

Synthesis Partners, LLC
Market Intelligence Update

Rare Earth Market Update

Prepared for the Department of Energy

Synthesis Partners, LLC

This report is intended for public release.

Please contact Steven Boyd, DOE or Synthesis Partners with questions or comments. Thank you.

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1. Tasking

Synthesis Partners was tasked by the US Department of Energy (DOE) Vehicle Technologies Program to undertake a brief research update on developments in rare earths markets and R&D. This targeted research follows Synthesis' detailed Rare Earth Materials and Rare Earth Magnets report, issued in August 2009.

The July 2010 update highlights selected developments in the fields of rare earths (RE) minerals exploration, mining, processing, refining, magnet production, RE-materials substitution, and recent US legislative and government actions. The information is provided in an outline format.

2. Sources and Methods

The research was conducted during the April through June 2010 timeframe.

Synthesis Partners conducted rapid, secondary and primary source research on the rare earth mining and magnetic sectors. The collection effort leveraged the primary source contacts and secondary sources developed by Synthesis and DOE in the course of prior RE market research.

Synthesis screened and reviewed 100s of company sources, technology, business and industry articles, white papers, web pages, and conference activities for this update. In terms of primary source contacts, the following table depicts the key companies, industry associations and industry consultants contacted in the course of our research.

Table 1: Primary Contacts

Source	Contact
Companies	
Adams Magnetic Products	Jack Powell
Arafura	Alistair Stephens
Avalon Ventures	Ian London
Electrodyne	Kevin Cook
Electron Energy Corp.	Peter Dent
Hitachi Metals	Brian Brilinski
J.A. Green & Co.	Jeff Green
Jack Lifton, LLC	Jack Lifton
Less Common Metals	David Kennedy
Lynas Corporation	Dr. Matthew James
Magnet Applications	Dr. James Bell
Molycorp	Mark Smith
Thomas & Skinner	Ed Richardson
UQM Technologies	Jon Lutz
Walt Benecki LLC	Walt Benecki
Wings Enterprises, Inc	Jim Kennedy
Associations	
U.K. Magnetics Society	J. Ward
Rare Earth Industry and Technology Association	Keith Delaney
Rare Earth Magnetics Association	

3. Market analysis and updates

Rare Earth Exploration

American Companies

Molycorp – Greenwood Village, Colorado

- The Board of Directors has approved an exploration program to be carried out in 2010 and 2011, for the purpose of better delineating the existence and extent of various Bastnasite, Monazite and other Rare Earth bearing mineral deposits known to exist outside the current mining area on the Company's property and claims at Mountain Pass, California. (March 1, 2010)
- In early March 2010, Molycorp's application for DoE loan guarantees intended to provide support for development of clean energy projects was rejected. According to Molycorp president Mark Smith, "the department thought that rare earths, while vital to a number of green energy technologies, did not fall under the program's mandate." In response, Colorado Rep. Mike Coffman "proposed the creation of a loan guarantee program for domestic rare earths producers, which Smith said could provide the low-cost capital needed to bring his company's Mountain Pass Mine in California back online by 2012." (See RESTART Act, below) (March 31, 2010)
- In April 16, 2010, Molycorp filed legal notice with the SEC of their intent to raise up to \$350M via an IPO. The Form S-1 is at <http://www.sec.gov/Archives/edgar/data/1489137/000095012310035593/d70469sv1.htm>.

Tombstone Exploration Corp. – Tombstone, Arizona

- Renewed six exploration permits totaling 3,025 acres with the Arizona State Land Department (August 10, 2009)
- Although the company lists rare earth minerals as an area they're interested in, it seems to be primarily interested in gold and silver exploration. Will continue to monitor for indications of rare earth exploration.

US Rare Earths, Inc. – Salt Lake City, Utah

- "...a privately owned company...announced this week that its rare earth element deposits in Idaho and Montana were listed as among the nation's most important domestic deposits in the annual listing of the worldwide distribution of rare earth element deposits, produced by the US Geological Survey (USGS). The US Rare Earths properties include Diamond Creek, in southeast Idaho's Webster Range; and a 600-acre site in the Lehmi Pass, at an elevation of about 7,200 feet on the Continental Divide, between Idaho and the Bitterroot Range of Montana." (February 10, 2010)
- "According to the USGS report, the company's ore bodies contain enough accessible and minable lanthanum, neodymium, dysprosium, terbium, and europium to make the United States independent from reliance on foreign suppliers."
- Nothing found to indicate any firm dates to begin development or mining on these sites
- "Current USGS reports show that U.S. Rare Earths, Inc. owns the mineral rights to one of the two largest resources and reserves of rare earth elements (REE'S) in the United States. According to the USGS current rare earth survey report, U.S. Rare Earths, Inc. is the only significant U.S. deposit that has heavy rare earth concentration commercially recoverable with current technology. The USGS now recognizes U.S. Rare Earth Inc.'s deposits in Idaho, Colorado and Montana as one of only five proven, substantial deposits of REE's in the world outside of mainland China or Chinese control. The company's data shows that its ore bodies contain enough accessible and minable lanthanum, neodymium, dysprosium, terbium, and europium to make the United States independent from reliance on foreign suppliers." However,

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there is no indication that mining or development work has begun on any of these sites. (June 2010)

- In June, the company initiated a strategic review of “alternatives to enhance shareholder value, including those involving a possible merger, sale or other transaction.” According to the press release, the company “holds 169 unpatented mining claims of individual major vein deposits of REEs in the Diamond Creek and the Lemhi Pass areas of Idaho and Montana” (June 14, 2010)

Xploracorp – Durham, North Carolina

- Although the company lists rare earth metals as a product, no info on rare earth exploration was found on their web site. No other information on company found. Will continue to monitor for indications of rare earth exploration.

