

## **Critical and Strategic Failure of Rare Earth Resources**

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Rare Earths: Strategic & Critical, National Defense, Green Technologies, Economics

### **Abstract**

Rare Earths: This paper outlines the complete failure of the U.S. in status and relevance in Rare Earth Oxides (REO). Although rare earth oxides are strategic and critical in their own right, refining these REOs into elements and alloys is even more important for the development of "Green Technologies" and advanced weapons systems.

America does not have an active domestic source of rare earth oxides. America does not have any heavy rare earth elemental or alloy capabilities.

The magnitude of this failure continues to become more apparent as the manufacture of REO based electronics and magnetic components moves eastward towards China.

China has succeeded in outmaneuvering the United States and the world in its quest to control the rare earth oxides, elements and alloys, and the many industries dependent upon REO. What can be done?

### **First, We Must Understand the Scope of this Failure**

The scope of failure is multi-fold, interdependent and compounding. Sustainability and growth of a mature economy, like the U.S., is dependent upon innovation. Innovation and research & development are dependent upon the overall macro-economic systems at the private, corporate and public level. Sustainable macro-economic systems require balanced economies comprised of producers and consumers.

The U.S. economy is grossly imbalanced as the result of two decades of off-shoring and a complete lack of any rational industrial policy. In the absence of balance, the system is self-correcting<sup>i</sup>. The current banking crisis reflects the magnitude of that imbalance. Looking at the net present value of all future federal liabilities supported by a failing U.S. economy, shrinking tax base and growing vacancies in our domestic industrial capabilities, the future looks grim.

On the commercial side the rapidly disappearing manufacturing and industrial base of America begins to resemble the Aral Sea: receding, stagnant, and unable to sustain the life of basic research<sup>ii</sup>. There is a growing body of research that shows a strong interdependence between basic research, measured by patents, and the health of the local or national industrial base<sup>iii</sup>. In other words, if you are shedding industry, innovation slips away. If you are growing technology-hungry businesses, innovation springs to life. This has been well demonstrated in a paper titled "Value Chain Off Shoring and the Location of Innovation<sup>iv</sup>," that specifically analyses the REO magnet market for China and the U.S.

America is now 100% import dependent upon others for rare earth oxides, elements and alloys. Resulting pricing, supply and tax disadvantages have decimated U.S. competitiveness for all REO related products. Today there are few remaining domestic manufacturers of value added rare earth components. REO enhanced products are typically components in some of the fastest growing markets in the world. For example, in 1990 The United States had 12 REO magnet producing facilities with 6000 employees for a global REO magnet market of about \$600 million in gross revenues. Today the U.S. has 4 REO magnet producers with less than 600 employees while the global REO magnet market has grown to over \$7 billion<sup>v</sup>. These magnets are in everything we use today, iPods, computer hard drives, automobile sensors, micro-motors, wind turbines and military guidance systems. Nearly all of the production for this rapidly expanding

market is increasingly coming from China. Experts agree the REO magnet market will at least double in the next 10 years<sup>vi</sup>.

### **REO's – A Failure of Historic Proportions in the Making**

The United States, as a nation, can only survive by leading in the commercial development, application and manufacture of high value products. Wealth creation and improved standards of living can only come from three things: agriculture, natural resources and manufacturing. Manufacturing is increasingly driven by technology.

As rare earth oxides, elements and alloys are critical in the development and production of enhanced materials performance in many materials science applications. America's failure to secure, control and produce these materials can only compound the broader failure from an economic and defense stand point.

REO technologies are increasingly present in the highest value applications, devices and products. These are the prized industrial base for any mature economy with higher cost for wages, capital and environmental issues.

The national defense issues are equally important. Rare earths are critical components for military jet engines, guided missiles and bombs, electrical countermeasures, anti-missile systems, satellite communication systems and armor, yet the U.S. has no domestic sources.

### **Innovation Drives Industry – Industry Carries the Economy**

Advances in Materials Science are a result of tireless innovation; innovation seeking improvements in the performance and characteristics of material properties or a change in their form or function. Much of this work must eventually translate into commercial and military applications. Today many advances in material science are achieved through the application of rare earth oxides, elements and alloys.

This group of elements, also known as the lanthanide series, represents the only known bridge to the next level of improved performance in the material properties for many metallurgical alloys, electrical conductivity, and instrument sensitivity and in some cases a mechanical or physical change in function. These lanthanides hold unique chemical, magnetic, electrical, luminescence and radioactive shielding characteristics. Combined with other elements they can help maintain or alter physical and structural characteristics under changing conditions.

