to be there for a Joint Session of Congress to hear the Prime Minister of Israel address Congress. So, that will be our deadline.

At this point, why don't we start with our first witness. Mr. Quinn, you may begin.

STATEMENT OF HAL QUINN, PRESIDENT AND CEO, NATIONAL MINING ASSOCIATION

Mr. QUINN. Good morning, Mr. Chairman, Ranking Member Holt, and Ranking Member Markey, and Members of the Subcommittee. I want to thank the Subcommittee for holding this hearing to address a serious challenge to our economic and national security; the availability of critical minerals that are the building blocks of our society.

Now, the definition of critical minerals may vary depending upon one's perspective, whether it is examining national security implications, our capabilities for continued innovation, and the development of new technologies.

But from a broader perspective, ensuring that our domestic mining industry performs to its full potential is critical to our economic success. The United States mining industry produces $64 billion in raw materials, that is then consumed in finished products that add $2.1 trillion, or 14 percent to our GDP.

Now consider if we had produced to our resource potential for just copper, rhenium, and iron ore, basic ingredients for the core sectors of our economy, an additional $32 billion of revenue would have been realized, and then converted into an additional $1 trillion in economic output for finished products.

Today, less than half the mineral needs of United States manufacturing are met from domestically mined minerals. Our import dependence for key minerals and commodities has doubled over the past two decades. If you had done a time series on that chart earlier, you would have seen it increasingly become blue over the last 20 years.

The economic and geopolitical perils posed by our Nation's oil import dependency is well understood. Less appreciated is the peril posed by our growing dependence on foreign sources of minerals.

Rare earth elements present a contemporary lesson. Twenty years ago the United States was a major producer of rare earths. Today, China supplies more than 95 percent of the world demand.

With that control, China has changed its business model from exporting rare minerals to exporting finished products using rare earth elements, such as electric motors, computers, batteries, and wind turbines.

In short, China has leverage in its commodity control so that it can provide price and supply preference to domestic consumers, including companies that move their manufacturing and research facilities to China.

The value proposition is clear. Instead of selling for the creation of hundreds of jobs derived from rare earths, or from buying rare earths, why not employ millions throughout the value added chain and seize the economic and technological advantages that come with building out your manufacturing capabilities.

There exists the real potential for a rare earths story to become an all too common experience for other natural or rare earths commodities. You are presently in the midst of an unprecedented super cycle demand for minerals. The cycle is fueled by a start transformation of nations from agrarian-based societies to industrial and urban commercial centers.

Growing urbanization and industrialization in developing the world means more demand for minerals to build the infrastructure and supply the products for a population with growing aspirations.

These trends have already translated to major shifts in global sources of demand and supply for key commodities. We as a Nation have become increasingly marginalized in the front end of the mineral supply chain, and the consequences are severe for our Nation's global competitiveness.

What the rare earths experience should teach us is that when secure and reliable sources of minerals supply disappear from our shores, so do the downstream industries, innovation, and technology that require them.

The good news is that the United States has resources and the know how to meet more of its domestic mineral needs. Our mineral endowment is immense and inevitable. According to the United States Geological Survey, when it comes to key minerals, what is left to be discovered in the United States is almost as much as what has been discovered.

Our resource potential in business advantages should provide us a leg up globally, and yet by several measures we are performing below our potential. I had previously mentioned that our Nation's import dependency continues to increase.

So, finding new resources and delineating our economic potential is critical to keep the commodity pipeline flowing. However, the percentage of worldwide exploration spending commanded by the United States has dropped from 20 percent in 1993 to a mere 8 percent today.

That is a leading indicator where future development capital will be deployed. Until recently the United States was a global leader in value added mining to the Nation's GDP. We have now slipped to second, but more of concern is that the ratio of our capital expenditures to the value added of mining to the economy lags so substantially that it may jeopardize the United States's current overall GDP rank.

So, while the United States has one of the greatest mineral endowments, our ability to get these minerals into the supply chain to help meet more of America's needs is compromised by some policies that place high hurdles in our lane of the global race to remain competitive.

Let me just quickly mention three; access to mineral lands. The 12 Western States are the source of much of our Nation's mineral endowment. Federal lands compromise almost 40 percent of the land area in the United States.

Half of that is either off-limits or under restrictions for mineral development. Unknown amounts of resources on adjacent State and private lands are also sterilized because of those restrictions.

The United States mining struggles under the highest statutory taxation rate. Federal and State taxes combined result in a 41 percent tax rate for United States metals mining.

Many countries that we compete against for development capital have already instituted their rate cuts, or targeted reforms to attract investments in mining. The Federal regulatory burden has recently been estimated to cost the United States economy $1.75 trillion.

On average that amounts to $8 thousand per employee. But while regulatory costs can solely drown out an enterprise, the uncertainties and delays in obtaining permits to commence operations can crush a mining enterprise before it even gets into the dirt.

Permit delays pose the highest hurdle for domestic mining, with necessary government authorizations now taking close to 10 years. If commodities super cycles are historically measured in 20 years in duration, the 10 years that it takes to obtain permits leaves the

United States mining still in the starting blocks with the race halfway over.

America's drift away from the greater self-sufficiency and the basic building blocks of our economy compromises our economic and national security, and surrenders the country's inherent advantage of rich reserves of metals and minerals.

This hearing is a good starting point for addressing head-on the larger issue of how our country can produce more minerals to meet a greater share of our domestic needs, and we thank you for holding this hearing, Mr. Chairman.

[The prepared statement of Mr. Quinn follows:]

Statement of Hal Quinn, President and CEO, National Mining Association

Good morning. I am Hal Quinn, president and chief executive officer of the National Mining Association (NMA). NMA is the national trade association representing the producers of most of the nation's coal, metals, industrial and agricultural minerals; manufacturers of mining and mineral processing machinery, equipment and supplies: and engineering and consulting firms, financial institutions and other firms serving the mining industry.

I want to thank the Subcommittee for holding this hearing to address a serious challenge to our economic and national security—the availability of the critical minerals that are the building blocks of our society. And these minerals are critical. Using one metric, the value added from industries consuming the $64 billion in raw materials from U.S. minerals mining translates into $2.1 trillion, or 14 percent, of our GDP. Yet today, less than half of the mineral needs of U.S. manufacturing are met from domestically mined resources. And when secure and reliable mineral supply chains disappear from our shores so do the downstream industries, related jobs, innovation and technology that depend on them.

Overall, the United States' import dependence for key mineral commodities has doubled in the span of two decades. This is not a sustainable trend, particularly in a highly competitive world economy in which the demand for minerals continues to grow. These dynamics has led NMA to launch a new education and outreach effort, Minerals Make Life, and we are ready to work with our elected leaders to ensure public policies and procedures address the challenges before us.

The Backdrop

Fast growing economies led by China and India have created an historic super cycle for commodities—one we have not seen on such a scale since the American Industrial Revolution more than a century ago. Metals are at the epicenter of this historic transformation of nations from agrarian-based societies to industrial and urban commercial centers. Consider the following megatrends:

- For the first time in our history, more than half of humanity lives in urban areas. It is forecast that more than 70 percent will be located in urban centers in the next 40 years. In China, alone, we are witnessing the largest internal migration in human history with perhaps 625 million Chinese living in cities by 2015. By 2025, there will be at least 29 mega-cities globally with more than 10 million people. These cities all require tremendous infrastructure to electrify, connect and transport their citizenry.
- At the same time, we are in the middle of an unprecedented explosion in the world middle class, and the pace will continue to pick up significantly. Some estimate that 25 percent of China's population qualifies as middle class—more people than the entire U.S. population today. And, China's middle class is expected to double in the next decade. Entre to the middle class brings with it expectations for better medical care, more goods and services, improved housing, safe drinking water and other hallmarks of a better life. All depend on minerals.
- What we see in China is also underway in other emerging countries such as India, Indonesia and Brazil. The demographics all point to sustained momentum behind these trends.

The Peril

It is important that we understand these critical trends because they will shape our future, presenting opportunities and challenges for both U.S. mining and the nation. These trends point to enormous growth and job-creation opportunities if U.S. mining is allowed to perform to its potential. If we do not, and become increasingly

marginalized, the consequences are severe for our nation's global competitiveness as we become more reliant upon extended and unstable supply chains for what we can produce here.

Recognizing that resource constraints can limit its growth, China, for one, has developed a comprehensive and multi-faceted strategy for assuring future supplies of minerals.

A powerful example of China's aggressive strategy to ensure access to needed minerals involves rare earth elements (REE). REEs are valued for their magnetic and optical properties and used in weapons systems, computers and energy technologies. Twenty years ago, the United States was the major producer of REEs. Today, China supplies more than 95 percent of world demand. China also recognizes the benefits of forward integration to its economy and technological advancement. As a result, it has changed its business model from exporting rare earth minerals to exporting finished products using REEs such as electric motors, computers, batteries and wind turbines. While the U.S. is reviving its REE production capability, we have let the situation go on far too long for these and other minerals commodities.

America's drift away from greater self-sufficiency for the basic building blocks of our economy compromises our economic and national security and ignores this country's rich reserves of metals and minerals. It is time for policymakers to meet head-on the larger issue of how our country can produce more domestic minerals to meet a greater share of our needs.

The Potential

The United States has the resources and the know-how to meet more of its domestic mineral needs. From a global perspective, the United States enjoys inherent advantages. Our mineral endowment is immense and enviable. Our bench is long and deep. According to the United States Geological Survey, when it comes to copper, silver and zinc and other key minerals "what is left to be discovered in the U.S. is almost as much as what has been discovered."

Beyond our rich mineral endowment, we also enjoy several other inherent advantages. We have a global-leading workforce in terms of skill and productivity. We possess top quality rail and port infrastructure for moving commodities to market. We enjoy an electricity infrastructure that is top of class in terms of quality, reliability and cost—thanks to abundant and low-cost coal. And the depth of our capital markets allows access to the capital necessary to find and develop new resources.

The Performance

Our resource potential and business advantages should provide us a leg-up globally. And yet, by several measures we are performing below our potential.

- When viewed through the lens of resource potential, we are punching below our global weight. If we had produced to our resource potential for copper, molybdenum, and iron ore—basic ingredients for key sectors of our economy—an additional $32 billion of revenue would have been registered in 2008—and multiply that by the value added to the GDP by major industries that convert these materials into finished products, and U.S. mining could have been the starting point for an additional $1 trillion in economic output.
- Finding new resources and delineating their economic potential is critical to keeping the commodity pipeline flowing. Here again, we see a disturbing trend with the percentage of worldwide exploration spending commanded by the U.S. dropping from 20 percent in 1993 to only 8 percent today. The percentage of global exploration spending is a leading indicator of where future development capital will be deployed. If you do not put the money in the ground, you cannot get the minerals out.
- Until recently, the U.S. was the global leader in value added of mining to the nation's GDP. We have now slipped to second, but more concerning is that when we look at the ratio of our capital expenditures to the value add of mining to the economy, we lag so substantially that absent significantly higher investments, the U.S. is unlikely to maintain its current overall GDP rank.

The Public Policy

So while the United States has one of the world's greatest mineral repositories, our ability to get these minerals into the supply chain to help meet more of America's needs is threatened. Numerous public policies have placed high hurdles in our lane of the global race to remain competitive.

- **Access**

Twelve western states are the source of much of our nation's mineral endowment. Federal lands comprise almost 40 percent of the land area in those states. Half of that is either off-limits or under restrictions for mineral development. Unknown

amounts of resources on adjacent state and private lands are also sterilized because of federal land restrictions. Both the elected and unelected continue to propose placing more of these lands off-limits.

• **Taxes**

U.S. mining struggles under the world's highest statutory taxation rate. And our payments to local, state and federal government in 2008, the last year for which we have complete data, resulted in a 41 percent effective tax rate for U.S. metals mining operations, according to an analysis by PricewaterhouseCoopers. Many of the countries we compete against for development capital have already instituted rate cuts or targeted reforms to attract investments in mining. Here in the United States, we more often see proposals that would add additional taxes or fees on mining and eliminate the percentage depletion allowance that allows us to secure the enormous financial commitments necessary for capital intensive enterprises.

• **Regulatory Burden**

The federal regulatory burden has recently been estimated to cost the U.S. economy $1.75 trillion annually. On average that amounts to about $8,000 per employee. The intensity is higher for an industry such as mining that must make regulatory filings and obtain government approvals for even the slightest changes in operating plans.

Regulatory costs can slowly drown an enterprise. But the uncertainties and delays in obtaining permits to commence operations can crush the mining enterprise before it even gets in the dirt. Permit delays pose the highest hurdle for domestic mining with necessary government authorizations now taking close to 10 years to secure. If commodity cycles are historically 20 years in duration, the 10-years it takes to obtain permits leaves U.S. mining still in the starting blocks with the race half way over.

Crafting Solutions

As Congress investigates long-term solutions and strategies to address our nation's mineral needs, it must also consider that many of today's emerging technologies rely on combinations of a variety of different minerals—not just single commodities. As new applications are found, markets for mineral commodities will expand considerably along with demand. For example, as cell phone technology has advanced, so too have the number of minerals needed to send an e-mail, take a photo or capture video. Today, cell phones are made from as many as 42 different minerals, televisions can be composed of 35 different minerals and computers are built from 66 different minerals.

Conclusion

An overreliance on imported minerals coupled with flat production at home, places the United States at greater risk of supply disruptions in an increasingly minerals-competitive world. Minerals are the building blocks of our future. Achieving sustainable economic growth will require a steady supply of minerals that will enable American corporations—large and small—to develop and make the technologies that will propel our economy, enable our country to compete globally, and improve the quality of our lives. The technologies that define innovation today all depend on minerals—lifesaving medical devices, smart phones and advanced energy technologies alike require minerals to function. The United States' ability to continue to innovate will depend on how we meet tomorrow's needs.

Mr. LAMBORN. OK. Thank you for your comments. Now, Dr. Roderick Eggert from the Colorado School of Mines.

STATEMENT OF DR. RODERICK EGGERT, DIRECTOR AND PROFESSOR, DIVISION OF ECONOMICS AND BUSINESS, COLORADO SCHOOL OF MINES

Dr. EGGERT. Thank you very much. Good morning, Mr. Chairman, and Members of the Committee. My name is Rod Eggert. I am a Professor at the Colorado School of Mines. I chaired the National Research Council Committee that prepared the 2008 report, Minerals, Critical Minerals, and the United States Economy.

This report described the broad context for current concerns about strategic and critical minerals. In particular, let me highlight three aspects of the report. First, definitions. The report defined a

critical mineral, or a critical element, as one that is both essential in use, or difficult to substitute away from, and also subject to supply risk.

And which specific minerals or elements is strategic depends on and varies from industry to industry, from country to country, and over time.

Second, a conceptual framework. The report articulated a conceptual framework for assessing the degree of criticality of specific elements or minerals, and at the time identified indium, magnesium, niobium, platinum group elements, and rare earth elements, as critical.

Third, policy relevant recommendations. The report did not make specific policy recommendations, but it did express and affirm an important Federal rule in collecting, and disseminating, and analyzing information about critical mineral markets and the science behind them. and also a critical Federal role in research, especially pre-competitive research.

Let me use the rest of the time to articulate for personal propositions. First, the issues are broader than rare earths, despite the prominence of rare earths over the last year or so in the news.

There are perhaps 15 or 20 elements that arguably are critical or strategic. Point number two. Each element has its own story, although import dependence can be a source of risk, by itself import dependence need not be risky if foreign sources are varied and otherwise secure.

Different elements have different constraints on availability, and are different supply risks, and in some cases are import dependence related to geopolitical risks. In other cases, basic geologic scarcity may be a source of a constraint; technical limitations on the ability to process; extract and process an element may be a constraint.