(Note: Rare earth exploration in Alaska, Wyoming and Nebraska is being conducted by Canadian companies Ucore Uranium, Rare Element Resources Ltd and Quantum Rare Earth Developments Corp, listed below.)

Canadian Companies

Avalon Rare Metals (Changed name from Avalon Resources Ltd in February 2009) – Toronto, Ontario

- “Avalon's primary asset is the 100% owned, advanced development stage project, Nechalacho Rare Earth Element Deposit located in the Northwest Territories, Canada. Avalon believes that Nechalacho is one of the highest quality undeveloped REE deposits in the world, unique in its exceptional enrichment in the heavy rare earths. Avalon also owns four other rare metals and minerals project in Canada, of which three are at advanced stages of development.” Although assays show the sites are rich in rare earths, no mining of resources has commenced at any of them.
- A revised 43-101-compliant resource estimate for the Nechalacho Rare Earth Element deposit that “resulted in a significant expansion of the total Indicated and Inferred Resources in the deposit.” The site “now ranks as the second largest REE deposit in the world by reported TREO and the third largest contained niobium deposit in the world by reported Nb₂O₅.” (June 14, 2010)

Eagle Plains Resources Ltd. – Cranbrook, British Columbia

- Although the web site lists four rare earth exploration projects, the company is primarily involved in gold exploration. The rare earth projects are all associated with, and appear to be secondary to, the company's exploration for uranium and other industrial minerals. At this time this company does not appear to be positioned to be a major player in rare earth production.

Great Western Minerals Group – Saskatoon, Saskatchewan

- Great Western Minerals Group Ltd. (GMWG) and Toyota Tsusho Corporation (TTC) have signed a non-binding letter of intent to examine the merits of jointly conducting exploration and development activities on the Douglas River and Benjamin River exploration projects. TTC will have an exclusivity provision in these discussions for a six month period. (July 22, 2009)
- Expiration date of letter of intent with Toyota Tsusho was extended to March 31, 2010. (January 20, 2010)
- Great Western Minerals Group has signed an exclusivity agreement with Rare Earth Extraction Co. of Stellenbosch, South Africa to bring the Steenkampskraal Mine in the Western Cape Province of South Africa back into production. The mine is a source of monazite with an average of 17% total rare earth oxide. (March 4, 2010)
- GWMG and TTC allowed the letter of intent to expire. TTC “recognizes the potential for these properties, the current stage of development is too early to meet TTC's needs as a trading company, as further technical and analytical information are required.” Great Western is

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discussing projects “with other potential partners who had previously expressed an interest in working” with Great Western. (April 1, 2010)

- Great Western was granted a mining permit by the South African government for the Steenkampskraal Monazite Mine. GWMC president and CEO Jim Engdahl predicted this “to be one of the highest grade Rare Earth mines in the world and therefore one of the world’s lowest cost producers.” (June 3, 2010)

Hudson Resources Inc. – Vancouver, British Columbia

- Exploration has begun on the Sarfartoq Carbonatite in Greenland, which is 100% owned by Hudson. They will begin in March 2010 with geophysical surveying, environmental baseline data collection, a minimum 3,000 meter drill program, and bench-scale metallurgical test work. In April they plan to start first phase drilling. The initial assays show that neodymium oxide and praseodymium oxide together average around 54% of the total distribution of rare earth mineralization.
- The first phase of a 5000m drill program is underway, with the second phase to begin in August. They expect the assay results by the end of July. (May 27, 2010)

Quantum Rare Earth Developments Corp - Vancouver, BC

- In May 2010, acquired the rights to the Elk Creek Carbonatite located in southeastern Nebraska. Elk Creek is one of the largest known carbonatites in North America, through the acquisition of Elk Creek Resources Corp. According to the US Geological Survey, “The Elk Creek carbonatite, located south of Lincoln, has the potential to be one of the largest global resources of niobium and rare earth elements (REE)”
- Test drillings done at the site in the 1970s and 1980s showed it contains rare earth elements, but no further development was attempted due to the depth of the deposits (500 feet or deeper) and the expense associated with mining at that depth

Quest Rare Minerals Ltd. (changed name from Quest Uranium Corporation in April 2010) - Montreal, Québec

- Company continues to explore the Strange Lake project and has confirmed heavy rare earths represent between 28.8 percent and 71.0 percent of the total rare earth content in the new drilling. (December 10, 2009)

Rare Element Resources Ltd. - Vancouver, BC

- Drilling has begun on the resource expansion program for rare-earth-element mineralization on the Company’s Bear Lodge property of northeastern Wyoming. Initial metallurgical testing of the near-surface oxide portion of the deposit has provided very encouraging results that could lead to a commercially viable process. (September 10, 2009)
- The Company has agreed to complete a \$3 million financing consisting of 1 million Units. The additional funds will be used to provide working capital for the Company’s rare earths exploration program at the Bear Lodge Project in Wyoming and for general working capital. (September 11, 2009)
- Assay results from ten drill holes at Bear Lodge show anywhere from 5.57 percent to 11.56 percent rare earth oxides. (February 8, 2010)
- The company increased the resource estimates in the Bull Hill deposits at Bear Lodge by more than 50 percent, to 1,210 pounds at a 1.5 percent REO cutoff grade (May 29, 2010)

Ucore Uranium - Halifax, Nova Scotia

- The company is primarily exploring for uranium but also has discovered high concentrations of rare earth oxides at their Bokan Mountain, Alaska property. Sampling continues to evidence unusually high concentrations of heavy rare earth oxides to as high as 17 percent, and total rare earth oxides to as high as 18 percent. (September 24, 2009)