Today, these rare earth elements are essential to every computer hard drive, cell phone, energy efficient light bulb, many automotive pollution control devices and catalysts, hybrid automobiles and most, if not all, military guidance systems and advanced armor.

Tomorrow, they will be used in ultra capacity wind turbines, magnetic refrigeration, zero emission automobiles, superconductors, sub-light-speed computer processors, nano-particle technologies for material and metallurgical applications, structurally amorphous metals, next generation military armor and TERFENOL-D Radar. America must lead in these developments.

The entire U.S. defense system is completely interdependent upon REO enhanced technologies for our most advanced weapons guidance systems, advanced armor, secure communications, radar, advanced radar systems, weapons triggering systems and un-manned Drones. REO dependent weapons technologies are predominantly represented in our 'first strike' and un-manned capabilities. This national defense issue is not a case of limited exposure for first-strike capabilities. This first-strike vulnerability translates into risk exposure in every level of our national defense system, as the system is built around our presumptive technological and first-strike superiority. Yet the DoD has abandon its traditional procurement protocols for "strategic and critical" materials and components for weapons systems in favor of "*the principles of free trade*"<sup>vii</sup>.

### **Scope of Failure**

All of the following statements represent the current status of America's failure to secure, develop and produce primary materials that are classified as "strategic and critical" to American industry and our national defense<sup>viii</sup>.

#### **Governmental and NGO Assessment:**

- Rare Earth Oxides have been classified as "strategic" to the defense of the United States<sup>ix</sup>.
- The National Minerals Advisory Board has classified rare earths as "strategic and critical" as defined under the legislation governing the national defense stockpile<sup>x</sup>.
- The National Academy of Science, the National Academy of Engineering, the National Research Council and the National Academy of Medicine all conclude that rare earths are "critical" to our Nation's industrial interests<sup>xi</sup>.
- The United States Geological Survey has listed Rare Earth Oxides as one of 19 minerals or materials that the United States is 100% import dependent upon<sup>xii</sup>.

#### **Domestic Production of Rare Earths:**

- There are currently no active rare earth mines in the United States<sup>xiii</sup>.
- The United States has two permitted world class rare earth deposits: Mountain Pass<sup>xiv</sup> with a massive light-lanthanide deposit; and Pea Ridge with a massive heavy-lanthanide deposit<sup>xv</sup>. The current financial crisis has put the development of both of these mines on hold.
- Currently there are no fully integrated rare earth elemental extraction operations in North America because the high development cost, typically \$600 million or more, is not justified against the risk of Chinese monopoly pricing pressure.
- There are no active commercial heavy rare earth elemental and alloy production facilities in the Western Hemisphere<sup>xvi</sup>.
- Consequently, in the event that any heavy rare earth oxides were mined in the United States these oxides would be sold to an overseas refinery for further elemental or alloy processing<sup>xvii</sup>.

#### **Scope of the Commercial Failure:**

- The United States is primarily dependent on China, who produces over 90% of the low value and up to 99% of the high value rare earth oxide elements, for world consumption<sup>xviii</sup>.
- Published global production and consumption estimates show that Asia alone could consume 100% of world production for many of the rare earth elements and alloys as early as 2015, if no new production comes on line<sup>xix</sup>. Under the current regimen of Chinese resource control there is little chance of new and sustainable<sup>xx</sup> capacity developing outside of China.
- Many of today's green technologies are rare earth dependent.
- Many of today's alternative energy technologies are rare earth dependent.
- Many of today's high value consumer electronics are rare earth dependent.
- Many of today's advances in materials science applications are rare earth dependent.
- Many future technologies, currently under development are rare earth dependent.
- Many of today and tomorrows jobs are rare earth dependent.

#### **Scope of the National Defense Failure:**

- The U.S. Military is 100% import dependent upon rare earth magnets, critical to all guided missile systems and ordinance. There are no substitutes.
- The entire U.S. Military's first strike, communications and most of its advanced weapons systems and armor are 100% import dependent on rare earths, with as much as 99% originating in China. There are no substitutes.