Reliance on byproduct production, or environmental, or social concerns, all can be sources of unavailability if you will.

Point number three. Markets are responding to concerns about availability and security of supply, and timelines can be significant. Markets provide powerful incentives for affected parties to respond.

On the supply side, there has been a minor mania of exploration for rare earths. There has been a significant increase in interest in recycling research over the last several years, but the timelines are significant; 5 to 15 years or so to take a mineral exploration project from its initial stages to actually operating a mine.

On the demand side, markets encourage users of mineral-based elements to obtain ″insurance″ against mineral supply risks. In the short- to medium-term users can, for example, maintain stockpiles, diversify sources of supply, develop joint-sharing arrangements with other users, or develop tighter relations with producers. Over the longer term, users might invest in new mines in exchange for secure supplies or, undertake research and development to substitute away from those elements subject to supply risks.

Point number four. But there are important roles for the Federal Government today in encouraging undistorted international trade where trade restrictions are the problem, and in improving the regulatory approval processes for domestic resource development when

there are opportunities to create value through domestic mineral production and downstream processing activities.

And, finally, there is an important Federal role in facilitating the provision of information and analysis in education, and in pre-competitive research activities. Thank you very much for the opportunity to testify. I look forward to responding to your questions.

[The prepared statement of Dr. Eggert follows:]

Statement of Roderick G. Eggert, Professor and Division Director, Division of Economics and Business, Colorado School of Mines, Golden, Colorado

Good morning, Mr. Chairman, members of the Committee, ladies and gentlemen. My name is Rod Eggert. I am Professor of Economics and Business at Colorado School of Mines. My area of expertise is the economics of mineral resources. I participated in two activities relevant for today's hearing. I chaired the committee of the U.S. National Research Council (NRC) that prepared the 2008 report *Minerals, Critical Minerals, and the U.S. Economy.* I served as a member of the committee of the American Physical Society and the Materials Research Society (APS/MRS) that prepared the 2011 report *Energy Critical Elements: Securing Materials for Emerging Technologies.*

I organize my remarks into three sections. First, I describe the context for current concerns about strategic and critical minerals. Second, I summarize the 2008 NRC report on critical minerals identified above. Third, I present my personal views on strategic and critical minerals, which are significantly shaped by the NRC and APS/MRS studies.

Context

Mineral-based materials are becoming increasingly complex. In its computer chips, Intel used 11 mineral-derived elements in the 1980s and 15 elements in the 1990s; it may use up to 60 elements in the future. General Electric uses some 70 of the first 83 elements of the periodic table in its products. In contrast, as recently as two or three decades ago, a typical household owned products containing perhaps 20 elements.

Moreover, new technologies and engineered materials create the potential for rapid increases in demand for some elements used previously and even now in relatively small quantities. The most prominent—although by no means only—examples are gallium, indium and tellurium in photovoltaic solar cells; lithium in automotive batteries; and rare earth elements in wind turbines, hybrid vehicles, compact-fluorescent light bulbs, and a number of defense and military applications.

These technological developments raise two concerns. First, there are fears that supply will not keep up with the explosion of demand due to the time lags involved in bringing new production capacity online or more fundamentally the basic geologic scarcity of certain elements. Second, and more-directly relevant to today's hearing, there are fears that supplies of some elements are insecure due to, for example, import dependence, export restrictions on primary raw materials by some nations, industry concentration, or the reliance on byproduct production that characterizes the supply of some strategic and critical minerals. In both cases, mineral availability—or more precisely, unavailability—has emerged as a potential constraint on the development and deployment of emerging and important technologies, especially in the clean-energy and defense sectors.

Minerals, Critical Minerals, and the U.S. Economy

It was in this light that the standing Committee on Earth Resources of the National Research Council initiated a study and established an ad hoc committee, which I chaired, to examine the evolving role of nonfuel minerals in the U.S. economy and the potential impediments to the supplies of these minerals to domestic users. The U.S. Geological Survey (USGS) and the National Mining Association sponsored the study, the findings of which appear in the volume *Minerals, Critical Minerals, and the U.S. Economy* (NRC 2008).

The report provides a broad context for current discussions and concerns. It defines a 'critical' mineral as one that is both essential in use (difficult to substitute away from) and subject to some degree of supply risk. Under this definition, 'strategic' minerals are the subset of critical minerals essential in military applications.

The degree to which a specific mineral is critical or strategic can be illustrated with the help of a figure (Figure 1). The vertical axis represents the impact of a supply restriction should it occur, which increases from bottom to top. The impact

of a restriction relates directly to the ease or difficulty of substituting away from the mineral in question. The more difficult substitution is, the greater the impact of a restriction (and vice versa). The impact of a supply restriction can take two possible forms: higher costs for users (and potentially lower profitability), or physical unavailability (and a "no-build" situation for users).[1]

The horizontal axis represents supply risk, which increases from left to right. Supply risk reflects a variety of factors including: concentration of production in a small number of mines, companies, or nations; market size (the smaller the existing market, the more vulnerable a market is to being overwhelmed by a rapid increase in demand); and reliance on byproduct production of a mineral (the supply of a byproduct is determined largely by the economic attractiveness of the associated main product). Import dependence, by itself, is a poor indicator of supply risk; rather it is import dependence combined with concentrated production that leads to supply risk. In Figure 1, the hypothetical Mineral A is more critical than Mineral B.

Taking the perspective of the U.S. economy overall in the short to medium term (up to about a decade), the committee evaluated eleven minerals or mineral families. It did not assess the criticality of all important nonfuel minerals due to limits on time and resources. Figure 2 summarizes the committee's evaluations. Those minerals deemed most critical at the time of the study—that is, they plotted in the upper-right portion of the diagram—were indium, manganese, niobium, platinum-group metals, and rare earth elements.

Any list of critical minerals reflects conditions at a specific point in time. Criticality is dynamic. A critical mineral today may become less critical either because substitutes or new sources of supply are developed. Conversely, a less-critical mineral today may become more critical in the future because of a new use or a change in supply risk.

Although the study did not make explicit policy recommendations, it made three policy-relevant recommendations, which I quote below:

1. The federal government should enhance the types of data and information it collects, disseminates, and analyzes on minerals and mineral products, especially as these data and information relate to minerals and mineral products that are or may become critical.
2. The federal government should continue to carry out the necessary function of collecting, disseminating, and analyzing mineral data and information. The USGS Minerals Information Team, or whatever federal unit might later be assigned these responsibilities, should have greater authority and autonomy than at present. It also should have sufficient resources to carry out its mandate, which would be broader than the Minerals Information Team's current mandate if the committee's recommendations are adopted. It should establish formal mechanisms for communicating with users, government and nongovernmental organizations or institutes, and the private sector on the types and quality of data and information it collects, disseminates, and analyzes. It should be organized to have the flexibility to collect, disseminate, and analyze additional, nonbasic data and information, in consultation with users, as specific minerals and mineral products become relatively more critical over time (and vice versa).
3. Federal agencies, including the National Science Foundation, Department of the Interior (including the USGS), Department of Defense, Department of Energy, and Department of Commerce, should develop and fund activities, including basic science and policy research, to encourage U.S. innovation in the area of critical minerals and materials and to enhance understanding of global mineral availability and use.

Four Propositions

I organize my personal views around four propositions. First, *the issues are broader than rare earths, despite the prominence of rare earths in the news over the last year.* Exactly which minerals are 'critical' (essential in use, subject to supply risk) varies from industry to industry, nation to nation, and over time. A number of recent studies suggest possible critical elements. Each list reflects a specific context.

In the field of energy, the U.S. Department of Energy (2010) identifies five rare earths (dysprosium, europium, terbium, neodymium, and yttrium) and indium as especially critical to wind turbines, fluorescent lighting, electric vehicles, and photo-

[1] When considering security of petroleum supplies, rather than minerals, the primary concern is costs and resulting impacts on the macroeconomy (the level of economic output). The mineral and mineral-using sectors, in contrast, are much smaller, and thus we are not concerned about macroeconomic effects of restricted mineral supplies. Rather the concern is both about higher input costs for mineral users and, in some cases, physical unavailability of an important input.

voltaic thin films. A study by the American Physical Society and Materials Research Society (APS/MRS, 2011) focusing on energy technologies identifies the same six elements as possibly critical, plus several other rare earths, the platinum-group elements, and several elements important for photovoltaics (gallium, germanium, selenium, tellurium), as well as cobalt, helium, lithium, rhenium, and silver.

For military hardware and defense systems, Parthemore (2011) identifies the following elements as critical: gallium, lithium, niobium, the rare-earth elements, rhenium, and tantalum.

For European industry, the European Commission (2010) identifies fourteen elements or families of elements as critical: antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, the platinum-group elements, rare earths, tantalum, and tungsten.

The Japan Oil, Gas and Metals National Corporation (JOGMEC) maintains joint government-industry stockpiles for seven elements (chromium, cobalt, manganese, molybdenum, nickel, tungsten, and vanadium) deemed especially important for Japanese industry and for which there are significant supply risks. JOGMEC is closely monitoring several others (gallium, indium, niobium, platinum, rare earths, strontium, and tantalum).

Over time, which materials are critical changes—with advances in materials science and engineering that reduce reliance on specific elements, and with advances on the supply side that relax supply constraints.

Second, *each element has its own story, and import dependence by itself need not be risky.* From all the attention rare earths have received, one might think that geopolitical risks and import dependence are the only cause for concern about availability and supply risk. Geopolitical risks and import dependence certainly are important for those elements with geographically concentrated production, where one or a small number of companies or governments might act opportunistically or unpredictably to the disadvantage of users. But import dependence by itself need not be risky if foreign sources are numerous and diversified, and if the associated foreign governments believe in undistorted international trade.

Different elements have different constraints on availability, as APS/MRS (2011) illustrates. Although essentially no element is in danger of being used up (or depleted) in a geologic sense, some elements are not significantly concentrated by geologic process above their average crustal abundance. Germanium—used in fiber optics, infrared optics, and photovoltaic cells—is an example. Germanium is not especially rare on average in the earth's crust but rarely is present as the main component in minerals.

In other cases, technical limitations constrain the availability of an element. Rare-earth elements actually are not very rare geologically. They exist in a number of minerals, such as eudialyte, that at present are not a source of supply because existing methods of mineral processing and extractive metallurgy are inadequate (both technically and commercially) to remove the rare earths from other elements and, in turn, separate the specific rare-earth elements from one another.

Byproduct supply is another source of supply risk. Indium, for example, is produced as a byproduct of zinc production. Tellurium is a byproduct of copper refining. The key insight here is that the availability of indium, tellurium, and other byproducts is strongly influenced by the commercial attractiveness of the byproduct's associated main product (zinc in the case of indium, copper for tellurium). A significant increase in the price of a byproduct may not result in a significant increase in the production of the byproduct, once the available byproduct is recovered from a main-product ore.

Environmental and social concerns are factors influencing the availability of an element. The point is not to dispute that mineral production can have negative consequences for the natural environment or local communities; it can and does in some circumstances. Rather the point is: processes to ensure that mineral production occurs in ways that are consistent with standards for environmental protection and respect for society can (a) increase the time lag between an unexpected increase in demand and new production capacity to meet this demand and (b) redirect the location of production away from nations with stricter (or less-predictable) environmental and social rules to nations with less-strict (or more-predictable) rules.

Third, *markets are responding, but time lags can be significant.* Markets provide powerful incentives for investments that re-invigorate supply and reduce supply risk. There are minor manias now in exploration for mineral deposits containing rare-earth elements and, separately, lithium. Over the next five to ten years, a number of non-Chinese rare-earth mines are likely to begin production. However, given the long lead times between initial exploration and mining (which can range anywhere from five to fifteen years or more), only those rare-earth projects in advanced

exploration or development prior to the rare-earths crisis of the last year will be producing rare earths in the next few years.

Increased recycling also can be an important response to constraints on supply. Recycling comes in two forms. The most obvious comes from recycling of products at the ends of their lives—for example, recovering ferrous and nonferrous metals from junked automobiles. Less obvious but very important is the recycling of manufacturing scrap or waste.

On the demand side, markets encourage users of mineral-based elements to obtain "insurance" against mineral supply risks. In the short- to medium-term users can, for example, maintain stockpiles, diversify sources of supply, develop joint-sharing arrangements with other users, or develop tighter relations with producers. Over the longer term, users might invest in new mines in exchange for secure supplies or, undertake research and development to substitute away from those elements subject to supply risks.

Fourth, *there are essential roles for government.* To ensure mineral availability over the longer term and reliability of supplies over the short to medium term, I recommend that government activities focus on:

- *Encouraging undistorted international trade.* The governments of raw-material-importing nations should fight policies of exporting nations that restrict raw-material exports to the detriment of users of these materials.
- *Improving regulatory approval for domestic resource development.* Foreign sources of supply are not necessarily more risky than domestic sources. But when foreign sources are risky, domestic production can help offset the risks associated with unreliable foreign sources. Developing a new mine in the United States appropriately requires a pre-production approval process that allows for public participation and consideration of the potential environmental and social effects of the proposed mine. This process is costly and time consuming—arguably excessively so, not just for mines but for developments in all sectors of the economy. I am not suggesting that mines be given preferential treatment, rather that attention be focused on developing better ways to assess and make decisions about the various commercial, environmental, and social considerations of project development.
- *Facilitating the provision of information and analysis.* I support enhancing the types of data and information the federal government collects, disseminates and analyzes. Sound decision making requires good information, and government plays an important role in ensuring that sufficient information exists. In particular, I recommend (a) enhanced focus on those parts of the mineral life cycle that are under-represented at present including: reserves and subeconomic resources, byproduct and coproduct primary production, stocks and flows of materials available for recycling, in-use stocks, material flows, and materials embodied in internationally traded goods and (b) periodic analysis of mineral criticality over a range of minerals. At present, the markets for most strategic and critical minerals are less than completely transparent, in large part because the markets are small and often involve a relatively small number of producers and users, many of which find it to their competitive advantage to keep many forms of information confidential.
- *Facilitating education and research.* I recommend that the federal government develop and fund pre-commercial activities that are likely to be underfunded by the private sector acting alone because their benefits are diffuse, difficult to capture, risky and far in the future. Over the longer term, science and technology are key to responding to concerns about the adequacy and reliability of mineral resources—innovation that both enhances our understanding of mineral resources and mineral-based materials and improves our ability to recycle essential, scarce elements and substitute away from these elements.

  Education and research go hand in hand. Educational programs, especially those at the graduate level, educate and train the next generation of scientists and engineers. On the supply side, education and research in the geosciences, mining, mineral processing and extractive metallurgy, environmental science and engineering, manufacturing, and recycling can help mitigate supply risks and increase mineral availability. On the demand side, improvements in materials design—fostered by education and research in materials science and engineering—can ease the pressures imposed by those elements or minerals subject to supply risks or limited availability. Government, in addition to simply funding education and research, can play an important role in facilitating collaborations among universities, government research laboratories, and industry.

A common conclusion of almost all recent studies on strategic and critical minerals is to urge governments to improve and expand activities related to information and analysis, education, and research (for example, APS/MRS 2011, European Commission 2010, NRC 2008).

A number of other government interventions in markets have been proposed, such as military or economic stockpiles of rare earths and other critical elements; loan guarantees for investments in mines and processing facilities; and special, fast-track environmental permitting for mines that would produce rare earths or other critical minerals. These more-direct market interventions, although perhaps advisable in specific circumstances, are more controversial and less compelling in general as responses to the challenges of critical minerals.

To sum up my personal views, the current situation with strategic and critical minerals requires attention but not panic. By undertaking sensible actions today, there is no reason for crises to develop. But I also am aware that without a sense of panic, we may not undertake these actions.