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- Assays show total rare earth oxides as high as 10.04 percent at Lost Pond in western Newfoundland. (February 8, 2010)
- The Alaska State House of Representatives unanimously passed a House Resolution in favor of expedited permitting and production of heavy rare earth resources at Ucore's Bokan Mountain project in southeast Alaska. (April 20, 2010)

Australian Companies

Arafura Resources, Ltd – Perth, Western Australia

- Planning to develop rare earth mine on Aileron station, north of Alice Springs, in four years' time and is considering South Australia and the Northern Territory as possible locations for a billion-dollar chemical plant; also considering overseas location. (September 15, 2009)
- Arafura announced that its Nolans Bore project would start production by 2013. They are also continuing with chemical plant design studies and the site selection work is in the final phase. (May 20, 2010)

Greenland Minerals and Energy Ltd – West Perth, Western Australia

- An Australian “mineral exploration and development company, focused on unlocking the mineral riches of Greenland” (<http://www.ggg.gl/>)
- The Kvanefjeld field is projected to contain the world's largest deposits of rare earth metals and uranium. (November 10, 2009)
- Greenland Minerals expects to start production at its Kvanefjeld project in southwest Greenland by 2015 with an annual production equivalent to 43,729 tpa rare earth oxides. (February 1, 2010)
- “The Kommuneqarfik Kujalleq (newly merged municipal council of south Greenland) met on May 12th” and “voted in favour of supporting a change from the zero-tolerance uranium policy, and acknowledged that a final decision to mine should be made based on the results of the definitive feasibility study and associated environmental and social impact assessments.” Greenland Minerals plans to start these programs in 2011. (May 26, 2010)

Rare Earth Mining/Processing (ore/rare earth oxide production)

American Companies

Molycorp – Greenwood Village, Colorado

- Preparations are underway to restart mining at Mountain Pass. They are currently producing approximately four million pounds of rare earth products per year. Plans are to ramp up annual production to 40 million pounds of rare earth products over a three-year period. The first phase will be the removal of water that has accumulated at the bottom of the mine since 2002. This will be followed by the removal of overburden to expose an area of fresh ore. The dewatering process is expected to take approximately 12 months, followed by an additional 12 months for removal of overburden. This will allow them to begin mining, crushing and milling fresh ore to meet their goal full production in 2012. After that they will conduct mining campaigns at two or three-year intervals, which should be sufficient to support full production of finished rare earth products at the planned rate of 40 million pounds per year. (August 11, 2009)
- “There is no public normal market for REs. It is understood that there really is no public market in REs. Rather, the daily, weekly prices of deals are unpredictable, as they are agreed to in private markets. There is no Commodity Futures Trading Commission, and therefore the nature of prices, their volatility, the rationale behind buying and selling, is all very murky.” Mark Smith, CEO, at Magnetics 2010 Conference
- “Only the Chinese are stockpiling REs. No one else is. And they control 95% of the world's market as well. That is notable.” Mark Smith, CEO, at Magnetics 2010 Conference

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- Molycorp signed a letter of intent with Neo Material Technologies Inc. (see below), for manufacture, supply and distribution of rare earth products. The non-binding letter of intent states Moly would provide rare earth carbonates, and Nd and Pr oxides or metals, and Neo would “provide Molycorp with technical assistance and know-how with respect to production of rare earth metals, alloys and magnets,” and market various Moly products. (June 8, 2010)

Wings Enterprises, Inc – Pea Ridge, Missouri

- Currently focused on restarting iron ore smelting facility and iron production
- In November 2009, asked for meeting with DoE and DoD “to discuss the Energy and National Security Issues risk related to Rare Earths, and how best to resolve this issues.”
- Focus seems to have shifted from rare earth production per se to promoting using the thorium by-products of rare earth production as alternative nuclear fuel. (June 2010)

Australian Companies

Arafura Resources, Ltd – Perth, Western Australia

- The East China Mineral Exploration & Development Bureau (ECE) will double its holding to 25 percent, a deal worth AUD 22.94 million. The company is trying to persuade other potential investors, including some Chinese companies, to give a hand to the financing for mine development. A total of about AUD 600 million is needed, including AUD 50 million for the development of the Nolans mine and AUD 550 million for the construction of a processing factory. (September 10, 2009)

Lynas Corporation – Sidney, NSW Australia

- The Australian Foreign Investment Review Board (FIRB) delayed a decision on Lynas Corporation's proposed \$A500m deal with China Non-Ferrous Metal Mining, which would give China Non-Ferrous a 51.6% stake in Lynas, for the third time in recent months. The decision is expected in early October 2009. (September 10, 2009)
- China Non-Ferrous Metal Mining dropped its attempt to acquire majority ownership of Lynas (September 25, 2009)

Rare Earth Refining (processes ore/oxide into metal)

American Companies

Primet LLC – Schaumburg, Illinois

- American company that manufactures rare earth metals in China, from Chinese materials. Chinese partners include Sichuan Provincial Mining, Leshan Primet New Materials, Primet Baotou. No current news found.

Canadian Companies

Great Western Technologies – Subsidiary of Great Western Minerals Group (above),

- Located in Troy, Michigan. Produces rare earth alloys and powder products and currently developing strategic partnerships with several Chinese and European companies to assist in developing rare earth manufacturing and processing facilities.