- America’s military contractors are three steps removed from a secure source of these strategic and critical materials:
  - there are no active rare earth producers in the United States
  - there are no refining capabilities for heavy rare earth elements in the United States and there are no active heavy rare earth alloy production capabilities in the United States<sup>xxi</sup>
- With China producing between 90 to 99% of these strategic materials, this level of ‘market concentration’ clearly constitutes a "significant and unacceptable risk of supply disruption"<sup>xxii</sup>.
- The United States does not maintain a “strategic reserve” of rare earth oxides, elements or alloys<sup>xxiii</sup>.
- The defense of the United States is Rare Earth dependent.

### **National Industrial Policy – They Have One, We Don’t**

In 1986 the Chinese government placed rare earths on a list of top secret National Priorities called Program 863. In 1992 the Premier Deng Xiaoping boldly stated to the world “The Middle East has oil, China has rare earths.”<sup>xxiv</sup> By 1998 Mountain Pass, the only other significant REO producer outside of China was forced to shut down under increasing pricing pressure from China and environmental pressure from the State of California. By 2003 China had acquired, closed and transplanted America’s most advanced rare earth magnetic facility into China (including its portfolio of patents). In less than 20 years China made rare earths into a national monopoly.

China uses its monopoly producer position to drive REO dependent technology manufacturing facilities within its borders. China uses its monopoly position as the single greatest producer and consumer of rare earth oxides, elements and alloys to eliminate any potential competition<sup>xxv</sup> (China recently acquired interest in two rare earth deposits in Australia). The threat of monopoly pricing pressure has resulted in the termination of a number of rare earth refinery and mining projects. China boldly used predatory pricing to eliminate all potential competitors for the production of these oxides world-wide<sup>xxvi</sup>. They are now using taxation and export policy to achieve the same dominance as it relates to refining.

Chinese strategic foresight now pays dividends because they now attract industrial and manufacturing companies who are producing advanced, high margin products, rather than combining cheap labor with low technology and low margin products at the end of their life cycle<sup>xxvii</sup>. China’s policies continue to exploit this leverage and build success upon success.

China’s domestic mining regulations and tax system further leverage national goals. Mining permits, production and environmental enforcement are strictly controlled for all rare earth mining<sup>xxviii</sup>. All rare earth oxide and element exports from China carry punitive tariffs. Alloys also carry a stiff VAT penalty unless they are incorporated into a finished good<sup>xxix</sup>. This makes refining outside of China non-competitive. China also has recently established an export quota system that will greatly restrict availability and exports of rare earth materials<sup>xxx</sup>.

### **Second Best – The New American Era?**

Traditional western finance<sup>xxxi</sup>, venture capital, the stock market and banking, are unwilling to accept a competitive disadvantage or supply risk, so American, European and Japanese firms are quickly adapting to this environment. Many small and large REO dependent technology firms have set up facilities inside China to secure long term supply and the competitive advantage from the Chinese REO tax regimen<sup>xxxii</sup>. This National Industrial Policy is skimming off the cream of ‘applied innovations’ from the rest of the world for China’s benefit.

Where does that leave us as American researchers, producers, manufacturers and working class? If America abdicates the domestic production, refining and value adding opportunities for all REO dependent

technologies, we are abandoning our future. If concentrated innovation breeds more innovation, then what else will be lost?

There is no chance that the United States can claim to be a leader in any field of applied advanced materials manufacturing or “green technologies” under the current balance of resources. Without a domestic and integrated REO presence, the U.S. will continue to lose ground in all areas of REO related research, materials science, development of technologies and high-value product manufacturing<sup>xxxiii</sup>. Under the current model, when the U.S. develops a new advancement related to REOs its commercial application will ultimately be exploited into a Chinese factory<sup>xxxiv</sup>. How does that support the overall domestic macro-economy or generate tax revenues for the heavily burdened local, state or federal governments?

The greatest gain of any achievement in materials science or technology is in its production<sup>xxxv</sup>. Commercial production generates jobs, tax revenues and profits. That commercial activity generates supporting jobs, more tax revenues and builds communities. After the U.S. pays for all of the basic science, research & development and the cost of converting that knowledge into a commercial product, a very expensive process, the production is done elsewhere. Without a change in the macro-economic direction of the U.S. manufacturing base in leading technologies the future prospects for U.S. living standards will continue to fall, possibly for decades.

### **How did we get here?**

If we have these resources, what is the problem? The problem arises from a morphed ideology calling itself “Free Trade,” when it is more aptly called “neo-trade.” Neo-trade is a financial system based on extracting comparative advantage outside of a national context. Free trade, as originally conceived, is nationalistic by definition<sup>xxxvi</sup>. Free Trade automatically assumes the objective is to achieve positive and growing trade balances. Positive trade balances would require that the United States remains a balanced producer and consumer of manufactured goods<sup>xxxvii</sup> relative to its trading partners. This is not happening.