Thank you for the opportunity to testify today. I would be happy to address any questions you have.

Notes

This testimony draws on the documents cited in the reference list, especially APS/MRS (2011), Eggert (2010), and NRC (2008). The testimony is a revised and modified version of related testimony I presented before (a) the Subcommittee on Energy, Committee on Energy and Natural Resources, U.S. Senate, September 30, 2010, on the role of strategic minerals in clean-energy technologies and other applications and (b) the Committee on Industry, Research, and Energy of the European Parliament, Brussels, January 26, 2011.

References

American Physical Society and Materials Research Society (APS/MRS). *Energy Critical Elements: Securing Materials for Emerging Technologies* (Washington, D.C., American Physical Society, 2011). Available online at: www.aps.org.

Eggert, Roderick G. "Critical Minerals and Emerging Technologies," *Issues in Science and Technology,* volume XXVI, number 4, 2010, pp. 49–58. Available online at: www.issues.org.

European Commission. *Critical raw materials for the EU,* report of the Ad-hoc Working Group on defining critical raw materials (Brussels, European Commission, June 2010). Available online at: http://ec.europa.eu.

Japan Oil, Gas and Metals National Corporation website, www.jogmec.go.jp, accessed May 13, 2011.

Parthemore, Christine. *Elements of Security: Mitigating Risks of U.S. Dependence on Critical Minerals* (Washington, D.C., Center for a New American Security, 2011). Available at: www.cnas.org.

U.S. Department of Energy, *Critical Materials Strategy* (Washington, D.C., Department of Energy, December 2010). Available online at: www.energy.gov.

U.S. National Research Council (NRC). *Minerals, Critical Minerals, and the U.S. Economy* (Washington, D.C., National Academies Press, 2008). Available online at www.national-academies.org.

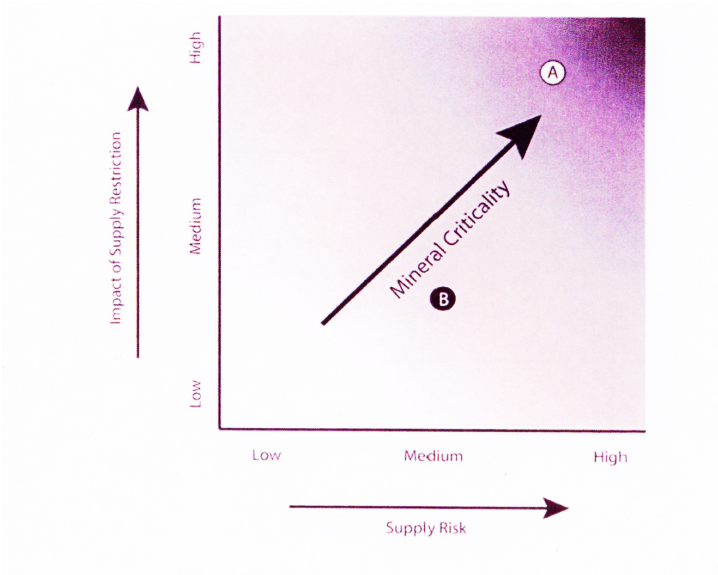

Figure 1. The Criticality Matrix. Source: *Minerals, Critical Minerals, and the U.S. Economy* (National Academies Press, 2008).

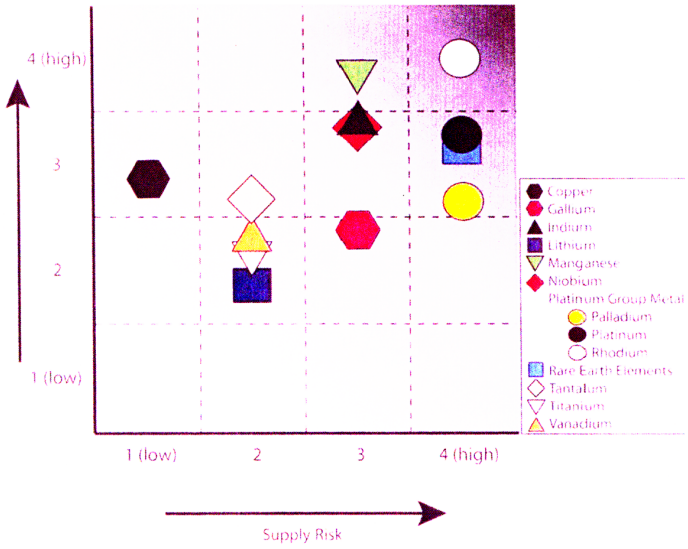

Figure 2. Criticality Evaluations for Selected Minerals or Mineral Families. Source: *Minerals, Critical Minerals, and the U.S. Economy* (National Academies Press, 2008).

Mr. LAMBORN. All right. Thank you for your testimony. Next is Dr. Robert Jaffe of the Massachusetts Institute of Technology.

STATEMENT OF DR. ROBERT JAFFE, MORNINGSTAR PROFESSOR OF SCIENCE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. JAFFE. Mr. Chairman, Mr. Holt, Mr. Markey, and Members of the Committee, thank you for the opportunity to testify. I am a Professor of Theoretical Physics at the Massachusetts Institute of Technology, and I am here to discuss the study on *Energy Critical Elements* that I chaired on behalf of the American Physical Society and the Materials Research Society.

Our study focused on chemical elements critical to new technologies that have the capacity to transform the way that we harvest, transport, store, and use energy. First, let me assure you the sky is not falling. The world is not going to run out of any of these elements anytime soon.

However, the problem of critical elements is serious and very real. While rare earths are perhaps the flavor of the month, a host of other elements are posed to present problems in the near future.

If appropriate steps are not taken, we face possible disruptive short-term constraints on the supply of some elements not presently mined, or refined, or traded in large quantities, that are critical to the deployment of potentially game-changing element technologies.

In our report, we refer to these as energy critical elements or ECEs. Constraints on the availability of these elements would limit the competitiveness of both United States industries and scientific enterprises.

It is our view that with careful stewardship by the government, coupled with the imagination of fundamental research, and the initiative of the United States industry, the problem of ECE availability can be managed for the foreseeable future.

To accomplish this, we recommend a three-component approach, including information gathering, research, and recycling. But first let me say a few words about what we do not recommend.

First, the United States cannot mine its way to ECE independence. Yes, we should certainly pursue domestic mining where economically appropriate, but not with the expectation that mining alone will solve the problem.

Many ECEs are simply not found here in economically viable deposits, and others are produced much more efficiently for a variety of reasons in other countries. Free international trade with a diverse set of suppliers works to everyone's advantage.

Second, we can't rely on stockpiling either. We found stockpiling anchors us to the status quo, and discourages innovation. Stockpiles have proved a poor way to moderate price fluctuations and stabilize markets, often with unintended negative consequences.

Note, however, that we did not consider defense stockpiles which may be motivated by other considerations. In developing our recommendations, we took a lesson from industry.

In 2006, General Electric projected the demand for rhenium an important ingredient in high performance turbines would out-pace world supply in a few years. Instead of stockpiling, General Electric reduced its immediate need for new rhenium with extensive recycling, technologically sophisticated.

And then began an intensive multi-year research program to develop an alternative alloy. By 2010, they had succeeded. General Electric succeeded, but many smaller United States companies, and university and national labs, who don't have the information gathering network, needed to recognize an impending supply disruption, and can't afford to carry out substitutional research, and can't engage in extended recycling.

Consequently, in general, we recommend the following. One, the government should closely monitor worldwide resources and make that information broadly available. Accurate information about availability will allow us to see beyond the price spikes and plan for the future.

Among other things the Federal information gathering entities should be designated a principle statistical agency, similar to the Bureau of Labor Statistics.

Two, the government should promote fundamental research aimed at the twin goals of increasing supplies and decreasing dependencies on ECEs. It is especially important to support fundamental research on earth abundance substances.

The goal should be to enable United States manufacturers or lab researchers to smoothly shift to a substitute in advance of supply disruptions.

Third, cell phones and i-Pods end up discarded at the back of sock stores. Discarded electronics contain ECEs in concentrations that exceed some of the richest ores. Those dispersed products should be gathered into a resource so that ECEs can be extracted for reuse.

Both industry and government need to explore means to stimulate recycling. To summarize, information gathering, research, and recycling.

Over the past two months, I have worked with a research fellow at the Heritage Foundation, and a resident scholar at the American Enterprise Institute, to draw attention to our panel's recommendations.

Although this might not be the typical collaboration for an MIT professor, it indicates that our recommendations identify an appropriate role for government and are physically responsible.

Several House bills have been introduced to address the materials availability issue. In particular, the recently introduced Hultgren bill has provisions on the full triad of recommendations that our committee supported, and is closely aligned with the point of view that I have described here.

Together, these bills present the full range of options from which an effective policy regarding critical elements can be crafted. Thank you for the opportunity to testify.

[The prepared statement of Dr. Jaffe follows:]

Statement of Dr. Robert Jaffe, Professor of Theoretical Physics, Massachusetts Institute of Technology

Mr. Chairman and members of the committee, thank you for the opportunity to testify today.

I am a Professor of Theoretical Physics at MIT but I'm not here to deliver a lecture on quarks. I'm here to discuss a study on *Energy Critical Elements* that I chaired on behalf of two leading scientific organizations: the American Physical Society and the Materials Research Society.

Our study focused intensely on elements critical to new technologies that have the capacity to transform the way we transport, store, or use energy. Please note that we did not consider defense-related issues. I enclosed a full copy of the report for the record, but this morning I'll simply highlight a few key recommendations.

First, let me first reassure you—the sky is not falling. The world is not going to run out of any of these elements anytime soon. However: the problem of critical elements is serious and very real. While rare earths are the "flavor of the month", a host of other elements are poised to present problems in the future.

If appropriate steps are not taken, we face possible disruptive short-term constraints on supply of some elements that are not presently mined, refined, or traded in large quantities, but are critical to the deployment of potentially game-changing energy technologies. Casualties might include things ranging from important petroleum refinery catalysts to state-of-the-art wind turbines or market competitive solar panels. In our report we refer to these elements as ECEs: Energy-Critical Elements.

Constraints on availability of these elements would limit the competitiveness of both U.S. industries and the domestic scientific enterprise.

It is our view that with careful stewardship by the government, coupled with the imagination of fundamental research and the initiative of U.S. industry, the problem of ECE availability can be managed for the foreseeable future.

To accomplish that, we recommend a three component approach: information, research, and recycling.

But first, let me say a few words about what we don't recommend.

The U.S. can't mine its way to ECE independence. Yes, we should certainly pursue domestic mining when economically appropriate—but not with the expectation that mining alone will solve the problem. Many ECEs are simply not found here in economically viable deposits, and others are produced more efficiently—for a variety of reasons—by other countries. Free international trade with a diverse set of suppliers works to everyone's advantage.

We can't rely on stockpiling either. We found that stockpiling is a disincentive to innovation because it anchors us to the status quo. Stockpiles have proved a poor way for governments to try to moderate price fluctuations and stabilize markets, often with unintended negative consequences. Note, however, that we did not consider defense stockpiles, which may be motivated by other considerations.

In developing our recommendations for the most effective way to address this issue, we took a lesson from industry.

> CASE STUDY: General Electric has for many years tracked the market for an exceptionally rare metal, rhenium, which is critical to its advanced turbines used both in jet engines and modern natural-gas fired power plants. In 2006, General Electric projected that demand for rhenium would outpace worldwide supply within a few years. Instead of stockpiling, GE reduced its immediate need for new rhenium by a wide-ranging recycling program, and began an intensive, multiyear research program to develop an alternative alloy. By 2010 they had found, tested, and certified several new alloys that use less rhenium. Meanwhile the price of rhenium had risen 20-fold to over $10,000/kg.
>
> LESSON: GE succeeded, but many smaller U.S. companies and university & national labs: 1) do not have the information gathering network needed to recognize an impending supply disruption; 2) can't afford to carry out substitutional research; and, 3) can't engage in extensive recycling.

Consequently, in general, we recommend the following:

1) The government should closely monitor worldwide resources and make that information accessible to U.S. industries and labs. Accurate information about availability will allow the scientific enterprise to see beyond the price spikes and plan for the future. This can be achieved by, among other things, elevating the federal information gathering entity to a "Principal Statistical Agency" similar to the Bureau of Labor Statistics and the Energy Information Administration.
2) The government should also promote fundamental research aimed at the twin goals of increasing supplies and decreasing our dependence on ECEs. It is especially important to support fundamental research on earth-abundant substitutes for ECEs. The goal should be a broad understanding of the advantages and disadvantage of technologies based on alternative materials, in order to enable U.S. manufacturers or lab researchers to more smoothly shift to a substitute in advance of supply disruptions.
3) Cell phones and iPods end up discarded in the back of sock drawers, yet they all contain ECEs in concentrations that exceed the richest ores. Those dispersed products could be gathered into a resource—an urban mine—so the ECEs can be extracted for reuse. There are various paths to achieve this:

government could help increase recycling by enabling greater consumer awareness and industry could stimulate it by providing consumer incentives.

We believe that this triad of information gathering, research, and recycling will provide the U.S. with the best safeguard against disruptions.

I believe that these steps can be implemented with a budget-neutral approach that respects the distinction between activities that belong in the private sector and those that fall to government. As a result, I've been able to team with a Research Fellow at the Heritage Foundation and a Resident Scholar at the American Enterprise Institute to draw attention to this approach. Although this might not be the typical collaboration for an MIT professor, it indicates that our recommendations identify an appropriate role for government and are fiscally responsible.

Several House bills have been introduced to address the minerals availability issue. The Johnson-Markey bill rightly emphasizes the importance of information gathering. The Coffman bill addresses rare earth elements and primarily addresses near-term issues. The Miller bill emphasizes some of the research and information gathering efforts recommended in the APS/MRS report. The recently introduced Hultgren bill has provisions on our full triad: information, research, and recycling, and is closely aligned with the point of view I have described here. Together these bills present the full range of options from which an effective policy regarding critical elements can be crafted.

Thank you for the opportunity to testify.

Mr. LAMBORN. OK. Thank you for your testimony. Mr. Latiff.

STATEMENT OF ROBERT LATIFF, PRESIDENT AND CONSULTANT, R. LATIFF ASSOCIATES

Mr. LATIFF. Thank you Mr. Chairman, and thank you, Committee, for this opportunity to testify on this very timely and important topic. The subject of critical and strategic materials is one in which I have had a strong interest, both as a materials scientist and in my long military career in the acquisition of military weapons systems and technology.

I might note here that I am also a research professor at George Mason University. Having retired from the Air Force, I was fortunate in 2007 to have been asked to chair the National Academy's Committee on Assessing the Need for a National Defense Stockpile.

I have since remained active in urging the government and the industry to be more proactive on the issues of mineral and materials availability and related topics. I have spoken frequently to representatives and groups in the Department of Defense, the aerospace industry, and in the intelligence community, and at major materials and manufacturing conferences.

I am also now honored to act as the Chairman of the National Materials and Manufacturing Board of the National Academies, and as such, remain actively engaged in reviewing research on these topics.

I must emphasize, however, here that my testimony, unless specifically related to Academy studies, reflects my opinion and not those of the Academies. By way of summary, the Committee on Assessing the Need for a National Defense Stockpile was formed in response to a request from DoD, having been mandated by the House Armed Services Committee.

The Academies published the Stockpile Committee results in a report entitled, Managing Materials for A Twenty-First Century Military. The major conclusions of the Committee were that the National Defense Stockpile was ineffective, and that the model used to calculate materials needed was outdated and needed to be replaced, that legislation and regulations were in need of review,

that previous studies and recommendations had been ignored, and that the DoD did not adequately understand its own materials needs, and had no system in place to determine them.