Australian Companies

Lynas Corporation – Sidney, NSW Australia

- The company has raised enough capital to lift the suspension of the project to construct a concentration plant in Western Australia and an advanced materials plant in Malaysia. Equipment and infrastructure vendors have been advised of the restart and engineering and

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procurement activities have resumed. (Quarterly Report for the period ending 31 December 2009)

- Contract awarded to Abesque engineering Ltd to “complete engineering design and construction of the Mount Weld Concentration Plant.” (March 5, 2010) The first feed of ore into the Concentration Plant is scheduled to occur in December 2010. (June 2010)
- Construction of the Advanced Materials Plant in Malaysia is “is on schedule for completion in the second quarter of next year. Lynas will offer the first source of supply of Rare Earths outside of China when it starts production as planned early in the third quarter of 2011. (June 2010)

North American Rare Earth Magnetic Material Producers (may also manufacture finished magnets)

Electron Energy Corp. – Landisville, Pennsylvania

- At the Magnetics 2010 Conference, Peter Dent indicated Electron Energy may be moving into NdFeB, possibly on basis of new nano-powder/new powder milling technique, but only after careful R&D work on innovative manufacturing processes, possibly including nano-powders, is completed.
- Other points from the conference:
 - Adding Fluoride increases density, but it is a challenge due to reactivity
 - “SmCaF shows promise, with precise milling of CaF grains”
 - Use of Fe is being proven to work, on nano-scale, but for isotropic cases so far
 - Need is for further focus on anisotropic materials, starting with Fe and Co
 - In theory, nano-level integration will produce Bmax of 2x current capabilities
 - Recyclability of magnetic materials is a “good area for entrepreneurs ... it is not yet economic but a major market if it could be made economic.”

Hitachi Metals America, Ltd – Purchase, New York

- No updated information found

Neo Material Technology - Toronto, Ontario

- “A global producer of neodymium-iron-boron magnetic powders and rare earth based engineered materials and applications.” It is headquartered in Toronto, Ontario but operates plants in China, Singapore and Thailand under its Magnaquench and Neo Performance Materials divisions. Neo signed a non-binding letter of intent with Molycorp as outlined above. (June 2010)

North American Rare Earth Magnet Producers (manufactures finished magnets from magnetic materials)

Arnold Magnetic Technologies – Rochester, New York

- No news since announcement of JV to produce rare earth magnets in the US with Molycorp in July 2009 (which has since lapsed due to Arnold’s inability to get license from Hitachi to produce NdFeB magnets in the US).
- Sold its powder core business unit in Shenzhen, China to Micrometals, Inc. of Anaheim, California (January 6, 2010)
- Purchased the assets of Semicon Associates’ rare earth samarium cobalt magnet manufacturing operations. “The equipment will be relocated to Arnold’s Rochester, NY facility where it, in conjunction with existing equipment, will enable Arnold to domestically produce samarium cobalt rare earth magnets.” (April 7, 2010)

North American Permanent Magnet Producers (other than Rare Earth)

Thomas & Skinner – Indianapolis, Indiana

- "The topic of rare earth magnets has gotten a lot of press recently. News organizations all over the world have run articles about rare earth metals, China, and how important magnets are to many of the new, emerging green technologies. But if we scratch the surface a bit, there are some startling contradictions in what is being said." – Ed Richardson, Vice President, at Magnetics 2010 Conference
- "Conservative estimate" \$1BN required to get full RE value chain back in place in US, including:
 - Mining
 - Refining
 - Alloying/Powder production
 - Magnet Production
- \$80M required to invest in manufacturing technologies, including:
 - Refining to alloys and powders and magnet production
 - Magnet production includes
 - Melting
 - Crushing
 - Milling
 - Pressing
 - Sintering
 - Grinding
 - Magnetizing
 - Testing
- \$30M required to invest in R&D, including:
 - "Areas of research will include the entire RE value chain, from oxides to finished products"

Industry Consultants

Walt Benecki (<http://www.waltbenecki.com/index.html>)

- "A comprehensive study of the worldwide permanent magnet marketplace is currently underway. This study will include market statistics by magnet type, forecasts of future market growth, applications, technology trends, NdFeB patent status, review of raw material issues and a comprehensive directory of over 300 industry participants listed by geographic region. This study will be available during the third quarter of 2010."
- Viewpoint on rare earth magnet recycling, from Magnetics 2010 Conference: "Industry is in the Stone Age when it comes to recycling. True recycling is not happening now. True recycling is when the product of recycling is a new Nd magnet. It is not happening now, but will, when the economic incentive is right, when REs are much more expensive."

Clint Cox (<http://www.theanchorsite.com>)

- "The Chinese view resources from the standpoint of reserves, not just production... a mindset that is very different from the Western approach of looking at production as the primary way to view rare earths... the Chinese recognize that they have the largest reserves in the world, but... they have chosen not to produce from these reserves for one reason or another (mostly pricing). The United States does have vast reserves of rare earths, but are not currently producing from these reserves.... the United States does not have great reserves of the heavy rare earths, and each country has its own unique set of mining laws and restrictions. So reserve numbers, in and of themselves, do not tell the whole story, but it provides another frame of reference. The problem of rare earth pricing with so much internal competition in China. This is part of what China is currently addressing — they wish to consolidate rare earth operations into fewer companies to create more efficient use of resources and provide better environmental controls. Of course, with fewer competitors, it will also help to better control the pricing."