Under the neo-trade system ‘comparative advantage’ is abbreviated to just ‘advantage’ and the model seeks out absolute cost advantage with no regard for trade reciprocation, or ‘comparative<sup>xxxviii</sup>’ cost advantages from normalized trading partners. The model cuts even deeper, including the division of labor. Labor is always cheaper in an undeveloped country<sup>xxxix</sup>, so the model eliminates the ‘division quotient,’ (implying from within a system) from the classic division of labor model, seeking labor from non-comparative labor markets. The new model is based on “non-comparative advantage.” Consequently nearly all of the ‘non-comparative advantage’ can be aggregated into the financial entity. Under this model the cost of labor in a target production country is typically far below subsistence standards for any modern economy, so why pay them more than that? Pocket the difference.

Because labor will always be cheaper somewhere else, capital is free to seek out returns regardless of the peril it may impose. Consequently, as money pursues its self-interest it may result in the demise of the butcher, the baker and the brewer<sup>xl</sup>. Without national allegiance the hand of capital is bent on the destruction of each and every Butcher, Baker and Brewer until they are all consolidated, or ‘rationalized<sup>xli</sup>,’ under the lowest cost, lowest tax, lowest regulation host country<sup>xlii</sup>. If wages or regulatory costs escalate in that country, money simply seeks out a new host country.

Neo-traders can be any entity with financial interests that are unconstrained by nationality: global financial institutions, multi-national corporations, small domestic firms seeking to off-shore all or part of their manufacturing, banking, investment banking, venture capital, mutual funds, lobbyists, foreign governments (low wage host countries), anyone who can gain from the transfer of capital or returns. Neo-trade is the consequence of the seamless integration and aligned ‘a-political’ interests of global finance. Global financial interests are naturally aligned because the motives are the same for all players: profit maximization without regard to nationality. This translates into a unified *a-political harmony* that is not easily matched by individual or collective national political interests.

Neo-trade is about exploiting non-comparative advantage and ‘privatizing’ these values. This puts neo-trade at odds with ‘national interest’ of any stripe, persuasion or nationality. As a consequence neo-trade is hostile to any structured National Industrial Policy, export controls or adverse tax policies with nationalistic goals.

This morphed ideology, posing as free trade, blends seamlessly with American and Western European ethos and ideals of fairness. Domestically, because their financial clout easily translates into political clout they control the debate and direction of American fiscal and monetary policy<sup>xliii</sup>. By leveraging their influence through the WTO, GATT, IMF, World Bank, G8, G20, Etc., and other international institutions, the neo-traders are successful in influencing and controlling the laws governing global capital flows, taxation, trade restrictions, etc.. Western governments, under the spell of neo-trade, are no longer free to pursue national industrial policies or protect resources, industries or technologies considered strategic or critical. Because of this, any attempt at defining or pursuing “National Interests” is quickly and effectively denounced as protectionist, or in opposition to *the principles of Free Trade*.

The path we are on is economic intermediation of non-comparative advantage on a global scale. During the late 1980’s the United States began to deconstruct itself. In the early 1980’s the term ‘multi-national’ became vogue. This reflected the transition point where the capital markets first rejected the notion of ‘nationalism’ in finance. It was during the late 1980’s that academics, economist and politicians first described the new *golden age* termed “service economy<sup>xliv</sup>.” This new ‘*promised land*’ would liberate workers from boring and dangerous manufacturing jobs. America would trade its “smarts” for high pay and higher standards of living. The enlightened class assured the public this was the right course, telling Americans that they should not be alarmed that their jobs and industries were being shipped overseas.

The apparently *unexpected* result was a huge reversal in balance of trade. Specifically for goods designated as “technologies” the swing from surplus to deficit was \$80 billion between 1998 and 2007 alone<sup>xlv</sup>. Over that same period of time the United States off-shored hundreds of its R&D facilities to China, Russia and elsewhere<sup>xlvi</sup>. It was 1995 when ‘Chinese interests<sup>xlvii</sup>’ were allowed to purchase Magnequench, the most advanced producer in REO magnets in the world and the supplier for Americas most advanced military guidance systems<sup>xlviii</sup>. Although there was considerable opposition to this move at the DoD and Congressional level, the ‘*principles of free markets*’ carried the day. The sophisticated production technology was quickly duplicated in China and eventually the entire facility relocated in China.