The report concluded that the DoD had not made critical and strategic materials a priority. Additionally, the Committee emphasized the criticality of the United States Geological Survey in maintaining accurate mineral availability information.

Interesting, the report highlighted the growing concern at that time and the need for DoD to pay attention to rare earth materials. The DoD, in its April 2009 report to Congress on this topic, addressed many of the issues raised by the Academy report.

To its credit the DoD suspended sales of many of the materials in the stockpile pending a thorough analysis of future need. It has taken action to revise its modeling system, and has created or is in the process of creating a strategic materials management program.

What is unclear at this point is any progress by DoD officials on a systematic approach to determining their overall need for specific materials. This has become especially urgent recently in the clamor for rare earths, but is equally important for all materials needed in United States weapons systems.

To the last point, I have written and spoken frequently on the need to maintain perspective in our critical minerals planning, and add that it is not only the rare earth materials about which we should be concerned, but also a broader range of important critical materials.

It is not only materials availability to which we should pay attention and work to mitigate disruption. We must also pay more attention to the importance of material recycling, and at least not dismiss out-of-hand a consideration of stockpiling, where appropriate.

While clearly we must have access to the materials, we also need to have facilities and an ability to process those materials once we have them, and be able to manufacture a product with the resulting materials. Assuring an ability to mitigate supply disruptions seems to be a necessary, but obviously insufficient, activity if we are then forced to depend on foreign sources of materials processing and manufacturing.

I should note here that other countries are in fact taking or considering comprehensive measures to strength their materials and manufacturing positions. I am more familiar and impressed by the work of the European Commission, even to the extent of supporting their national materials policy.

At home, recent Congressional and Executive Branch interest in these activities are extremely welcome. Finally, numerous sources of data indicate a growing concern about the relative production of scientists, engineers, and technicians, in the United States, as compared to the emerging economies of China, India, et cetera.

Naturally, I have a particular concern about the materials sciences and related fields, and manufacturing and its related fields. In both, the United States has given up much of its historical lead.

The National Academies have highlighted this issue as well, in a 2005 report, entitled, The Globalization of Materials Research

and Development, and of course, in the widely read and often quoted Rising Above the Gathering Storm.

It is of interest that here is a growing recognition by many that processing and manufacturing capabilities diminish, so, too, do fertile grounds for innovation and creativity.

I am honored by this invitation to testify before the Committee and applaud its interest in taking action on this important issue.

[The prepared statement of Mr. Latiff follows:]

Statement of Robert H. Latiff, President and Consultant, R. Latiff Associates

I would like to thank the Committee for the opportunity to testify on this very timely and very important topic. The subject of critical and strategic materials is one in which I have had a strong interest, both as a materials scientist and in my long career in acquisition of major military weapons systems and technology. Having retired from the US Air Force, I was fortunate, in 2007, to have been asked to chair the National Academies' Committee on Assessing the Need for a National Defense Stockpile. I have since remained active in urging the government and industry to be more proactive on the issues of mineral and materials availability and related topics. I have spoken frequently to representatives and groups in the Department of Defense, the aerospace industry, and the intelligence community, and at major materials and manufacturing conferences. I am also now honored to act as the current Chairman of the National Materials and Manufacturing Board of the National Academies and, as such, remain actively engaged in reviewing research on these topics. I must emphasize, however, that my testimony here today, unless specifically related to published Academy studies, reflect my opinions alone, and not the position of the National Academies.

By way of summary, the Committee on Assessing the Need for a National Defense Stockpile was formed in response to a request from DOD, having been mandated by the House Armed Services Committee. The Academies published the Stockpile Committee results in a report entitled Managing Materials for a Twenty First Century Military. The major conclusions of the Committee were that the National Defense Stockpile was ineffective, that the model used to calculate materials needs was outdated and needed to be replaced, that legislation and regulations were in need of review, that previous studies and recommendations had been ignored, and that the DOD did not adequately understand its own materials needs and had no system in place to determine them. The report concluded that the DOD had not made critical and strategic materials a priority. Additionally, the Committee emphasized the criticality of the US Geological Survey in maintaining accurate mineral availability information. Interestingly, the report highlighted the growing concern and need for DOD to pay attention to the rare earth materials. The DOD, in its April 2009 Report to Congress on this topic, addressed many of the issues raised by the Academy report. To its credit, the DOD suspended sales of many materials pending a thorough analysis of future need, it has taken action to revise its modeling system, and has created a strategic materials management program. What is unclear at this point is any progress by DOD officials on a systematic approach to determining their overall needs for specific materials. This has become especially urgent recently in the clamor for rare earths, but is equally important for all materials needed in US weapons systems.

To the last point, I have written, and spoken frequently, of the need to maintain perspective in our critical minerals planning and add that it is not only the rare earth materials about which we should be concerned, but also a broader range of important critical materials. It is not only materials availability to which we should pay attention and work to mitigate disruption. We must also pay more attention to the importance of critical material recycling and at least not dismiss, out of hand, a consideration of stockpiling, when appropriate. While clearly we must have access to the materials, we also need to have facilities and an ability to process those raw materials once we have them and be able to manufacture a product with the resulting processed materials. Assuring an ability to mitigate supply disruptions seems to be a necessary but obviously insufficient activity if we are then forced to depend on foreign sources of materials processing and manufacturing which could just as easily be disrupted. I should note here that other countries are in fact taking or considering comprehensive measures to strengthen their materials and manufacturing positions. I am most familiar and am impressed by the scope of the work of the European Commission, even to the extent of supporting the formulation of a National

Minerals Policy. At home, recent Congressional and Executive Branch interest in and activities in this area are extremely welcome.

Finally, numerous sources of data indicate a growing concern about the relative production of scientists, engineers, and technicians in the US as compared to the emerging economies of China, India, etc. Naturally, I have a particular concern about the materials sciences and related fields and manufacturing engineering and its related fields. In both, the US has given up much of its historical lead. The National Academies have highlighted this issue as well, in a 2005 report entitled The Globalization of Materials Research and Development and, of course, in the widely read and often quoted Rising Above the Gathering Storm. It is of interest that here is a growing recognition by many experts that as processing and manufacturing capabilities diminish, so too do fertile grounds for innovation and creativity.

I am honored by the invitation to testify before the Committee and applaud its interest in taking action on this important issue.

Mr. LAMBORN. Thank you for your words, and now Mr. Richardson of the Magnetic Materials Association.

STATEMENT OF ED RICHARDSON, PRESIDENT OF THE MAGNETIC MATERIALS ASSOCIATION, VICE PRESIDENT OF THOMAS AND SKINNER

Mr. RICHARDSON. Chairman Lamborn, Ranking Member Holt, Distinguish Members of the Subcommittee, thank you for the opportunity to testify today. I represent the Untied States Magnetic Materials Association, a trade association dedicated to the reestablishment of the entire supply chain of materials used in magnet systems.

These systems play a vital role in the health of the United States defense industrial base and renewable energy. Our association represents all segments of the United States magnetic industry and rare earth supply chain, including miners, processors, metal and alloy producers, and finished magnet manufacturers.

My comments today will relate to strategic-level rare earth issues and the challenges we face in accessing reliable supplies of the critical materials. It is common knowledge that rare earth materials play a critical role in the basic functionality of key green technologies, such as hybrid cars and wind turbines.

They are essential to electronic consumer goods, such as flat screen televisions and disk drives. Rare earth products are necessary in vital military technology, such as munitions, missiles, radar surveillance, and avionics.

Often overlooked is the global market for rare earth materials and the value chain itself. Today's domestic rare earth supply chain consists of one company capable of mining and separating rare earth elements into oxides; no active rare metal makers; two companies that can make limited quantities of rare alloy, and one rare earth permanent magnet maker.

The United States is largely dependent on foreign sources for these critical materials. China firmly controls 97 percent of the world's rare earth oxide supply, nearly 100 percent of commercial sales of rare earth metal, and over 75 percent of neo magnet production.

This dominance allows China to wield considerable influence. For instance, merely a rumor of an expert ban on rare earths to Japan sent a chill through the industry last summer.

China has linked access to its markets and resources with moving operations to China, and providing them with key technologies. The members of the USMMA could feasibly provide a secure, non-Chinese source of the supply to the United States in as little as 12 months, but policy and funding decisions will need to be made to do so.

With little guaranteed domestic demand for many rare earth metals and alloys, and the lack of a single licensed producer of neo magnets, the future of the domestic rare earth industry remains uncertain.

To mitigate the impact of foreign supply disruptions, the USMMA is a strong proponent of a manufacturing first strategy. By establishing the ability to manufacture rare earth end products, the manufacturing first strategy creates downstream demand for rare earth elements.

This provides incentives for commercial interests to fill in the domestic value chain, while leveraging raw material from ally nations and domestic producers. By supporting the manufacturing first strategy, the United States government could signal to industry that it will not stand by as China attempts to dominate the global rare earth magnet industry.

Through our advocacy efforts, the USMMA has identified numerous misperceptions in the media, academia, and sometimes on Capitol Hill. To counter these misperceptions, the USMMA released a myth-fact paper earlier this month. I would like to share with you a few of the points.

First, it has been said rare earths are not rare. This is not totally accurate. While rare earths are abundant in the earth's crust, the ability to locate concentrations that are economically viable for extraction and processing is rare.

Second, some believe United States capabilities can come online rapidly to fill the supply gap. However, mining and extraction is only a small part of the rare earth value chain. Aside from the 10 year average permitting time for a rare earth mine, concentration and separation facilities are extremely complex and can cost upwards of $500 million per location.

Third, recent reports from market analysts and previous statements from the Department of Defense suggest that supply will soon equal or exceed demand for rare earths. While demand will be met for some of the more prevalent elements, shortages for materials like the heavy rare earth dysprosium will continue.

Fourth, some suggest that substituting, recycling, or reusing rare earths is a viable alternative. While the USMMA supports efforts in all these areas, they are not a panacea. Currently, no viable alternatives are available for many materials. R&D, though promising, faces a development cycle of up to a decade for commercialization.

Finally, some suggest that stockpiling will further restrict an already tight supply. The bipartisan RESTART Act, H.R. 1388, and the Rare Earth Inventory Plan included in the Fiscal Year 2012 National Defense Authorization Act, would require planning for a limited vendor-managed inventory of rare earth materials to support our national security.

This inventory would likely constitute a tiny fraction of global demand, but provide an insurance policy for the United States. Rare earths are an example of the broader strategic and critical materials issues that our Nation faces. Solutions are possible.

The USMMA has suggested a six-point plan to close those gaps, which can be applied to other strategic and critical materials. It includes: (1) establish a baseline through a government supply and demand analysis; (2) team with allied nations to provide critical raw materials to supplement existing domestic mining and separation capability; (3) ensure fair trade practices; (4) invest in domestic manufacturing capability through programs such as the Defense Production Act; (5) establish an inventory of rare earth material using the Defense National Stockpile; and (6) invest in research, development, and education.

Because this is a Natural Resources Committee, we would add a seventh item. Establish an interagency task force to address the often bureaucratic lengthy permitting process. We do not support circumventing appropriate rules and regulations, but we do encourage focusing resources and finding efficiencies to support the process.

In closing, China will continue to leverage its global dominance in the strategic and critical material supply chain until the United States and its allies can commit to action that will counter-balance this influence.

The United States needs to begin to take the steps immediately to eliminate this current and growing threat to our economic and national security.

[The prepared statement of Mr. Richardson follows:]

Statement of Ed Richardson, President,
U.S. Magnetic Materials Association

Chairman Lamborn, Ranking Member Holt, distinguished Members of the Subcommittee,

Thank you for the opportunity to testify today. I represent the United States Magnetic Materials Association, a trade association dedicated to the reestablishment of the entire supply-chain of materials used in magnet systems. These systems play a vital role in the health of the U.S. defense industrial base and in the future potential of renewable energy in our nation. Our Association represents all segments of the U.S. magnet industry and rare earth supply-chain, including miners, processers, metal and alloy producers and finished magnet manufacturers. My comments today will relate to strategic-level rare earth issues and the challenges we face in accessing reliable supplies of the critical materials needed to support our industry.

When you hear about the crumbling infrastructure in the United States, it's not just roads, bridges, and sewer pipes. It's advanced industrial technologies, as well as the supply chain of critical materials to support those technologies. Frankly, we've lost many of the key capabilities to produce these technologies domestically—losing our nation's technological edge in the global marketplace. This situation absolutely holds true when it comes to advanced applications—both energy and defense—that use rare earth oxides, alloys, metals, or magnets

The Rare Earth Value Chain

It is common knowledge that rare earth materials play a critical role in the basic functionality of key green technologies such as hybrid cars, wind turbines, and compact fluorescent lights. They are essential to digitized and miniaturized electronic consumer goods such as flat screen televisions, mobile phones, and disc drives. Rare earth products are necessary in vital military technologies such as munitions, missiles, radar surveillance, and avionics. Discussion forums at think tanks, in academia, and in the media often raise these issues.

Less frequently discussed is the global market for rare earth materials and the value chain itself. This value chain consists of three distinct elements:

- The miners of rare earth oxides, such as Molycorp in California and Lynas in Australia, both of whom are in the process of starting new operations;
- The processors that turn the oxides into usable alloys, such as Great Western Technologies and Santoku America; and
- The magnet manufacturers such as Electron Energy Corporation that take those metals and alloys and produce finished products.

It is important to note that most assets that make up the rare earth value chain do not exist here in the United States. In fact, today's U.S. rare earth supply-chain consists of one company capable of mining and separating rare earth elements into oxides, no active rare earth metal makers, two companies that can make limited quantities of rare earth alloy, and one rare earth permanent magnet maker.

Thomas & Skinner, for instance, had made sintered neodymium iron boron permanent magnets—used in several missile systems—but like other producers, got out of this business years ago and do not have a plant to make these magnets today. Companies such as Thomas & Skinner and Arnold Magnetic Technologies have publically stated their desire to reenter this market if and when market conditions support it.

Foreign Sources

The United States is largely dependent on foreign sources for these critical materials. China firmly controls 97 percent of the world's rare earth oxide supply, nearly 100 percent of commercial sales of rare earth metal, and over 75 percent of neodymium iron boron magnet production.

This monopolistic power enables them to wield considerable influence. For instance, merely a rumor of an export ban on rare earths to Japan sent a chill through the industry last summer. China has linked access to its markets and resources with moving operations to China and providing them with key technologies. On May 19, the Wall Street Journal reported that China is once again expanding its export-quota systems and imposing higher taxes on rare earth materials. This further constricts an already tight supply. Moreover, this announcement contains a worrisome new requirement that export limits, which once only applied to concentrates and then expanded to oxides and metals, will now include ferroalloys. This demonstrates yet another move down the supply-chain from natural resources to value-added processes.

As they continue to reduce export quotas and expand the materials covered, manufacturers must make the hard choice of either relocating to China to access raw materials or risk severe uncertainty regarding long-term availability of supply.

Thankfully, there are companies in ally countries that can assist in this dilemma. For instance, Less Common Metals currently has a metal processing and alloying operation in the UK. Through its members, the USMMA has joined together existing global assets to provide non-Chinese rare earth elements, metals, alloy and magnets. The members of the USMMA could feasibly provide a secure, non-Chinese source of the supply to the United States in as little as 12 months, but policy and funding decisions will need to be made to do so. With little guaranteed domestic demand for many rare earth metals and alloys, and a lack of a single licensed producer of neodymium iron boron magnets, the future of the domestic rare earth industry remains uncertain.