Jack Lifton (Jack Lifton, LLC)

- “I believe that Avalon Rare Metals and Great Western Minerals Group will both be producing heavy rare earths within 3 to 5 years in countries outside of China... within 5 years the world's principal supplies of heavy rare earths will NOT be from China”
- “China has a policy of predatory pricing, which has allowed it to gain monopoly control over some strategic natural resources such as the rare earth metals. The policy has now backfired as the low revenues to Chinese producers have deprived them of the investment funds they need to not only expand production but also to maintain the production they have. The result is a massive Chinese environmental problem, which threatens all by itself to cut non-Chinese end users off from their only supply. I have said before and I will continue to say that the so-called prices set for rare earth metals by Chinese producers at all levels are arbitrary. When the crunch point comes, and it may come very soon, when there are no rare earth metals to be had in China for export, the prices of the rare earth metals will skyrocket and institutional investors will squander billions to re-start the western supply and value chains for the rare earth metals. Western institutional investors simply don't know how to value rare metal resources; they are about to have an expensive lesson. Let me repeat: I believe that the rare earth metals are underpriced already at the present time, because they represent a Chinese pricing set for the main purpose of keeping the production of the rare earth metals and of their end use products in China to maximize the jobs created by this industry within the domestic Chinese economy. This situation cannot last much longer, because China itself is running short of rare earth metals due to inefficient production methods, environmental problems, and corruption.”
- On reports that China is going to build a stockpile of 300K tonnes of rare earth ore concentrates over the next three years: “I think that the rare earth mining industry in China is now facing a large environmental cleanup program; the Chinese government has decreed a halt to new mining projects including expansion of existing operations until 2015 or until environmental pollution due to a history of mining for volume without regard to environmental consequences has been “remediated.” This can take years and huge amounts of money. But, in any case, there is already too much dependence on this mining at many stages in the supply chain for components and finished goods, and simply stopping mining during the “clean up” and restructuring, which would be normal at some point, could well be an economic disaster for China.” (May 18, 2010)
- Recently published reports:
 - “Rare Metals in the Age of Technology”
 - “The Supply Issue for All Metals”
 - “Rare Metal ETFs: The Positives and the Negatives”
 - These reports were reviewed and while interesting, were found to contain no significant, new information for this report. (June 2010)

Rare Earth/Magnetics Organizations in the US

REITA - Rare Earth Industry and Technology Association

- Members include (this list is growing)
 - Molycorp (founding company)
 - Electron Energy
 - Arnold Magnetics
 - GE
 - Colorado School of Mines
 - Worcester Polytechnic Institute
 - Rare Element Resources
 - AMES/Iowa State University
 - University of Delaware
- REITA has given presentations to:

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- Electric Drive Transportation Association Annual Meeting (January 27, 2010)
- U.S. Department of State, Bureau of Economic, Energy and Business Affairs, Global Energy Seminar Series (March 16, 2010)
- Technology and Rare Earth Metals for National Security and Clean Energy (TREM '10) (March 17, 2010).
- All presentations dealt with the Chinese control over the rare earth industry and the implications on the US defense industry should China decide to limit exports. (June 2010)

USMMA (US Magnet Materials Association)

- Members include
 - Electron Energy Corporation
 - Thomas & Skinner
 - US Rare Earths, Inc.
 - Hoosier Magnetics
- Currently building database of all permanent magnet compositions
- Successfully advocated for inclusion of a congressionally mandated study of the rare earth supply-chain in the FY10 National Defense Authorization Act. (See RESTART Act, below)

US Government Actions

RESTART Act

On March 17, 2010, Congressman Mike Coffman introduced the H.R. 4866, Rare Earths Supply-Chain Technology and Resources Transformation Act of 2010 (RESTART Act). Govtrack.us summarizes the bill as follows:

Directs the Secretaries of Commerce, of Defense, of Energy, of the Interior, and of State to: (1) appoint an Executive Agent, at the Assistant Secretary level, to serve as a representative on an interagency working group to reestablish a competitive domestic rare earth supply chain; and (2) assess and report to Congress on the chain, determining which rare earth elements are critical to national and economic security. Directs the United States Trade Representative (USTR) and the Office of Science and Technology Policy also to appoint representation to such working group. Requires the Secretary of Defense to commence procurement of critical rare earth materials and place them in a national stockpile, and the Defense Logistics Agency, Defense National Stockpile Center to serve as Administrator of the stockpile. Authorizes the Administrator, if necessary to meet U.S. national security and economic needs, to purchase rare earth materials from the People's Republic of China. Instructs the USTR to: (1) initiate and report to Congress on a comprehensive review of international trade practices in the rare earth materials market; or (2) initiate an action before the World Trade Organization (WTO) as a result of the review. Directs the Secretaries of Commerce, of the Interior, and of State to report to the domestic rare earth industry about mechanisms for obtaining government loan guarantees to reestablish a domestic rare earth supply chain. Directs the Secretaries of Defense and of Energy to issue guidance for the industry related to obtaining such loan guarantees. Expresses the sense of Congress regarding a prioritization of Defense Production Act projects with respect to the domestic rare earth supply chain.

The bill was referred to the House Financial Services Committee on March 17 and still is in committee.

The USMMA takes credit for getting this bill introduced and is lobbying heavily for its passage.

On June 22, Sen Lisa Murkowski (Alaska) introduced S. 3521, a companion bill with the same name, into the Senate. It was referred to the Senate Committee on Energy and Natural Resources.

GAO Report - Rare Earths in DoD Supply Chain

On April 14, 2010, the GAO released a report titled Rare Earths in the Defense Supply Chain. The report was prepared in response to the National Defense Authorization Act for Fiscal Year 2010, which required GAO to submit a report on rare earth materials in the defense supply chain to the Committees on Armed Services of the Senate and House of Representatives.

The report confirms the US' dependence on Chinese sources for rare earth materials and estimates that it could take up to 15 years to rebuild a domestic supply chain. Doing so "is dependent on several factors, including securing capital investments in processing infrastructure, developing new technologies, and acquiring patents, which are currently held by international companies."

The GAO "found examples of components in defense systems that use Chinese sources for rare earth materials and are provided by lower tier subcontractors." A DoD assessment on "its dependency on rare earth materials" is due by the end of September 2010.