Beginning sometime in the late 90’s the financial class even began to off-shore Americas’ new *powerhouse of promise*, the service economy, to call-rooms in India and elsewhere<sup>xlix</sup>. The U.S. butcher, the baker and the brewer were off-shored because of prevailing cost advantages elsewhere. The non-comparative advantages filled the pockets of global finance.

### **Inventory Assessment – A Good Place to Start**

Mountain Pass and the Pea Ridge mines may both eventually reopen. However, the continued, or continuous, production of domestic rare earth resource is a risky proposition. As Mountain Pass’s survival would be based on REO production only (mostly light lanthanides); they will be the most vulnerable to Chinese pricing manipulation and potentially financial failure. The Pea Ridge deposit is primarily an iron ore mine with multiple product streams and ultimately represents a more viable project. However, even the high value REO production from the Pea Ridge deposit will be subject to Chinese pricing pressure. Wings Enterprises, Inc., the owner and developer of the Pea Ridge deposit, would not continue to produce REOs if ‘market prices’ fall below production cost. With the prospects of Pea Ridge and Mountain Pass both becoming ‘Swing Producers,’ there is little domestic benefit in reopening these mines from a national industrial policy perspective. If the United States wants a presence in the production of high value REO dependent technologies it will take a national industrial policy commitment to succeed.

America must develop a value added resource base in rare earths. Even with sustainable domestic REO production, without the necessary mineral processing and refining capabilities these resources would be

shipped to Asia for further processing, refining<sup>li</sup> and ultimately, consumption<sup>lii</sup>. Creating privately funded refining facilities is risky, as China, a foreign government, has a history of eliminating competitive producers of rare earth oxides, elements and alloys through predatory pricing<sup>liii</sup>. Private investment is subject to ‘market conditions,’ including government sponsored monopoly risk from China.

### **Where to Start – A National Industrial Policy**

If America intends to participate in the production of high value goods then we must define the preconditions to succeed. One of the preconditions for success is in the production and refining of domestic rare earths in a fully integrated rare earth refinery capable of producing high value elements and alloys.

This facility must be a public / private partnership with a clear and unequivocal sanction from the Federal Government. The Public investment communicates a U.S. National Interest in the project – hands off China. Without this overt Federal Support history suggests that this project would become subject to predatory pricing – ultimately resulting in failure.

- The rare earth refinery must stand committed to supplying the U.S. Defense industry. In exchange the DoD must reciprocate with price supports – as it does with other Strategic and Critical materials.
- The domestic REO mining companies must commit to firm supply contracts. In exchange, these suppliers will be compensated with proportional ownership of net proceeds.
- The ‘Public’ nature of this facility should provide research, university and commercial interaction through an accessible metallurgical campus for the training and exchange of the basic knowledge in metallurgical and mineralogical rare earth sciences.

Our economy must be restructured upon National Interests. Adam Smith, the worlds’ most recognized proponent of “free trade,” would denounce today’s neo-traders as charlatans and enemies of the state. The founding principles of free trade were based on Mercantilism, or the relative accumulation of trade surpluses<sup>liv</sup>. The very principles of free trade are based on National Interests<sup>lv</sup>.

### **Concluding Remarks**

This paper is a call for self preservation through the pursuit of our national interests. As our overall macro-economy is vital to the health and future of our nation, this paper calls for the rapid development of a value-added natural resources facility to supply our current “Strategic and Critical” technologies needs of today and to support the high value-added manufacturing and Defense needs of the future. This paper calls for all researchers, scientist, the DoD, DoE and members of the commercial and defense industry to rally to the cause of a domestic rare earth Refinery and other national endeavors that can translate into domestic advantage.

The United States Congress and the Executive Branch of Government have a Constitutional duty to protect and defend the United States. These duties and obligations are clearly defined within our national borders. The laws governing capital flows, taxation, tariffs, export controls, fiscal and monetary policy need to address domestic issues foremost.

America’s failure to remain current and relevant in rare earths is accelerating the rate of our decline in participation and competitiveness in what may prove to be the greatest area of future growth in high value manufactured goods. This failure has also left our National Defenses naked and vulnerable to the caprices of China.

The “Invisible Hand,” at the service of global financial institutions, has the world by the throat<sup>lvi</sup>. We must redirect that invisible hand towards our self preservation.