Manufacturing First Approach

To mitigate the impact of foreign supply disruptions, the USMMA is a strong proponent of a "Manufacturing First" strategy. By establishing the ability to manufacture rare earth end products, the "Manufacturing First" strategy creates downstream demand for rare earth elements. This provides incentives for commercial interests to fill in the domestic value chain for rare earth elements while leveraging oxides available from ally nations and domestic producers coming online. By supporting the "Manufacturing First" strategy, the U.S. government could signal to industry that it will not stand by as China attempts to dominate the global rare earth magnet industry. In addition, this approach provides U.S. manufacturers an alternative to Chinese suppliers. This would be the first critical step in decreasing U.S. industry's dependence on foreign suppliers.

Perhaps of greatest concern is the total lack of any current capability to make sintered neodymium iron boron magnets. As I noted, there are currently no U.S. producers of these magnets; this is due to the inability to obtain the necessary license from the current patent holder. This imperils U.S. national security in particular because this patent holder, as a matter of policy, will not produce defense-specific magnets. This leaves our defense supply-chain largely dependent on China for access to these key materials.

Moving Forward Through Increased Understanding

In sum, much of our most critical and strategic technologies are dependent on foreign suppliers to make them work. And this is a situation that should make anyone—whether in the U.S. government, military, industry, or general public—very uncomfortable.

Through our advocacy efforts, the USMMA has identified numerous misperceptions in the media, academia and sometimes on Capitol Hill. To counter these misperceptions, the USMMA released a Myth-Fact paper earlier this month. I'd like to share with you a few:

- First, it has been said "rare earths aren't rare." This is not totally accurate. While rare earths are abundant in the earth's crust, the ability to locate concentrations that are economically viable for extraction and processing is rare.
- Second, some believe U.S. capabilities can come online rapidly to fill the supply-gap. However, mining and extraction is only a small part of the rare earth value-chain. Aside from the 10-year average permitting time for a rare earth mine, concentration and separation facilities are extremely complex and can cost upwards of $500 million per location.
- Third, recent reports from Goldman Sachs and previous statements from the Department of Defense suggest that supply will soon equal or exceed demand for rare earths. While this is true for some of the more prevalent elements, a long-term global shortage for materials like the heavy rare earth dysprosium will not be mitigated in the foreseeable future.
- Fourth, some suggest that substituting, recycling or reusing rare earths is a viable alternative. While the USMMA supports efforts in all these areas, they are not a panacea. Currently, no viable alternatives are available for many materials and R&D, though promising, faces a development cycle of up to a decade for commercialization. Furthermore, many systems using rare earths, such as weapons, are legacy systems that will be in inventory for decades. This also applies to commercial technologies and refining capabilities that will both require increasing quantities of rare earths.
- Finally, some suggest that stockpiling, as proposed in H.R. 1388, the Coffman RESTART bill, will further restrict an already tight supply. This is a misinterpretation of what Mr. Coffman is proposing. The RESTART Act and the Rare Earth Inventory Plan included in the FY12 National Defense Authorization bill would require planning for a very limited vendor-managed inventory of rare earth materials such as alloy and magnets that would be available to support our national security in the event of a crisis. This inventory would likely constitute a tiny fraction of global demand and be inconsequential in the market, but provide an "insurance policy" for the United States.

Rare earths are an example of the broader strategic and critical materials issues our nation faces. Solutions are possible. We hope this committee will address these challenges and help close the gap on other critical materials. The USMMA has suggested a six-point plan to close those gaps, which can be applied to other strategic and critical materials. It includes:

1. Establish a baseline by thorough supply-demand analysis conducted by the U.S. Government
2. Team with ally nations to provide critical raw materials to ensure a reliable source of supply supplements existing and future domestic mining and separation capabilities
3. Ensure fair trade practices are enforced by the United States Trade Representative
4. Invest in domestic capability through programs such as the Defense Production Act to close critical supply-chain gaps
5. Establish domestic manufacturing capability through tools such as the Defense National Stockpile that both incentivize industry investment and address national security concerns; and
6. Invest in future innovation through research, development and education

Because this is the Natural Resources Committee, we would add a seventh item to that list: establish an interagency Task Force to address the often bureaucratic and unnecessarily lengthy permitting process. We do not support shortcuts that circumvent appropriate rules and regulations, but we do encourage expediting applications by focusing resources and finding efficiencies to support the process.

In closing, China will continue to leverage its global dominance in the strategic and critical material supply chain until the United States and its allies commit to action that will counterbalance this influence. The US needs to begin to take steps immediately to eliminate this current and growing threat to our economic and national security.

Mr. LAMBORN. OK. Thank you.

Mr. HOLT. Mr. Chairman, at this point, I would like to raise a parliamentary inquiry.

Mr. LAMBORN. Can I say one thing first?

Mr. HOLT. Yes.

Mr. LAMBORN. Our last speaker will be Daniel McGroarty of the American Resources Policy Network. And I have been told by staff that he was invited at the last minute, and so we appreciate your ability to be here given the lateness of the request. And now, Mr. Ranking Member, did you have a comment?

Mr. HOLT. Yes. Mr. Chairman, is it not true that Committee Rule 4[a] applies, which requires that each witness to appear must submit to the Committee at least two working days before the appearance written testimony, and failure to do so could result in barring the testimony? I believe that applies.

Mr. LAMBORN. I do.

Mr. HOLT. I am not trying to make trouble here, and will agree to the witness continuing. I just want to make the point that having the testimony in advance is really important for the Committee and the Committee staff to be able to prepare for the hearing.

And I don't know whether this was because the witness was invited too late, or the witness was slow in providing the testimony, I don't know. All I know is that without the prepared testimony that it makes it more difficult for us.

Mr. LAMBORN. Well, Mr. Holt, that is a point well taken, and we certainly don't want to blame the witness, because he was invited late. So, we will blame it on the Committee, the staff, myself, for not having been far enough in advance on that.

Mr. HOLT. Thank you, Mr. Chairman.

Mr. LAMBORN. But that is a point well taken.

Mr. HOLT. I withdraw my parliamentary objection and inquiry.

Mr. LAMBORN. OK. Thank you. Now to you, Mr. McGroarty.

STATEMENT OF DANIEL McGROARTY, PRESIDENT, AMERICAN RESOURCES POLICY NETWORK

Mr. MCGROARTY. My thanks to the Members of the Subcommittee for the opportunity to testify today. My organization, the American Resources Policy Network, is a newly launched experts forum dedicated to informing public opinion and public policy on the importance of developing United States mineral resources.

I am also a member of the Board of Directors of Colorado Rare Earths, a publicly held development company. The subject before this Subcommittee, the concept of critical minerals, and the potential for supply disruption, has become front page news, particularly after the de facto embargo imposed by China against Japan last fall, in the wake of a dispute over claims involving mineral rights beneath the East China Sea.

Some consider this a case of China test firing a resource weapon. Others point to China's rapid growth as the reason that it is cutting back exports and using more rare earths at home.

In the end, whether China withholds its rare earths or consumes them, the result is the same—a shortage of metals critical to our technological and economic development, as well as our national security.

In April, I took part in a Rare Earths Markets conference in Sanya, China. My informal conversations with Chinese attendees followed a well-worn track. They hear that the United States is studying the rare earths, issuing reports, and writing bills.

They hear that American companies are taking steps to develop rare earths mines. Their immediate question is do you have your permits? How many tons will the mines produce? How soon? The message is, unmistakably, if there is a resource race, China is in full sprint. They see us standing at the starting line.

This issue goes well beyond the rare earths, and take what I call the single scariest page. We have already seen it in any government document: page 6 of the United States Geological Survey's annual report, 18 metals, a hundred percent dependent, and 13 more, 80 to 99 percent dependent.

Compare that with foreign oil, where the United States imports only 57 percent. In fact, if oil were on the United States Geological Survey's list, it would appear in forty-second place.

Look further down that list and you will see mainstay metals like copper, in increasing demand, and at increasing risk. In addition to its commercial uses, copper is critical for defense applications. DoD reports show that copper ranks second behind aluminum in annual consumption for defense industrial applications.

Compared to near 100 percent dependency for rare earths, the fact that the United States today imports 30 percent of the copper that we consume may seem manageable, even acceptable, but to put that number in perspective, look back to 1993—the year the last metric ton of copper was sold out of the National Defense Stockpile.

In 1993, United States mines produced 1.8 million metric tons of copper, roughly 60 percent more than 2010. Our net import dependency was 7 percent, not 30 percent, as it is today.

As for disruption, the key concern of this Subcommittee, an OSD study lists copper as a metal that has—and I quote—already caused some kind of significant weapon system production delay for DoD.

If the United States were to simply stop mining copper today, there are known copper prospects in a number of countries—Chile, Peru, the Philippines—that might step up supply, or demand might be met through mines in Russia, Angola, Afghanistan, Democratic Republic of the Congo, or China, including decisions taken in Beijing to exploit copper reserves in the Tibet Autonomous Region. There is also copper in Pakistan and Iran.

With the exception of Pakistan, rated partly free, all of the latter group are rated not free in the current Freedom House index. So, while the world copper market does offer choices, we might find those choices unpalatable from a policy perspective.

In the end, base metals and technology metals are not so easy to separate. Take rhenium, as you have already heard. Rhenium isn't mined, but rather recovered during the processing of copper and molybdenum, captured in the flue-dust thrown off by the roasters. Otherwise, rhenium goes up in smoke.

Rhenium is used today in jet engines, like those in the Boeing 777, and in the national security sphere, you will find rhenium in rocket thrusters that reposition satellites, high performance test

engines that power the F-15, F-16, F-18, and the new F-35 Joint Strike Fighter, as well as in stealth aircraft.

Global rhenium production is minuscule; 52 tons worldwide. That is roughly the weight of about two dozen SUVs, but the need is critical. The United States imports 86 percent of its rhenium, much of it in recent years from Chile and Kazakhstan.

Once again, we face critical questions about a critical material. Will the market supply sufficient rhenium for our commercial and national security needs? Are we comfortable with the geopolitical risk implicit in 86 percent foreign dependency?

Should we add rhenium to the National Defense Stockpile, or instead advise American copper and moly producers to invest in technologies necessary to capture rhenium now lost in the roasting process?

Similar questions can be asked about several dozen minerals, and it is my hope through this Subcommittee that they will be. We cannot maintain our modern economy without a steady supply of metals and minerals.

Those that we do not possess here at home, we must source from other countries, but those that we possess, but choose not to produce, perpetuate needless foreign dependence, leverage that other nations may use to America's disadvantage. We must recognize resource security as a national strategic imperative. Thank you.

[The prepared statement of Mr. McGroarty follows:]

Statement of Daniel McGroarty, President, American Resources Policy Network

My thanks to the members of the House Sub-Committee on Energy and Mineral Resources for the opportunity to testify today. I am Daniel McGroarty, President of the American Resources Policy Network (www.AmericanResources.org), a newly-launched experts organization dedicated to informing the public—and ongoing policy debates—on the importance of developing U.S. mineral and metals resources and reducing American dependency on foreign sources of supply. I am also a member of the Board of Directors of Colorado Rare Earths, a public-held company currently developing Rare Earths properties, with the aim of adding to the domestically produced supply of metals critical to our green-tech economy and our cutting-edge defense systems. The subject before this sub-committee—the concept of critical metals and minerals, and the potential for supply disruption—is an issue of enduring interest to me.

The Rare Earths

In recent months, the Rare Earths have put this issue on the front page—particularly since last fall, with the apparent embargo imposed by China against Japan, in the wake of a dispute over claims involving mineral rights beneath the East China Sea.

With China providing 97% of the world's Rare Earths supply, that episode underlined for the U.S. the dangers of resource dependency, and sparked an acceleration of interest in the U.S. policymakers.

Whether this episode constituted a test-firing of China's "resource weapon," or whether the shut-off was due to more benign factors continues to be debated. Even if there were no geo-strategic motive behind China's supply interruption, there is the fact that Chinese demand for Rare Earths—and dozens of other metals and minerals—is surging, with only a minor pause due to the global economic downturn. With 1.3 billion people and an 8 to 9 percent annual economic growth rate, Chinese mining officials have begun to float the possibility that China may be a net importer of Rare Earths as early as 2015.

So, whether China withholds its Rare Earths supply for geo-strategic purposes, or consumes an ever-increasing amount of the metals it used to export to the so-called "Rest of the World," the result will be the same: A shortage of a group of met-

als critical to our technological and economic development, as well as our national security.

In April, I presented as a panelist—the only American presenter—at the 2011 Rare Earths Markets Seminar, in Sanya, China. I'd like to share with the sub-committee a recurring theme in my informal conversations with the Chinese attendees. Ideology aside, for a Chinese technocrat, pragmatism rules the day. They hear that the U.S. is studying the Rare Earths situation, issuing reports, preparing bills and even considering participating in a possible WTO action. They also hear that American companies—Molycorp being the most prominent, but others including Colorado Rare Earths—are pressing forward to develop rare earths mines. But their immediate question is: When will mining begin? Do you have your permits? How much will the mine produce? They simply do not take the U.S. seriously on this issue—not compared to Australian companies or Canadian companies—and that's an ominous sign. The message was unmistakable: If there's a resource race, China is in full sprint, and they see us standing at the starting line.

Profile of Dependency

And the Rare Earths are simply the most prominent group of metals where the U.S. has a significant dependency. Consider what I call the single scariest page in any document to come off the presses of the U.S. Government Printing Office: Page 6 of the U.S. Geological Survey's (USGS) Mineral Commodity Summaries, 2011. There you'll find a chart titled: "2010 U.S. Net Import Reliance for Selected Nonfuel Mineral Materials."

The Rare Earths, taken as a group, are just 1 of 18 metals and minerals for which the U.S. is 100% dependent on foreign sources of supply. Add another 13 metals and minerals for which our dependency is 80 to 99 percent.

Compare that with foreign oil, where the U.S. imports "only" 57%.

In fact, if oil were on the USGS list, it would appear in 42nd place—with 41 metals and minerals above it.

The names may be exotic—indium, thorium, vanadium, tantalum, germanium—but the industrial sectors affected constitute a cross-section of the U.S. economy, from aircraft engines, auto batteries, compact fluorescent bulbs and flat-screen displays to the wind turbines we hope will power clean energy and weapons systems we count on to protect us.

Copper: A Mainstay Metal

So-called technology metals may grab the spotlight, but mainstay metals like copper are also seeing rising demand. This may run counter to our own personal perceptions—as we think of PVC replacing copper pipe in household plumbing, or fiber optics displacing copper wire in telecomm—but that's misleading. Copper continues to be a critical material in electronics, building construction, durable goods and automobiles. In the last category, for instance, hybrid vehicles require double the amount of copper as gas-fueled automobiles.

Copper is critical for defense applications as well.

Department of Defense reports show that, by volume, copper ranks second—behind aluminum—in annual consumption for defense industrial applications.

But what about the general level of U.S. dependency for foreign-sourced copper?

Compared to near 100 percent dependency for Rare Earths, the fact that the U.S. today imports 30 percent of the copper we use from foreign sources may seem manageable, even acceptable. But to put that number in some historical perspective, I ask the sub-committee to look back to 1993—the year the last metric ton of copper was sold out of the National Defense Stockpile.

In 1993, U.S. Mines produced 1.8 million metric tons of copper—roughly 60% more than in 2010. Our net import dependency was 7%—not 30% as it is today. Half of what we did import came from Canada. Today 60% of our copper imports come from Chile, Peru and Mexico.

While total reserves are not a perfect proxy for exploration efforts, nonetheless—since 1993, world copper reserves have more than doubled. Over that same period, U.S. copper reserves have declined—from 15% of the world total, to just over 5%.