The report notes that 'officials of the minerals and rare earth company [Molycorp] that owns the Mountain Pass mine expect that by 2012 it will achieve full-scale production of mining and separating" rare earth oxides. However, it also states this "facility does not currently have the full capability needed to refine the oxides into pure rare earth metals," nor does it have "the manufacturing assets and facilities to process the rare earth ore into finished components, such as permanent magnets. The Mountain Pass mine also does not have substantial amounts of heavy rare earth elements, such as dysprosium, which provide much of the heat-resistant qualities of permanent magnets used in many industry and defense applications."

It doesn't hold out much hope for the US rare earth industry for the immediate future. "Other U.S. rare earth deposits exist, such as those in Idaho, Montana, Colorado, Missouri, Utah, and Wyoming, but these deposits are still in early exploratory stages of development. Once a company has secured the necessary capital to start a mine, government and industry officials said it can take from 7 to 15 years to bring a property fully online, largely due to the time it takes to comply with multiple state and federal regulations."

Other factors which may affect restarting a rare earth industry in the US include:

- Capital investment – Investors are concerned that the Chinese will drastically undercut US prices, negatively impacting their ROI.
- Processing plants – Industry official estimates it would take two to five years to develop a pilot plant to refine oxides to metals, and companies with existing infrastructure say they will not restart production without a consistent non-Chinese source of oxides.
- Environmental concerns – Complying with existing environmental regulations and dealing with radioactive products such as thorium and radium found with many rare earth minerals complicate the extraction process and drive up the cost.
- New technologies – Academic experts believe new processing technologies are necessary to compete pricewise with the Chinese, but these technologies won't be available for four years, and will involve high start-up costs.
- Intellectual property rights – Japanese and other foreign companies hold patents for manufacturing NdFeB magnets, and some of these do not expire until 2014. Companies wanting to manufacture NdFeB magnets will have to wait for the patents to expire or pay royalties to the patent holders.

Chinese Industry

Industry Update

The Chinese rare earth industry is undergoing consolidation as large companies merge and buy out smaller companies. Development plans from The National Development and Reform Commission include a reduction to fewer than 20 refiners by 2020.

One goal of the industry consolidation is to stabilize prices, as competition between producers resulted in “unreasonably low” prices of exports. Since 1990, China's rare earth exports have grown nine fold while the price has dropped by 36 percent. China is cutting this year's exports by 8.1 percent, to 31,300 tons. Future plans call for capping exports at 35,000 tons per year in 2010 to 2015. Twenty-five percent of China's rare earth exports go to the US and 50 percent to Japan.

The global economic slump has hit the Chinese rare earth industry hard. Over the last 10 years Bayan Obo, Inner Mongolia, has supplied about 80 percent of the world's supply of rare earth. The rare earth industry in this region was at its peak in 2008, with an industrial output value reaching 9.88 billion Yuan (\$1.48 billion) and export volume totaling \$131.3 million. However during Q1 of this year, sales revenues totaled only 375 million Yuan -- a 47 percent drop from the same period last year. Its losses exceeded 78 million Yuan, and export volumes dropped more than 70 percent.

The world's largest research institute for the industry, Baotou Research Institute of Rare Earth, initiated seven projects applying new refining technologies at a cost of 1.34 billion Yuan in 2008. They predict when the technological applications are all realized, the industry's annual output will reach 4.17 billion Yuan.

Exploration outside of China has changed their situation. In the 1990s, China held 88 percent of the world's known rare earth reserves. That dropped to 52 percent in 2008. Zhou Hongyu, a deputy to the National People's Congress, stated, "At the present rate of mining, China will have no rare earth to mine in the next 20 or 30 years, and then we will have to import rare earth at great cost." Note that he is talking about mining, not rare earth production. Refining the ore could take years beyond the time spent mining it.

A report titled 2008 Report on China's Magnetic Material Market states: “There are now 1,096 magnetic materials producers in China, of which 359 focus on ferrite, 226 on rare-earth and metallic magnets, with the rest producing associated equipment and auxiliary raw materials.” The report was published in January 2009. The report costs \$2195 in electronic (pdf) format or \$2145 in hard copy. No more recent information on Chinese magnet manufacturers was found.

Xu Guangxian, a 90-year-old chemist with Peking University, known as China's "father of rare-earth", suggested that China should "establish a national reverse system for rare-earth." China's Ministry of Industry and Information Technology (MIIT) has approved Inner Mongolia Baotou Steel Rare-earth (Group) Hi-tech Co., Ltd to carry out a rare-earth strategic reserve program. The company will build 10 rare-earth oxide reserve projects with over 200,000 tons of total capacity.

China's Ministry of Commerce has issued its first batch of 2010 export quotas of 5,978 tonnes of rare earth for foreign-invested firms.

In late May 2010, China announced it will tighten controls over mining rare earth minerals. According to a report in the *New York Times*, China's State Council “is weighing a proposal to put the government in control of private and unauthorized mines that produce rare earth minerals.” While some companies and governments have expressed concern that this is a move to tighten China's control on the rare

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earth industry, Chinese officials say they are tightening control “because the mining has led to environmental ruin and chaotic development.” (June 2010)

As stated above, industry expert Jack Lifton views the Chinese stockpiling efforts as a way to keep their rare earth industry going while they shut down mining for a period of time to address environmental issues associated with their past mining practices. The industry associations such as USMMA and REITA do not share this view and still maintain the stockpiling is in preparation for tightening their control of the global rare earth market. (June 2010)

In May 2010, Research and Markets released a “China Rare Earth Permanent Magnet Industry Report, 2009-2010.” From the description of the report on their web site (http://www.researchandmarkets.com/research/09c400/china_rare_earth_p):

From 2000 to 2008, the average annual growth rate of global rare earth permanent magnet market maintained 25% or so. The downstream demand for rare earth permanent magnet declined sharply in 2009 because of the financial crisis. Along with the economic recovery in 2010, the consumption of Nd-Fe-B has upturned quickly, increasing by more than 30% in Q1 of this year. In the following years, there will be a vigorously increasing demand for rare earth permanent magnet in the fields such as wind power, new energy vehicles, and energy-saving home appliances with the improved requirements of energy saving & environment protection as well as the solutions of technical matters.