## References & Footnotes:

- <sup>i</sup> The United States has been a net consumer for three decades, culminating in record financial and trade imbalances for 2009, expected to exceed \$1 trillion (goods, services and debt related to the current budget).
- <sup>ii</sup> The exception being the DoE. However, that will not last forever if overall macro-economics do not improve.
- <sup>iii</sup> Please see “The internationalization of industrial supply chains and the location of innovative activities” by Brian Ficarek, et al, Carnegie Mellon. Also see Off-Shoring and Innovation by Francisco Veloso – CEEApLA.
- <sup>iv</sup> Brian J. Ficarek, Francisco Veloso and Cliff I. Davidson.
- <sup>v</sup> “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner. Also from presentation materials by Terry K. Clagett and Walter Benecki from the 2008 Magnetics Conference in Denver.
- <sup>vi</sup> Presentation materials by Terry K. Clagett and Walter Benecki from the 2008 Magnetics Conference in Denver.
- <sup>vii</sup> December 2008 Congressional mandate, to reflect the outgoing administrations ‘free trade preferences / credentials.’
- <sup>viii</sup> This list has been reviewed by Rick Lowden, acting head of Industrial Policy for the DoD, Jim Hedrick with the USGS, and many others.
- <sup>ix</sup> Federal Register February 2009 – Sec. 843-109-364. The Bush administration forced through its “Free Market” ideology in a December 12, 2008 meeting. This forced the DoD to adopt semantics into its arsenal and redefines the term “Critical.” Semantics do not perform well on the battlefield.
- <sup>a</sup> National Materials Advisory Board – 21<sup>st</sup> Century Military publication, 2008.
- <sup>xi</sup> Comprehensive work by the National Academies, 2008
- <sup>xii</sup> USGS data on Import Dependence, 2007.
- <sup>xiii</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mountain Pass). Also conversations with Rick Lowden, acting director of Industrial Policy for the DoD. Also conversations with Gary Smart former metallurgist with Santoku (Formerly Nuclear Corp, then Rhodia, before Rhône-Poulenc then Research Chemicals), and Les Hammond who recently developed two new REO refineries in China.
- <sup>xiv</sup> Mountain Pass is owned by Molycorp, but was formerly part of Chevron. Mountain Pass was the largest producer of rare earths, world-wide, for decades. Nationalist policies inside China helped force its closure through aggressive pricing policies.
- <sup>xv</sup> The Pea Ridge mine operated for 38 years as an iron ore mine. Rare earths were discovered in the late 70s. In the late 80s the USGS determined that the heavy REO deposit was Strategic and Critical to the United States. The former owners never initiated production due to lack of capital and increasing pricing pressure from the Chinese. The Pea Ridge deposit has four of 19 materials that the U.S. is 100% import dependent. The Pea Ridge deposit also has recoverable values of Tellurium (Te), Molybdenum (Mo), Cobalt (Co) and Tin (Sn).
- <sup>xvi</sup> Santoku, formerly Nuclear Corp., then Rhodia, before Rhône-Poulenc then Research Chemicals, currently purchases metals and some alloys from China directly. Dudley Kingsnorth Clint Cox – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mt. Pass). Also conversations with Rick Lowden, acting head of Industrial Policy for the DoD.
- <sup>xvii</sup> Dudley Kingsnorth – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mountain Pass). Also conversations with Rick Lowden, acting director of Industrial Policy for the DoD. Also conversations with Gary Smart, formerly a metallurgist with Santoku (Formerly Nuclear Corp, then Rhodia, before Rhône-Poulenc then Research Chemicals), Les Hamond (who recently developed two new REO refineries in China) and Cornel Holder with the DoD-NDS.
- <sup>xviii</sup> From multiple sources including USGS, China Rare Earth Society, Dudley Kingsnorth, Jack Lifton, and multiple trade Journals. The lowest percentage used was +95%, but the most frequently used percentage is 98%.
- <sup>xix</sup> Jack Lifton. Also extrapolated from 2008 SEM presentation materials by Dudley Kingsnorth and others, including interviews with the technical director of Toyota.