I do not present these statistics as an argument for a return to the stockpile concept as it existed at the close of the Cold War. My purpose is to suggest that the realities that prevailed less than 20 years ago—when we effectively stopped thinking about the strategic aspects of mineral and metals supply—no longer pertain.

As for disruption—the key concern of this sub-committee—OSD Defense Planning Scenarios show that copper is among the metals vulnerable to PSD—Peacetime Supply Disruption. Another OSD study lists copper as a metal that has—and I quote—"*already* caused some kind of significant weapon system production delay for DoD." According to MIT's Dr. Elisa Alonso—one of American Resources Policy Network's

experts—". . .the risk of copper disruption is significantly greater than for other major metals (e.g., iron and aluminum) and is at or near to a historical high."

Now, to be sure, we live in a globalized economy, and indeed—if the U.S. were to simply stop mining copper today—there are known copper prospects in a number of countries. We might turn to Chile, Peru and the Philippines for increased copper supply. Then again, world demand might be met via development of known copper reserves in Russia, Angola, Afghanistan, DRC Congo, or China—including decisions taken in Beijing to exploit copper reserves in the Tibet Autonomous Region. And there is copper in Pakistan and Iran. With the exception of Pakistan—rated "Partly Free"—all of the latter group are rated "Not Free" in the current Freedom House index. So while the world copper market does offer choices, we may well find many of those choices unpalatable from a policy perspective.

Rhenium: Where Base and Technology Metals Meet

In the end, the so-called base metals and technology metals are not so easy to separate. Take my third example this morning: Rhenium, a relatively obscure element, Atomic Number 75 on the Periodic Table.

In the commercial economy, rhenium is used to process lead-free gasoline, in gas-to-liquid power plants and in jet engines like those found on the Boeing 777. In the national security sphere, rhenium is used in the small rocket thrusters that reposition satellites in geo-sync orbit, as a super-alloy in the high-performance jet engines that power the F–15, F–16, f-18 and the new F–35 Joint Strike Fighter—as well as in stealth aircraft. Rhenium is prized for its ability to retain its strength, shape and conductive properties at extremely high temperatures.

While global copper production is 16,000,000 metric tons and global rare earths production is more than 100,000 metric tons—rhenium production is 52 tons, worldwide. That's roughly the weight of a dozen SUVs.

The catch is that rhenium isn't mined; rather, it is recovered—extracted as a by-product during the processing of copper and molybdenum, by special scrubbers that capture rhenium particles in the flue-dust thrown off by the roasters.

Right now, the U.S. imports 86 percent of its annual rhenium requirement, much of it in recent yearsfrom Chile and Kazakhstan. More could be done to capture rhenium from domestic copper and moly mining, which otherwise literally goes "up in smoke."

Once again, the U.S. has critical questions to ask about a critical material. Will the market supply sufficient rhenium for our commercial and national security needs? Are we comfortable with the geo-political risk implicit in an 86% dependency on foreign supply? Should we add rhenium to the National Defense Stockpile—or otherwise incentivize American copper and moly producers to invest in the technologies necessary to capture rhenium now lost in the roasting process?

These same sorts of questions can be asked about several dozen metals and minerals, and it is my hope they will be.

Encouraging Domestic Supply

Whether we are talking about copper, rare earths, rhenium or others among the dozens of metals and minerals where the U.S. presently relies on significant levels of foreign supply, it is time to consider whether U.S. policy is impairing our ability to develop domestic supply—and how we can remove obstacles that will allow the U.S. to achieve a greater degree of resource independence.

Clearly, the U.S. Congress is turning its attention to critical metals. Remedies under discussion range from reviving the National Defense Stockpile to utilizing loan guarantees, and re-examining a mining permitting process that routinely runs 7 or 8 to 10 years to bring a new American mine into production. In the House, several bills on Rare Earths have been introduced, including Congressman Mike Coffman's RESTART Act, which, among its provisions, directs that federal agencies expedite the permitting process for Rare Earths "without waiving environmental laws." A comprehensive review of U.S. permitting processes is also central in the draft bill being circulated by Senator Lisa Murkowski. The argument for such a review is evident in independent reports like the Behre Dolbear Group's "2011 Ranking of Countries for Mining Investment" survey—known in mining circles as the "Where Not to Invest" Report—where the U.S. once again ranks worst—dead last—among 25 mining nations in the length of its permitting process.

Critics of U.S. mining will assert that any re-assessment of our permitting practices will involve weakening or watering down our requirements—the assumption being that a process that lasts a decade or more is the price we pay for safe and environmentally sound mining projects. The choice will be cast as trading developed nation standards for a 3rd World "anything goes" approach. From a public policy perspective, that's not at all the case. Australia, for instance—one of the world's

most prosperous nations, and no one's candidate for a country that is an environmental scofflaw—manages to permit new mining projects in one to two years.

Reviewing our own permitting process with an eye towards rationalizing that process is not at all a matter of cutting corners—quite the contrary: Mining projects developed here in the U.S. are, on balance, likely to be conducted with higher standards of safety, against stronger environmental strictures, with better benefits to the surrounding communities than projects in many parts of the world. And projects developed here will lessen if not eliminate the "surety of supply" issue and fear of materials disruption that concerns this sub-committee.

We cannot maintain our modern economy without a steady supply of metals and minerals. Those we do not possess here at home, we must source from other countries. But those we possess but choose not to produce perpetuate a needless foreign dependence—leverage that other nations may well use to America's disadvantage.

I commend the Congressmen and -Women who called today's hearing, a step that suggests critical metals and their continued supply are beginning to receive the attention they deserve—given their importance to our economy, our technological progress and our national security. Thank you.

Mr. COFFMAN [presiding]. Thank you, Mr. McGroarty, for your testimony, and I thank everyone for their statements. We will now begin questioning. Members are limited to five minutes for their questions, but we may have additional rounds. I now recognize myself for five minutes.

I have been actively involved in legislation regarding today's hearing topic over the last few years. Just last month, I reintroduced the RESTART Act, the Rare Earths Supply Chain Technology and Resources Transformation Act, to avert a United States rare earths supply chain crisis, by restoring our Nation's production of rare earth metals.

In essence, the legislation would focus on the United States supply chain—as we in our country often rely on unreliable foreign suppliers. During the House Armed Services Committee markup of the Defense Authorization Act earlier this month, I offered an amendment that requires the Defense Department within what we use to call the Defense National Stockpile, to develop a plan to establish an inventory of rare earth oxides, metals, alloys, and magnets, for defense purposes.

These rare earths are absolutely critical to the functionality of numerous weapons systems. An inventory would help assure defense manufacturers that they will have access to a reliable domestic supply to meet national security requirements.

I ask the witnesses to consider the advantages and challenges of creating such an inventory. My legislation also focuses on expediting the permit process here in the United States.

I know that some of you have discussed this in your testimony, but could you elaborate on this problem? Go ahead and proceed. Why don't we start with Professor Eggert.

Dr. EGGERT. Thank you very much. With regard to stockpiles, in general, it is important I think to distinguish between economic stockpiles and defense stockpiles. As I understand it, your legislation focuses on defense stockpiles.

My personal view is that I would look toward the analysts at the Defense Department and those who have studied this specific issue, and if they believe that stockpiling is an important part of a series of activities to secure supplies, then I would support that.

Mr. COFFMAN. Good. Anyone else? Yes.

Mr. LATIFF. Yes, sir. The question of the stockpiling is an excellent one. I have not read the legislation, but I would actually support that. Having managed major weapons systems for many years, I can tell you, and as you probably already know, that any disruption in the supply of material for the manufacture of a weapons system can only lead to increased costs and an increased schedule.

So, having a stockpile of these most critical ones is probably a very good idea. Number two, the type of stockpile is really at question, and whether or not it is a stockpile of materials, or perhaps a rolling inventory, might be a pertinent question to ask as well.

Mr. RICHARDSON. Mr. Coffman, I would just add that from our perspective the USMMA thinks a stockpile is a very important part of the solution. We think that there are ways to stockpile metals that can quickly then be used in the case of a defensive need.

It is not necessarily advantageous to stockpile neodymium oxides, for instance. A better way might be to stockpile a generic neodymium boron alloy, and stockpiling alloys would give us capabilities beyond what we have today.

Mr. COFFMAN. My time is limited. Mr. McGroarty, could you—I have been concerned that China is not a reliable trading partner, and I wondered if you could—well, the fact that they have a near monopoly status on these rare earth metals puts us, the United States, in a vulnerable position. Could you comment on that?

Mr. MCGROARTY. Thank you, Mr. Coffman. I can draw attention to the speculation about what China particularly did last fall when there was some controversy, but clearly in retrospect, and fairly quickly in retrospect, it seems like imports to Japan were cut off.

This had to do with a controversy in the East China Sea, which interestingly involves mineral rights, at least in part, underneath the sea. Their intentions, I think, in China, and perhaps not a single line that the Chinese government follows on these issues, many people—and I was inclined in this direction, and thought that this could have been kind of a test fire of a resource weapon, and China cracked the whip if you will when they had this dispute with Japan, I wonder in retrospect if that was wise, because it seemed to raise concern and interest in the United States and other countries about the surety of supply, and may have sparked, and did spark, an accelerated interest in coming up with the remedy that did not involve dependence on the Chinese.

That said, the Chinese are growing at 8 to 9 percent. These are technology metals, particularly in the rares. The Chinese, we know, want to build their own green manufacturing base.

They are looking to not just mine metals and export them, but to bring manufacturing to where the metals, particularly in the north of China, that is economic, and that is not national security. They are growing at this rapid rate, and they are using more and more of these metals.

My sense in some of the interaction at the conference when I was in China last month, there is actually a strong contingent in China that is actually encouraging non-Chinese development, because they may want to be a buyer of rare earths.

They may want to see a non-Chinese supply that they can buy into, and certain Chinese companies have been State-supported

companies and interested into buying into non-Chinese sources of rares. It is a whole different issue.

So, it has got a national security edge, and it has got an economic edge, and either one argues for more pressure in terms of our access to supply.

Mr. COFFMAN. Thank you for your testimony. The Chair now recognizes the Ranking Member for five minutes.

Mr. HOLT. I thank the Chair. I would like to pursue the broad questions of research and education here. It seems to me that it is not just supply, but it has to do with identifying deposits, concentrating, and refining, as much as anything.

And, Professor Eggert, I would like to begin with you. What conceivable advances are there in—and let us talk about rare earths, or you can choose some other minerals if you want, in identifying deposits that haven't been identified?

I mean, is there a lot of work yet to be done in understanding where these things are, and then in concentrating, refining, and developing other sources outside of these recalcitrant countries?

Is there research to be done that we have a reasonable expectation of being productive?

Dr. EGGERT. If we look at rare earths in particular, my view is that we should, in balancing research on the demand side, and substitutional research, yes.

Mr. HOLT. Well, I wanted to get to that in a moment.

Dr. EGGERT. Well, versus the supply side, and that there is relatively more opportunity on the supply side than the demand side in the following sense. Rare earths are a relatively young resource in terms of our devoting any attention to discovering minable deposits.

There are probably two deposits, the Mountain Pass deposit in California, and the Baiyun Obo Mine in China that probably account for 40 to 50 percent of all the rare earths ever mined in the world, and so we have not spent a lot of time looking for them.

Mr. HOLT. Right, and if I am not mistaken, they may be 40 or 50 percent of the rare earths that are acquired and mined, but a rather small fraction of the rare earths that might or are expected to be out there?

Dr. EGGERT. That is right. There is significant room for progress in the geologic science aspect of this issue. Also, arguably the greatest supply constraint of rare earths relates to mineral processing and extraction of metallurgy, and the separating of the rare earths from one another. They like to be together. We don't do a good job at present of separating them.

Mr. HOLT. Well, again, that is what I was getting at. So, there is research work to be done. Who does that, and what is the role of the United States Geological Survey, for example, in supporting such research?

How much is the private sector doing now, and who supports the doctoral students, or the research students that you might have at the Colorado School, for example?

Dr. EGGERT. At present, there is very little, if any, Federal support for graduate education in economic geology, mineral processing, and extractive metallurgy. There is some support from in-

dustry, and clearly industry is doing work, research, related to geology and extractive metallurgy.

But it is in the realm of recompetitive research activities that I think we are missing out on the opportunity for.

Mr. HOLT. And what about the United States Geological Survey?

Dr. EGGERT. The United States Geological Survey is undertaking research related to geologic aspects of rare earths. It probably could be enhanced, and I would certainly support that.

Mr. HOLT. OK. Dr. Jaffe, for end-use research, what is the role of the Department of Energy? What is the Office of Science and Technology Policy doing to promote or categorize, or direct the end-use research? Do you have any thoughts on that?

Dr. JAFFE. Well, historically, the Office of Science and the Department of Energy has supported energy and the basic energy sciences relating to materials and materials fabrication, and determining the properties of materials that would make them useful as possible substitutes for rare materials.

This has not to my knowledge been reconstituted in the recent past in order to provide more emphasis on these emerging shortfalls. Typically, the characterization of materials is done in a university and national lab environment, and a relatively half-hazard way, focused on individual end-users, and not on analyzing a wide spectrum of materials looking for earth abundant substitutes. That kind of research would be needed.

Mr. HOLT. Thank you, Dr. Jaffe. And let me just say to the Chair that I hope that we can have continuing hearings involving representatives of our trade negotiators, and the State Department, as well as the Department of Energy, and the Department of Defense, and even agencies that are outside of our jurisdictions, so that we can have a good understanding of really what the problem is, and how we can address the problem on the supply side and the demand side. Thank you.

Mr. COFFMAN. Thank you, Mr. Holt. Mr. Thompson for five minutes.

Mr. THOMPSON. Thank you, Mr. Chairman. Thank you, gentlemen, for your testimony. Dr. Eggert, you state in your written testimony that these rare earth materials are specifically needed for some energy technology, such as solar cells, wind turbines, hybrid vehicles, CFLs with the light bulbs.

Are there other—what is the impact on other manufacturing or potential manufacturing within the United States for the application of technologies utilizing the rare earth or the other minerals that were in question today?

Dr. EGGERT. The main concern is what I would call the specter of unavailability, and the idea that an essential element that is needed usually in only small quantities creates a no build situation for a manufacturer.

In most cases the issue is not so much one of high prices resulting from shortages, but rather the essentialness of the element for a specific application, and the knock on effects in terms of production, profitability, and so on.

Mr. THOMPSON. Very good. When you look at the application, and I know that we are looking at our dependence, foreign dependence on these, but I have to believe that maybe even some industries

that we have lost, maybe if we had a ready supply of this the application of this new technology and these minerals, with the proper supply, we could repatriate some industries back to the country.

It has been made clear by several panelists that none of these materials are anywhere near being depleted, but I agree that it is important that we do what we can to recycle these materials.

Dr. Jaffe, you suggested consumer incentives to help recycle materials and devices such as cell phones and i-Pods. Do you have any specific ideas?

Dr. JAFFE. Well, there are a variety of ideas that are being tried out in the European Union, including rental rather than purchase of materials. So, your cell phone comes to you from a company, and then when you are finished with it, they take it back.

Another example that is being done here in the United States for the Solar Corporation, which is one of the leading manufacturers of thin film photovoltaics, which use both exotic and toxic compounds.

They use tellurium, which is very rare, and cadmium, which is toxic, and they create a bond when they sell the solar panels, the bond assuring repatriation, or repossession of those solar panels when their lifetime is finished, so that they can not only control the toxic cadmium, but also reuse the very valuable tellurium.

This is in a very early stage, and our report urged that the Committee on Critical Minerals of the National Science and Technology Committee within OSTP carry out a study of these different alternatives so that one could shape a more effective policy.