China is the main Nd-Fe-B producing country in the world and its output in 2009 was 94 kilotons. The major Nd-Fe-B manufacturers in China include Zhong Ke San Huan, Ningbo Yunsheng, Taiyuan Twin-Tower, AT& M, etc. Since 2003, Chinese Nd-Fe-B manufacturers have gradually turned from medium and low-end low value-added application market to high-end application market, for instance, VCM, automobile, wind power, MRI instrument, and so on.

The report is available in hard copy for \$1500 or in PDF form for \$1600.

Rare Earth Companies of Interest

China Minmetals Non-Ferrous Metals Co.

- Expects to “become the largest global rare earth enterprise in the next five years.”
- In February 2009, the company listed its processing capacity at 8,500 tonnes. According to the company's plan, when the company is listed on the stock market in three to five years, the capacity will reach 13,500 tonnes.
- In February 2010 Zhou Zhongshu, president of Minmetals, said “We aim to be the world's largest rare earth supplier.”
- CMN's “export volume of rare earth metals, oxides, salts and fluorescent powder and magnetic materials” in 2009 accounted for “10 percent of the nation's total.” The web site gave no indication of what their overall production of rare earths was. (June 2010)

HEFA Rare Earth Canada Co. Ltd.

- North American subsidiary of Baotou HEFA Rare Earth, “one of the world's largest and most experienced producers.”
- Owns five rare earth processing factories with 5000+ metric ton rare earth oxide production capacity

Inner Mongolia Baotou Steel Rare-Earth Hi-Tech Co., Ltd

- Taking over smaller rivals in Inner Mongolia to consolidate rare earth operations into one company

Tianjiao International

- American supplier for products from Baotou manufacturers

Rare Earth Research

Baotou Research Institute of Rare Earth

- The largest rare earth research and development institution in China; “focuses on the comprehensive exploitation and utilization of rare earth resources and the researches on rare earth metallurgy, environmental protection, new rare earth functional materials, rare earth applications in traditional industry.”
- Owned by Baotou Iron & Steel.

The Chinese Society of Rare Earths

- A rare earth science and technology organization. Claims more than 100,000 registered experts, which would make it the biggest academic community on rare earth in the world.
- No news updates, articles or research updates have been published to their web site since 2006.

Rare Earth Conferences

Recent

TREM '10

March 17-18, 2010

Washington DC

“...a gathering of senior government policy makers and influencers, technology companies from the minerals, defense, energy and automotive sectors. Together, they will discuss and change the policies that affect the way America imports, produces and uses technology metals”

<http://trem10.memberlodge.org/>

Clint Cox' highlights and summary of the conference:

(<http://www.theanchorsite.com/2010/04/13/conference-cornucopia-part-2-trem/>)

It was stated at the Technology and Rare Earth Metals for National Security and Clean Energy (TREM) Conference in Washington DC on March 17-18, that there are two modes of energy policy in Washington:

1. Complacency
2. Panic!!!

This may prove true for the rare earths as well. Please don't misunderstand, the Conference was filled with intelligent and fantastic conversations, but the mood has changed and it is now clear that this issue is beginning to gain some favor in Washington DC.

Now for some highlights!

Dudley Kingsnorth of IMCOA had plenty of insight to share with the audience. At one point, he spoke about the importance of the pilot plant phase for rare earth exploration companies. Pilot plants are built in order to establish the flow sheet and according to Kingsnorth are required to:

- * Generate samples for customer approval as basis for sales contracts
- * Demonstrate technical viability
- * Provide data for bankable feasibility study

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** Generate data for environmental impact statement*

The real shocker that Kingsnorth revealed didn't seem to garner much fanfare, but is critical to this discussion and should change the tenor of discussion: Rest of world (ROW) demand has been lower than exports since 2005. In other words, all the hype about China shutting off the rest of the world isn't necessarily backed by the facts. At this point, the Chinese export quotas have easily accommodated the demand by the rest of the world for material outside of China. This opens up other discussions, but may change the character of some of the arguments being made.

Constantine Karayannopoulos of Neo Material Technologies Inc. offered some great perspective as president and CEO of a company that operates facilities within China. He pointed out that China has one strategy in the rare earth business – employment growth. Provincial governments are judged on job growth.

His final points for the audience were:

- * Reduce red tape*
- * Research & development (R&D) are indispensable*

Paul Werbos, the Research Program Director of the National Science Foundation, reinforced Karayannopoulos' last point. Werbos emphasized that R&D can have a dramatic effect, and he pointed out that new cross-disciplinary research might maximize the probability of breakthrough designs.

Gareth Hatch of Dexter Magnetic Technologies explained some of the issues surrounding new wind turbine capacity and its demand for neodymium (Nd) oxide moving forward. For instance, he pointed out that demand for Nd in wind turbines might reach 2,950 tonnes by 2013.

Peter Dent of Electron Energy Corporation stated that samarium-cobalt is a \$300 million industry and that ferrites (magnets based on iron technology) still retain a 90% share of the entire market.

Sheeraz Haji of Cleantech Group LLC spoke of the revolution in financing for green technologies, as the percentage of venture capital that goes into green tech has risen from less than 2% in 2003 to a predicted 27% in 2010. Wow! That is significant. He pointed out that 72% of global Cleantech investment is happening in Asia / China. This is very startling.