- <sup>xx</sup> The chance of a rare earth only mining operations surviving Chinese pricing manipulation is very low outside any type of protective structure. Any such financial capital committed to such a rare earth only mining resources venture would be in jeopardy. Any such facility would become a “swing producer (producer, producing in good markets and shut down in bad markets)” at best. A U.S. based swing producer of rare earths serves no strategic interests, and would only harm our long term National Interests.
- <sup>xxi</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also conversations with Rick Lowden, acting head of Industrial Policy for the DoD.
- <sup>xxii</sup> Context from Federal Register February 2009 – Sec. 843-109-364. When “Critical” means “DoD Dependent.”
- <sup>xxiii</sup> Federal Legislation, and conversation with Cornel Holder, director of the National Defense Stockpile.
- <sup>xxiv</sup> That same year, the State Council approved the establishment of the Baotou Rare Earth Hi-tech Industrial Development Zone.
- <sup>xxv</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also Moly Corporation (Mountain Pass). Also articles by the Chinese Society of Rare Earths.
- <sup>xxvi</sup> Moly Corporation (Mountain Pass), Tony Mariono, Jack Lifton, Clint Cox and others.
- <sup>xxvii</sup> This represents a new threat to Western Economies. Mature Western economies depend on high value production and manufacturing to off-set wage, capital and regulatory advantages in emerging economies.
- <sup>xxviii</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mountain Pass). Also articles by the Chinese Society of Rare Earths.
- <sup>xxix</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mountain Pass).
- <sup>xxx</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mountain Pass).
- <sup>xxxi</sup> U.S. & European capital markets, traditional banking or project financing will not support projects that have an inherent competitive disadvantage without some type of guarantee (this project is far too costly for Venture Capital).
- <sup>xxxii</sup> Eriez Magnetics, Magnequench and other U.S. Producers of REO dependent technologies have moved facilities to China. Other companies in the green technology and wind turbine business such as Vestas, Gamesa, GE, Nordex, & Suzlon have also relocated production facilities to China.
- <sup>xxxiii</sup> To reiterate, wealth can only come from 3 things: Agriculture, Natural Resources or Manufacturing. All other human institutions spring from this.
- <sup>xxxiv</sup> I cannot think of an exception, including Magnequench, the Patent holder and producer of REO magnet technology for military guidance systems. In fact, the actual facility that produced the RE-Alloy magnets required for the Cruise Missile, smart-bombs and other weapons systems was packed up and moved to China in the 90’s.
- <sup>xxxv</sup> Mathematically: Unit Production = X, Unit Margin = Y, Sale or Royalty value of patent = Z. The value of Z must be smaller than the expected value of X\*Y. Z is subject to pirating. The accumulated value of X\*Y aggregates in China. The value of Z may be owned by a network of global investors and is evenly dispersed.
- <sup>xxxvi</sup> From the title “In inquiry into The Nature and Cause of the Wealth of Nations” and the entire work National interests were measured by the accumulation of gold bullion, or a positive balance of trade.
- <sup>xxxvii</sup> It should be obvious by now that you cannot trade ‘Services’ for manufactured goods indefinitely...
- <sup>xxxviii</sup> Outside of a ‘national context,’ what is best for a country,’ comparative advantages cannot be achieved because people (as a nation) are immobile, but capital flow is not. Consequently, in the absence of national constraints, comparative advantage becomes the global aggregation of all potential profits (rents). In a senses, outside of a national context, the “Invisible Hand” is nothing more than a “rate collector” in the service of the new ‘global empire of money.’
- <sup>xxxix</sup> Skill levels are easily overcome through automation, or the absence of automation (e.g., hand sewn toys).
- <sup>xl</sup> Adam Smith, In inquiry into The Nature and Cause of the Wealth of Nations 1776. The famous illustration shows that the Butcher, Baker and Brewer seek their own gains, but through the division of labor all will benefit.