Mr. THOMPSON. Professor Eggert, you suggested in your testimony that we should encourage undistorted international trade of these raw materials. Do you believe that such a policy could have a negative effect on our own domestic supplies?

Dr. JAFFE. I am not an economist, I have to say, but my impression is that international trade without artificial constraints works to the advantage of all the members. We would be just as happy to sell our supplies of molybdenum, where we are a major player, as we should be, to buy supplies of chromium or cobalt, where we have very little.

Mr. THOMPSON. Professor, can I have your thoughts?

Dr. EGGERT. Well, I, like most people in the academic, or in the economics community, support undistorted international trade. We should buy raw materials from the cheapest source.

Having said that, when there are supply risks, our end game with regard to rare earths should be a more diversified global set of suppliers, and not simply undistorted international trade that leads us prone to supply risks.

Mr. THOMPSON. Thank you. A final question for Mr. Latiff. You mentioned that it is unclear at this point that any progress is being made by the Department of Defense officials on a systematic approach to determining their overall needs for specific materials.

Do you believe that any other specific departments or agencies should also be determining their future needs for these materials?

Mr. LATIFF. Yes, sir, I do. Clearly, the Department of Energy, and my focus primarily with the work that I have done has been on the Department of Defense, and the criticality of the defense

systems, as I said, number one, their availability, and number two, their costs. But, yes, sir, I do.

Mr. THOMPSON. OK. Thank you, Mr. Chairman.

Mr. COFFMAN. Mr. Duncan of South Carolina for five minutes.

Mr. DUNCAN. Thank you, Mr. Chairman. Virtually every time that I walk into this Committee room, it seems as though the Administration is tampering with three sources that belong to the American people.

Our Nation's natural resources don't belong to the President or his cabinet. It is time that they are returned to where they belong, and that is to this Nation and our citizens.

And over the past month, we have celebrated huge victories in this Committee dealing with energy, and putting the Gulf of Mexico back to work, but in doing some research and listening to some of the testimony, I understand that 22 percent of the rare earth minerals are used in the refining of hydrocarbons.

So, unfortunately, it is clear to see that if we do not halt the rapid overreach of government agencies, we will not ever have the opportunity to use domestically produced oil here in the United States because we won't be able to refine it due to the rare earth minerals that are used in that process, and not being able to tap those American resources either.

So, we will continue to lose this valuable market to other countries as we see the increase of stringent regulations. Many rare earth minerals that can be found in our Western States can be used in the refining of oil.

And it could be counterproductive to produce and explore for oil here in this country, but have it shipped to another country to be refined, where they do have access to these rare earth minerals.

I appreciate you gentlemen testifying today on this. So, what is next? Well, we have a mine here and not there philosophy, like we have a drill there and not there philosophy with this Administration—and where the President will applaud Brazil for their mining efforts. It is just amazing.

So, not being from a Western State, and not fully understanding the impact of owning huge swaths of land out there that could be utilized for mining efforts for rare earth minerals, the question I have for you is what can we do to open up more Federal lands?

What sort of barriers do we need to overcome that stand in the way of the industry's ability to access these lands for exploration and development? So, I lay that out there for any of you gentlemen. Maybe the Mining Association would be better, but what can we do to increase access to those Federal lands?

Mr. QUINN. Thank you, Mr. Duncan. I think the first thing we need to do, before we start headlong putting more lands off-limits, is to take a look at those lands that people want to put off-limits. We need to get a serious evaluation of their resource potential, what is there, and then delineate its potential.

And then make some real decisions, real judgments, on whether we are going to put those lands off-limits to resource development. It is also the same question with perhaps lands that have been placed under certain restrictions, and not totally off-limits, but with certain restrictions.

They should be re-examined in terms of what their resource potential is, and decide whether the restrictions that have been placed on them years ago still should apply based on our current needs for resources.

So, those are two things with respect to access. I have also talked about permitting and regulatory burdens, and that is something that the government should bring a real sense of urgency to.

And as I said, if it is taking us 10 years to get a mine fully authorized, we are still in the starting blocks halfway through the race. If I have a large billion dollar proposition to build a mine, which is what it would really take to scale, and in today's climate for many commodities, if I can get those authorizations in other countries like Chile and so forth in 18 months to 24 months, it is rather clear where I am going to put my capital, because I will get a return eight years sooner than I will here in this country.

Mr. DUNCAN. Mr. Chairman, in the essence of time, I will yield my time back so that the Western States can maybe ask questions. Thank you.

Mr. LAMBORN [presiding]. Well, we appreciate those questions and so thank you very much. Next we have on the list Mr. Flores of Texas.

Mr. FLORES. Thank you, Mr. Chairman. I have to agree with Mr. Duncan's comments to start with. It seems like it is deja vu all over again. We hear continuing testimony from witnesses in industry and in business, and consumers, about the things that we do as a country that reflect a lack of foresight when it comes to taxation, regulation, restriction to our access to public lands.

They continue to damage our economy, and damage our way of living, and to bankrupt the future of our kids and grandkids, and I am quite frankly fatigued from hearing us continuing to go that wrong direction. Mr. McGroarty, did I pronounce that correctly?

Mr. MCGROARTY. Yes.

Mr. FLORES. Your comments were particularly poignant, I thought, when you talked about what you heard in China, and I want you to repeat what you heard, that they understand that we talk a lot, but what was their question again, where were the permits? Can you repeat that?

Mr. MCGROARTY. Mr. Flores, you are absolutely right, and it is done in a very courteous way, and with a lot of respect, but there is a certain impatience there when you are having the conversations.

Idealogy aside, a Chinese diplomat is an extraordinary pragmatic individual at this point, in the year 2011. We would have a discussion, and I was one of less than a handful, that——

Mr. FLORES. Keep it short.

Mr. MCGROARTY. There were nine Chinese presenters, and they would immediately cut in and say how many million tons, how soon, where are your permits. They were telling us basically that we are doing this, and you are talking about it.

Mr. FLORES. OK. That reminds me of that commercial that some of us have seen on t.v., where you have the Chinese laughing about how we drove our country toward bankruptcy, and they owned us because of the fact that they financed us.

Mr. Quinn, in your testimony, you talked about the fact that it takes 10 years to get a permit domestically, vis-a-vis 18 months to 2 years in some other countries, such as Australia.

Can you tell me, and just give us, that if you were to write legislation today and wave the regulatory wand, or the legislative wand, what are the four or five things that you would do that would fix that permitting process overnight?

Mr. QUINN. Well, the first thing is to eliminate some duplication that we have. We have Federal to Federal duplication, in terms of looking at the same environmental issues and similar issues.

We have State and Federal duplication with State agencies, delegated authority to implement certain Federal laws with the Federal Government, and that overseeing them is actually quite a bit of what they are doing, and second-guessing it.

So, I would take a look at minimizing duplication. I would look at putting some accountability into the process, where timelines or deadlines are set, and also in terms of evaluating an agency's performance based on accountability.

Agencies are not, to my knowledge, rated on their ability or their effectiveness in issuing authorizations.

Mr. FLORES. And I assume that what we are doing wrong that Australia is doing correctly—I mean, is the Australia model the correct analog for us to follow?

Mr. MCGROARTY. Well, I think perhaps in some cases. I think that one of the things that strikes me is that people believe that when our companies are doing business overseas that somehow we are performing at a lower level, in terms of environmental stewardship, which is not the case.

Our companies export their environmental values and stewardship to the countries that are hosting them. So, it is not a matter that the regulations are less stringent or anything like that, but they are more efficient, and they have a certain sense of urgency about the importance of putting projects and employing people, and I think that is a big difference there.

Mr. QUINN. It sounds like they recognize not only the urgency, but the critical economic impact of a particular industry on their own economy, and I would sure applaud our regulatory bodies feeling the way in this country, both at the State and Federal level.

Dr. Eggert, and this is a little bit of an off-the-wall question, and we have only got a few seconds left, but when you look at our investment, and our educational infrastructure when it comes to rare earth metals.

And I may be going out of your area of expertise, but how do you feel about our investment in higher education in terms of mining processing, recycling, disposal of these rare earth metals? Are we just not there, or do we need to invest in higher rates?

Dr. EGGERT. I feel strongly that we need to reinvigorate and invest in these areas. We have lost as a Nation most of our institutional capacity to educate geologists, mining engineers, mineral processors, extractive metallurgists, and so on.

Mr. QUINN. Thank you very much, and I yield back eight seconds.

Mr. LAMBORN. Every eight seconds counts. Next, Dr. Benishek, from Michigan.

Mr. BENISHEK. Thank you, Mr. Chairman, for calling this hearing. As a physician, I know firsthand how rare earth minerals are critical to the development of life saving technologies, and I am concerned about our country's ability to mine these minerals.

In addition, Michigan's First District is the home of many minerals. We have iron mining and the potential for copper mining, and nickel, gold. There is a lot of mining potential in my mineral-rich district.

And my question is actually for Mr. Quinn. A topic often in Congress is that United States industries, including the mining industry, are faced with some of the world's highest taxation rates makes it extremely difficult to compete with foreign countries on a global scale.

How does the United States tax burden compare with other major mineral producing countries?

Mr. QUINN. Thank you, doctor. It is actually the highest effective rate, around 41 percent when you combine Federal and State taxes, in terms of the metals industry. Other countries that were close to that level have already taken measures to reduce their rates, and also make other adjustments in their tax system to attract new capital for mining.

Mr. BENISHEK. What would be the first step that you would do if you were in my place to get an increase in production here in this country?

Mr. QUINN. Well, I think the highest hurdle that we have currently is delays in permitting, and people like to say that if you have plenty of time, then you can mine here in the United States.

Unfortunately, we don't have that time, and if it takes you 10 years or more to actually get your capital on the ground, and then to get a return on it, then that capital is going to go somewhere else.

So, permitting would probably be the number one, and number two, I would look at the tax burdens, and regulatory burdens, on the industry. I am not saying that we would be supporting reductions in the existing regulatory framework, but I think in terms of going forward, there should be some clear assessment of cost benefit, in terms of new regulations, new standards.

I mean, let's be frank. In China, they are worried about where they are going to put their billion people in the cities, and here in the United States, we are still trying to track down the latest part per billion on some substance, and there is a stark difference how they approach their particular economic needs. I think that there is a balance here that we can find that is better.

Mr. BENISHEK. Well, I agree with you. We need to have the potential for jobs here in this country, and I want a clean environment as well, but there is certainly a balance that doesn't exclude mining from our industrial base.

I look forward to working on this Committee to help streamline these rules. Maybe we can get something going here this year. Thank you very much, sir, for your testimony, and I yield back the remainder of my time.

Mr. LAMBORN. Thank you, and next we have Representative Gosar from Arizona.

Dr. GOSAR. Thank you. Mr. McGroarty, in your testimony—and we are going to switch up a little bit here—you state that United States mines produced 1.8 metric tons of copper in '93, roughly 60 percent more than they produced last year.

In the same time period, you stated that world copper reserves have more than doubled, but the United States reserves have declined from 15 percent to 5 percent. What accounts for the drastic decrease over less than 20 years?

Has the United States simply tapped a larger proportion of its ore deposits than the rest of the world, or are we just failing to get these projects off the ground?

Mr. MCGROARTY. Congressman Gosar, that is a very good question. The answer has to do with exploration budgets, and how much time on tasks, and how many dollars does the United States mining industry put into exploring and expanding United States copper reserves.

There is a general decrease, and most of the exploration money is going into gold and silver, or gold and diamonds rather, and less so into copper. There is an issue about exhausting the current resource and not replacing it.

You had testimony several years ago about the fact that we would need many—upwards of a dozen—new mines brought on to replace mines that are basically reaching end of life of mine.

I think it ties back to some of the points that Mr. Quinn has made. If the permitting process in the United States is extraordinarily long, capital requires very, very high, and companies just looked elsewhere in the world to develop the resource.

Dr. GOSAR. Well, I am glad that you brought that up, and I asked because I recently introduced Legislation H.R. 1904, a bill that would open up the third largest undeveloped copper resource in the world.

How critical to our national security is it to ensure deposits like the one located in Central Arizona can be opened up for production? And considering the prevalence of copper in alternative technologies, like hybrid cars, solar panels, wind turbines, isn't the meteoritic rise on our dependence for foreign minerals such as copper over the past 20 years an alarming national security risk?

If we are truly trying to reduce our dependence on foreign fuels isn't it critical that we use domestic resources to construct alternative energy infrastructure?

Mr. MCGROARTY. I would agree. The signals are there. I mentioned the OSD study that indicates without any specificity that there has already been some sort of program disruption, and copper is one of the metals that was mentioned in that category.

That is not a new study. It was from several years ago. So, the signal is being sent, and your indication about the increasing utility copper is true as well. Cooper has been used in automobiles for a long, long time, but the hybrids use something like twice the amount of copper.

So, cars that we want to encourage people to drive are going to create a larger requirement rather than a smaller requirement.

Dr. GOSAR. I think you are right. I think the average turbine uses over four tons of copper just in matrices of alternative energy

if I am not mistaken. So, thank you. You know, permitting in my district, is a concern, because I have the actual numbers.

I mean, when we start looking at this, the average number for a NEPA to be processed in my District One in Arizona is 5.9 years and growing, and it seems that we have increased numbers of lawsuits that have been curtailed.

I would like to start with you first and ask you how has the lawsuits using the Equal Access to Justice funding affected your ability to actually mine, and have access to these ores?

Mr. MCGROARTY. My understanding of the permitting process is limited to my involvement with the Rare Earths Company in Colorado, and so I yield to others on the panel, who maybe have a better idea. But generally speaking time is money.

Dr. GOSAR. Mr. Quinn, can you answer that question for me, please?

Mr. QUINN. In terms of how it has impacted, what I can say is this. You basically have a law there that pays people, and has the taxpayer reimburse people to stop the projects. I don't have any metrics on how much money has been spent in that regard.

As you are inferring, Congressman, that ample opportunity for opponents to mining projects to slice and dice them through the litigation process.

Dr. GOSAR. Isn't it true that it is basically an ecological terrorism type aspect when we know that one envelope with one postage stamp on the last day of a recourse could be starting the whole process all over again?

Mr. QUINN. Well, I could certainly say this. That a low level investment can stop a huge investment. A postage stamp and a signature on a protest can stop a billion dollar project.

Dr. GOSAR. Thank you. I have more questions, but I will take them on the next round.

Mr. LAMBORN. OK. Thank you. Next we have Representative Johnson from Ohio.

Mr. JOHNSON. Well, thank you, Mr. Chairman, for holding this important hearing on how critical and strategic minerals are so essential to our economy, and I thank the panel for joining us today.

Those minerals are essential not only to our economy and our livelihood, but to national security as we have heard. These rare earth minerals are important components to a large amount of consumer products, and more importantly, to national defense.

That is why I think that it is so important that we remove any barriers to mining these important minerals, and I have a few questions. The United States of America is home to some of the world's greatest mineral deposits.

Yet, as you, Mr. Quinn, and the mining industry, are all too aware, accessing these minerals is no easy feat. What can we look to do to ensure that we have the ability to domestically mine these critical minerals? What are our barriers, and how do you think we can break them down?

Mr. QUINN. Well, as I mentioned before, there are a number of programs and laws that actually entice placing more of these areas off-limits, or either totally off-limits, or to severe restrictions.

I think we can reexamine how those laws are applied going forward. We have a better understanding before those decisions are

made about what the resource potential of those lands are, and those that are already off-limits, maybe those from time to time merit some reconsideration based on what the growing needs are of this country and changing values.

And also we have the same issue in terms of some of the private lands. There are laws out there that authorize parties to try to petition to have private lands put off-limits to future development.