<sup>xli</sup> This is how it is explained by the proponents of “Neo-Traders,” as the maximizing of competitive advantage. Although it is true that if we can export all manufacturing to a nation with no wages, regulations or environmental consequences, we will have the cheapest products. However, that benefit can only accrue to those invested in said company, and all accumulated gain flows to said group. Of course you can quickly see that this is unsustainable, but remember the world of ‘global finance’ is build on a series of exit strategies, where every investor believes that they will exit in the penultimate round.

<sup>xlii</sup> This is in fact, the ultimate outcome.

<sup>xliii</sup> The global financial class has no nationality, but their allegiance to the rules of finance are perfectly aligned.

<sup>xliv</sup> The U.S. economy is currently based on consumption. Consumption is based on oil-backed dollars. Oil-Backed dollars are based upon an agreement with OPEC nations that converts world energy consumption into dollars, for the purchase of oil. That relationship, that replaced the gold standard in the early 1970s, is under attack as the United States wages wars in 3 Islamic nations and provokes resentment from most of the other members of OPEC. Without the support of OPEC, trading oil for U.S. currency reserves, the system will fail.

<sup>xlv</sup> Business Week magazine June 15, 2009 “Innovation, Interrupted.”

<sup>xlvi</sup> See Congressional Testimony from Dr. Robert D. Atkinson to the Committee on Science and Technology, Sub Committee on Technology and Innovation October 4, 2007.

<sup>xlvii</sup> The purchasing and managing companies were run by son-in-laws of the Premier himself, Deng Xiaoping.

<sup>xlviii</sup> Insight Magazine, Vol. 19, Issue #5, February, 18, 2003. Also Congressional Testimony of Frank J. Gaffney to the House Armed Services Subcommittee July 2005.

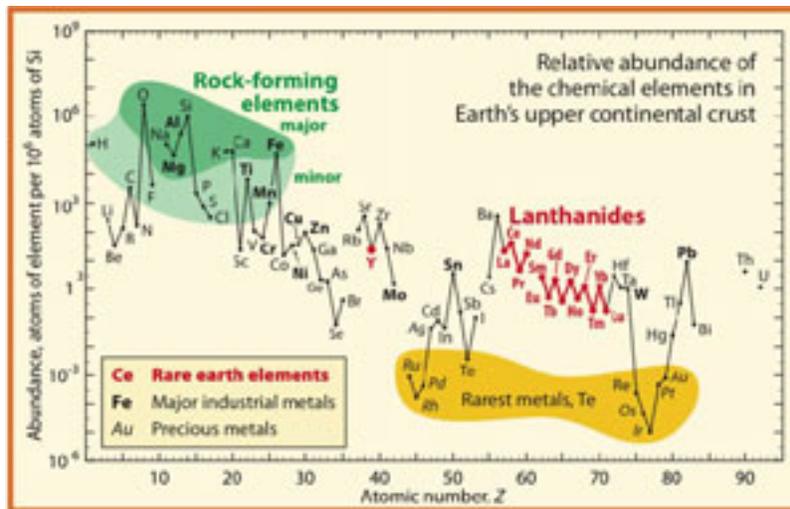
<sup>xlix</sup> The stock market in its current state is no longer sustainable. Historical returns from 1980 back provided nominal, single digit, returns over U.S. Treasuries and inflation. Today it reflects a mathematical impossibility. Since 1980 investor expectation are for double digit returns in perpetuity in an economy growing less than 3%. Every investor holding out for what he believes to be the peak price, and selling to a new investor seeking the same double digit return. It is a series of exit strategies starting with the original entrepreneur and investment banker selling out to the public markets, to the newly incentivized signor management and board of directors and an endless parade of demanding and transient shareholders (day traders, index funds, hedge funds, retail traders, momentum players, technical players, etc..) the average turn-over in a mid-capitalization company is about 90% per year, with some individual fund portfolio turnover ratios at several hundred times per year. If the average turnover is about one year, then the term “trade” or “bet” is a more accurate term than “investing (implying a long view)”.

<sup>l</sup>Recent history of Chinese industrial policy for REOs suggests that they will once again drive prices below Western production cost to maintain their near-monopoly position.

<sup>li</sup> Dudley Kingsnorth, Clint Cox – public articles and presentations at the 2008 SME convention. Also “High Performance Magnets” – a paper presented at the Strategic Materials Conference in Ohio, April 2009, by Ed Richardson, Thomas & Skinner, and a similar presentation by Moly Corporation (Mountain Pass).

<sup>lii</sup> Asia consumes well over 90% of rare earth oxides, elements and alloys. Asia is hungry for more rare earths, especially the heavy lanthanides. Asia alone is projected to consume over 100% of global production for many rare earth oxides, elements and alloys. In fact, Toyota’s projected production of the Prius alone would consume 100% of global production for two or more rare earth oxides, elements and alloys. It is also well documented that industry and innovation are interdependent.

<sup>liii</sup> The majority of REO mines and rare earth refining facilities in China are supported, subsidized, owned or controlled by the Chinese Government including the establishment of the Baotou Rare Earth Hi-tech Industrial Development Zone, an entire City dedicated to Rare Earths (Baotou’s population is 2.5 million people).



**Rare Earth Elements**

														Y 39									
La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71									
Lanthanides																							
H																	He						
Li	Be																	B	C	N	O	F	Ne
Na	Mg																	Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
Fr	Ra	Ac	Lr																				