Mr. JOHNSON. OK. Thank you. As you mentioned in your testimony also, Mr. Quinn, less than half of the mineral needs of the United States manufacturing are met from domestically mined resources.

Obviously, when we are unable to provide the components necessary for a healthy and viable manufacturing industry, our ability to be a leader in manufacturing, and manufacturing innovation, is at risk.

What do you suggest we do to ensure that the United States remains not only a key producer of critical minerals, but also remain at the forefront of innovation and new technology in the manufacturing arena?

Mr. QUINN. Well, I think there are a number of public policy hurdles in our way in terms of having or maintaining a healthy and a viable minerals industry here, and as you are inferring, Mr. Johnson, that if we cut off the front end of the supply chain, the minerals part, over time the rest of that value added chain will go off-shore as well.

We just heard from various Members today about the rare earths story. I think that is instructive about what happens when the beginning of the supply chain gets cut off, and the innovation and the technology goes and follows suit on that, and downstream also goes offshore to where it can source reliably.

And as Dr. Eggert has said, sometimes prices are an issue, but actually it is having a dependable supply, because if you are going to set up a manufacturing system, you don't want to have that up and down based on a commodity risk, in terms of supply.

Mr. JOHNSON. OK. The answers to your questions kind of highlight for me what we have heard not only in this hearing, but in other hearings as well. Our regulatory process, and the lack of aggressive movement forward with the robust permitting process, is really hampering our ability across the board.

Not only in this arena, but in others. It is almost as if those regulatory agencies have become the Department of No, you can't. I would like to see, and I urge that not only the Administration, but the Congress, force these regulatory agencies that if you are going to deny a permit for health or safety reasons, that is OK.

But don't just say no. If you say no, you have to come to the table with ideas on how to move that process forward, and how to solve the problem, and not simply to be an impediment. Do you think that would help?

Mr. QUINN. Absolutely, Mr. Johnson. Sometimes they just say no without the adequate reasons, and even worse, sometimes they say nothing for years, and they keep sending you back for more information, and you keep asking did I bring the right rock back, and they keep saying we will tell you when we see it.

And you presided as I recall over several hearings several weeks ago where that is exactly the issue, and where we have people worn out, and an industry worn out, where at the end of the day, we have more permits actually withdrawn than actually issued.

Mr. JOHNSON. I thank you for that, and Mr. Chairman, I yield back.

Mr. LAMBORN. Thank you. And I will ask my questions now, except that I want to instead defer or yield three minutes to the gentleman from Arizona.

Dr. GOSAR. Mr. Eggert, you know, my colleague, Mr. Holt, talked about recycling these metals and rare earths. I am a big recycler, but there is no way that we can keep up with demand by recycling.

We ought to be looking at both sides of this story. One is to recycle, but two is to explore, and use environmental stewardship in mining. What is alarming to me is what seems to be going on—and I am concerned about it—is that foreign governments are cornering the market and artificially inflating the market.

A good example would be what we are undergoing now with OPEC, and then China with the rare earths. In regards to these special elements that we are involved with, I have a company that has revolutionized the electric motor, and they are very dependent upon these magnets.

How do you foresee or how do you see our current environmental standards and this moving bar helping extort the American taxpayer and the American consumer in regards to production of these revolutionary type of discoveries?

Dr. EGGERT. Could you repeat the last portion of the question? I didn't hear the key part of the question.

Dr. GOSAR. How is the American consumer and the industry being extorted by artificially raising prices by foreign markets?

Dr. EGGERT. Well, when one or a small number of powerful producers can act opportunistically to raise prices, or to restrict availability, either you pay the higher price, and it increases your costs, and reduces your profitability, or in the case of physical unavailability, one faces the choice of not building, or in cases where there is an effort to redirect investment of manufacturing facilities to other locations, manufacturing can be redirected and relocated.

Dr. GOSAR. Mr. McGroarty, can you address that a little bit for me, please?

Mr. MCGROARTY. Congressman, you raise an interesting question. My thought goes to how one would cost out lost innovation as well. Unavailability of resources, the general sense that one would not be pursuing and exploring new applications, because you don't feel that you can outsource the components, the precursor metals. It has to have some sort of drag effect. I don't know how one would measure it. I am not an economist.

Dr. GOSAR. But you could really agree with me that the American taxpayers are going to be one fronting this, because it is artificially inflated?

Mr. MCGROARTY. Yes, I think so. You have phrased it in terms of the consumers, and I am thinking also what would the consumer not have five years from now, and how would they even know that they don't have it.

Dr. GOSAR. So, it is our own Federal Government that is standing in the way of that marketplace?

Mr. MCGROARTY. I think the Federal Government can make changes and talk about permitting.

Dr. GOSAR. Thank you.

Mr. LAMBORN. All right. That concludes the question portion of this hearing. We are going to wrap up now. I would like to submit for the record two articles from the New York Times regarding the issue of Chinese mineral embargoes. Without objection.

Mr. LAMBORN. And I want to thank the witnesses for being here today and taking up their valuable time to come and help us understand this important issue. While today's hearing was focused on what we know from the National Research Council Reports and our expert witnesses, there is still much we don't know.

We don't know what areas are open for mineral development or minerals requirements for domestic manufacturing infrastructure and national defense. We don't know fully the status of the workforce with mining and materials expertise, or a decent assessment of permitting timelines for projects on Federal lands, with its associated litigation and hurdles to domestic development, but we need these answers.

Later this week, I will be introducing legislation to direct the Department of the Interior to prepare a series of reports to get the answers that we need to address the challenges laid out in this hearing today.

The goal of this legislation is to increase both our understanding of our national mineral needs and the barriers to meeting our needs with domestic production. Our national mineral policy is failing our Nation.

It is failing to keep us supplied with the resources that we need to defend our Nation, build our infrastructure, create jobs, secure our manufacturing base, and keep our economy healthy.

Today is the beginning of an effort to right the course and to restore America's leadership in minerals and materials technology. Members of the Committee may have additional questions for each of you witnesses for the record, and I would ask that you would respond to these in writing.

And if there are no further questions, without objection, we stand adjourned.

[Whereupon, at 10:48 a.m., the Subcommittee was adjourned.]

[Additional material submitted for the record follows:]

[The New York Times article entitled "Supplies Squeezed, Rare Earth Prices Surge" submitted for the record follows:]

Supplies Squeezed, Rare Earth Prices Surge

By KEITH BRADSHER

Published: May 2, 2011

HONG KONG—Rare earth prices are reaching rarefied heights.

Malaysia has delayed granting an operating permit for the refinery in Kuantan as it reviews disposal plans for radioactive waste.

World prices have doubled in the last four months for rare earths—metallic elements needed for many of the most sophisticated civilian and military technologies, whether smartphones or smart bombs.

And this year's increases come atop price gains of as much as fourfold during 2010.

The reason is basic economics: demand continues to outstrip efforts to expand supplies and break China's chokehold on the market.

Neodymium, a rare earth necessary for a range of products including headphones and hybrid electric cars, now fetches more than $283 a kilogram ($129 a pound) on the spot market. A year ago it sold for about $42 a kilogram ($19 a pound).

Samarium, crucial to the manufacture of missiles, has climbed to more than $146 a kilogram, up from $18.50 a year earlier.

While the price inflation is a concern to manufacturers, consumers in many cases will barely notice the soaring cost of rare earths. Even though the materials are crucial to the performance of everyday equipment like automotive catalytic converters and laptop computer display screens, rare earths typically are used only in trace quantities.

One exception is the Toyota Prius hybrid car, whose manufacture uses a kilogram of neodymium.

Toyota has been raising prices for the Prius, but has cited demand for the car and economic conditions. While acknowledging that rising prices for raw materials in general have affected the company's overall financial results, Toyota has declined to provide a breakdown of the role of rare earths. (Production problems stemming from the Japanese earthquake and tsunami have also crimped supplies of Prius cars, which are made only in Japan.)

The high prices for rare earths reflect turmoil in the global industry that mines and refines them. China, which controls more than 95 percent of the market, has further restricted exports so as to conserve supplies for its own high-tech and green energy industries. That is despite the World Trade Organization's ban on most export restrictions.

Meanwhile, an ambitious effort to open the world's largest rare earth refinery in Malaysia, which had seemed certain to begin operating by this autumn, is tied up over regulatory reviews of the disposal plans for thousands of tons of low-level radioactive waste the plant would produce annually. Public opposition to the refinery is evident in the weekly protest demonstrations now being held.

At the same time, Japanese companies are finding it harder than originally hoped to recycle rare earths from electronics and to begin rare earth mining and refining in Vietnam.

Although rare earths are crucial to the supply chains of some of the world's biggest manufacturers, the industry that mines and refines them has long been characterized by small, entrepreneurial companies. Lately, though, soaring prices have contributed to industry consolidation.

Last month, for example, Solvay, a big Belgian chemical-industrial corporation announced that it would pay $4.8 billion to acquire Rhodia of France, a technological leader in making complex chemicals based on rare earths.

That same day, April 4, Molycorp, the only American company currently producing rare earths, said it had paid $89 million for a more than 90 percent stake in Silmet of Estonia, a much smaller company that is Rhodia's only European rival in rare earth processing.

In Malaysia, where the giant rare earth refinery is under construction near the eastern port of Kuantan, regulators are delaying approval for an operating permit amid public concern about naturally occurring low-level radioactive contamination of the rare earth ore, which will be mined in Australia.

Raja Dato Abdul Aziz bin Raja Adnan, the director general of the Malaysian Atomic Energy Licensing Board, said the board had asked the Lynas Corporation of Australia, which is building the refinery, to provide additional documentation before accepting its application for an initial operating permit. It will take up to six months to review the application, Raja Adnan said, and Lynas will not be allowed to bring any raw material to the plant until a permit is issued.

But Nicholas Curtis, Lynas's executive chairman, said that he believed the company could obtain the necessary approvals before September and that his company was sticking to its plan to begin feeding Australian ore into the Malaysian refinery's kilns by the end of that month.

The Malaysian government also announced last week that it would appoint a panel of international experts to review the safety of Lynas's plans. The company said it welcomed the move.

But Fuziah Salleh, an opposition legislator who represents downtown Kuantan and has been leading weekly protests, is mistrustful.

"The people's concerns are that the independent panel will be formed by the government to prove that they are right," she wrote in an e-mail message.

Toyota Tsusho, a materials purchasing unit of the Toyota Group, has separately encountered complex local regulations as it seeks to open rare earth mining and processing operations in Vietnam. The project was announced last October during a Chinese embargo on rare earth shipments to Japan. Takeshi Mutsuura, a spokesman, said that Toyota Tsusho now hoped to reach a contract in Vietnam this summer and start production in early 2013.

As recently as last autumn, there were also ambitious hopes in Japan to recycle rare earths from electronics waste. Dowa Holdings tried then to come up with ways to separate rare earths at a recycling factory in northwest Japan but found the task significantly more difficult than recycling other, more widely available precious metals. The recycling factory is now recovering 19 other metals instead, including cobalt and lithium.

All of this has left the world even more dependent on China. The Chinese government last autumn showed a willingness to use that near monopoly as a trade weapon, halting shipments to Japan from late September to mid-November, during a territorial dispute over islands in the East China Sea.

Although Beijing has officially denied that it imposed a Japanese embargo last fall, China's own trade data released since then show that its shipments to Japan suddenly fell to zero in October for rare earth metals, and to nearly zero for rare earth oxides—which are more processed chemical compounds. At the beginning of this year China reduced its rare earth export quotas to all countries, while raising export taxes on some rare earths to 25 percent, from 15 percent previously.

Since April 1, China has also raised taxes on rare earth mining companies to the equivalent of $8 for each kilogram of refined product; rare earths were previously taxed like many other nonferrous minerals in China, at less than 50 cents a kilogram.

One of the biggest questions hanging over the rare earths industry is whether the United States, the European Union and Japan will file a World Trade Organization case against China, challenging its export quotas and duties. James Bacchus, a former chairman of the W.T.O. appeals tribunal in Geneva, said that Chinese trade data shows a virtually complete halt in shipments to Japan last autumn could be cited to buttress any W.T.O. filing by rare earth-importing countries.

China denies violating the W.T.O. ban on export restrictions, saying that it qualified for an exception to the ban for environmental protection and conservation of natural resources. But China has done little to restrict its own industries' consumption of rare earths, usually a prerequisite for invoking an environmental defense.

A version of this article appeared in print on May 3, 2011, on page B1 of the New York edition with the headline: Supplies Squeezed, Rare Earths Surge.

[The Wall Street Journal article entitled "China Tightens Rare-Earth Rules" submitted for the record follows:]

China Tightens Rare-Earth Rules

THE WALL STREET JOURNAL, ASIA BUSINESS

MAY 19, 2011, 8:21 P.M. ET

BEIJING China moved to tighten its control over rare-earth metals Thursday by expanding its export-quota system and imposing higher taxes on the minerals, which are used in such high-tech applications as laser-guided weapons and hybrid-car batteries.

It also said it will get tough with companies that resell export quotas and won't approve any new projects or the expansion of existing ones in rare-earth separation over the next five years.

The measures were announced separately by the State Council, or cabinet, and the Commerce Ministry in an apparently coordinated offensive in a sector that has become highly politicized.

China, which supplies around 95% of the world's rare-earth metals, has been tightening its control over the sector by raising the threshold for entry, imposing stricter environmental standards and slashing export quotas. First-half 2011 quotas total 14,508 metric tons, down about 35% from the same period last year, according to the Ministry of Commerce.

These measures have boosted rare-earth prices and made export quotas much more valuable.

Opinion

Rare-Earths Showdown Looms

In the latest move, Beijing said it is raising the tax on light rare-earth ores to 60 yuan ($9.22) per ton, from a range of 40 fen to 30 yuan per ton, as of April 1, while lifting the tax on heavy ores to 30 yuan per ton, also from a range of 40 fen to 30 yuan per ton.

"[China will] greatly increase rare earth taxes and refine its pricing mechanism to reduce the excessive profits in the rare earth mining industry," the State Council said.

China will also raise the threshold for companies applying for export quotas, though it didn't say whether this will reduce the number of qualified exporters. China granted quotas to 22 Chinese companies and 10 foreign companies this year.

The Commerce Ministry said it will start imposing export quotas on ferroalloys containing more than 10% rare-earth minerals by weight, effective Friday.

This year, China began imposing 25% tariffs on exports of alloys with more than 10% rare earth content.

Prior to the latest announcements, China had issued export quotas for rare-earth primary products, including minerals and oxides, but its quotas didn't include alloys.

Rare earth alloys include rare-earth ferrosilicon?with 17%-37% rare-earth content?which is used as an additive in steel and iron smelting, and magnesium rare earth, which contains 2%-10% of rare-earth elements yttrium and gadolinium and is used in the aviation, automotive and defense sectors.

Rare earths, comprising 17 elements, are usually categorized into two kinds?heavy rare earth, also called ion-absorbed rare earth, which is abundant in southern China, and light rare earth, which is found in northern China.

Heavy rare earths are more valuable, giving exporters an incentive to ship overseas for higher returns.

The State Council said it "clearly forbids" the resale of quotas and has promised to improve the system of allocating quotas. People familiar with the situation have said previously that some companies with export quotas make big profits by re-selling export quotas.

Beijing also pledged to combat illegal rare-earth mining and mining above quota levels, as well as improve the export-monitoring system to stamp out smuggling.

China is also building strategic stockpiles of rare-earth metals, an effort that could give Beijing increased power in influencing global prices and supplies.

The State Council said it will halt approvals of rare-earth separation projects in the next five years and "resolutely ban" capacity expansions at existing plants.

—*Yajun Zhang*

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