Haji also stated that Walmart is demanding energy usage, water usage, and waste data from suppliers.

Steven Duclos of General Electric Global Research had some fantastic perspective on REEs and strategic materials. He showed a criticality diagram which displayed the supply and price risk associated with individual elements and their potential impact on General Electric.

He is very aware of the effect of supply issues, and suggested that parallel paths must always be taken because you don't know which path will be successful.

One of the great charts that he used showed the elements used to make incandescent lamps, fluorescent lamps, white LEDs, and White OLEDs. The surprise? No rare earths at all in the white OLEDs.

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David Sandalow, the US Assistant Energy Secretary for Policy and International Affairs, had much to say regarding rare earths.

“It goes without saying that diversified sources of supply are important for any strategic material. So too are substitutes and strategies for re-use and recycling. If rare earth metals are going to play an increasing role in our economy, we need to pursue those strategies. And there’s every reason to believe that rare earth metals could play an increasing role in the global economy as the world transitions to clean energy.”

To address the availability of REEs and other strategic materials, Sandalow suggested a three-part approach:

- 1. Globalize supply chains for strategic materials*
- 2. Develop substitutes*
- 3. Promote recycling, re-use and more efficient use*

He also announced the proposed development of a strategic plan:

“To help address these concerns, I am today announcing that the Department of Energy will develop its first-ever strategic plan for addressing the role of rare earth and other strategic materials in clean energy technologies. The plan will apply the approaches described above and draw on the strengths of the Department in technology innovation. We will build on work on these topics already underway, including in DOE’s national labs, and work closely with colleagues from other agencies throughout the U.S. government. We will solicit broad public input, including from the stakeholders and experts here in this room.”

Sandalow mentioned that there was lots of work underway already, and that there were no firm timelines yet in place.

His talk was well received by the audience, and we look forward to hearing more.

Full Metal Jacket, a panel discussing rare earths from the Pentagon’s perspective, addressed the complexity of assessing the both the Big Picture and specific needs. Some of the issues raised during the panel were:

- * Looking at both civilian and military uses for REEs*
- * The DOD doesn’t buy rare earths – it buys tanks, ships, guns, etc.*
- * There is no national strategy on REEs thus far*
- * They are looking at cradle to grave issues with materials*

Mark Smith of Molycorp Minerals pointed out on the producer’s panel that it is hard to find qualified people with REE skills.

Congressman Mike Coffman spoke about HR4866 – a new rare earth bill that he had just introduced the day before. From the bill:

A bill to reestablish a competitive domestic rare earths minerals production industry; a domestic rare earth processing, refining, purification, and metals production industry; a domestic rare earth metals alloying industry; and a domestic rare earth based magnet production industry and supply chain in the United States.

Many people in the audience have been watching this closely, so it was great to have Congressman Coffman talk about this with us in person.

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Cindy Hurst gave a good talk on the history of China and the rare earth industry. She has written a paper entitled "China's Rare Earth Elements Industry: What Can the West Learn?".

We spent the afternoon of the second day in breakout sessions that were both fascinating and illuminating, as this diverse group of participants was able to discuss and debate these issues together. (June 2010)

Rare Metals Summit

April 7-9, 2010

Los Angeles, California

"...the definitive meeting place for this new era of collaborative relationship-building for critical metals users, producers, refiners, fabricators, traders and investors. The event will explore the complete value chain from mine to refiner/processor to "component" OEM to final "product" OEM and global demand."

<http://www.infocastinc.com/index.php/conference/raremetals>

No succinct summaries of the conference found. Approximately 70 people attended, and speakers were from various industry sources. From all reports found on various corporate web sites, nothing new was discussed or disclosed there. (June 2010)

Rare Earth Summit 2010

April 22-23, 2010

Beijing China

"China is still the largest country in terms of rare earth reserves, production, consumption, and exportation. The Chinese government has focused on its policy to protect rare earth resources and optimize efficiency of the market. The question remains, however, how to coordinate the industrial chain of rare earth production, processing, and exporting enterprises? Japan, another big consumer of rare earth, is suffering the most severe recession in 35 years, and the country's automotive and electronics industry has dropped sharply. How do Japanese rare earth enterprises adjust their supply? Are there any updated progressions and problems in the field of rare earth applications? There are innumerable changes in rare earth supply around the world. What is the prospect of development and supply for rare earth in the US and Australia? What is the rare earth market tendency in Europe?"

http://www.asianmetal.cn/Events_2010/2010RES/Index_2010RES_en.asp

Jack Lifton's summary of the conference: <http://www.techmetalsresearch.com/2010/04/from-the-2010-rare-earths-summit-in-beijing/>

I'm in Beijing, China, where I spoke yesterday at the Asian Metal "Rare Earths Summit 2010". I sort of stumbled through my presentation, because I was absolutely distracted by the candor of the speakers from the Chinese rare earth mining, refining, and end-user industries. Considering the volume of nonsense being broadcast outside of China by stock promoters, the conference was an amazing breath of fresh air in a city not well known for its air quality (although I must say that Beijing weather and its air are first class right now).

Subscribers to The Jack Lifton Report can read the paper that I presented (Synthesis is a subscriber). I warn you that it's not for the complacent. You're going to find out some facts about the Chinese metals industry, particularly about its size and growth rate, that will make you think very hard about the position that America's foolish concentration on not producing natural resources, has put us into.

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I heard fascinating talks by Dr. Zhu Baoliang, Chief Economist of the Economic Forecasting Department of the China State Information Center, and Professor Zhao Yumin, Director of the Chinese Academy of International Trade and Economic Cooperation. Both of these speakers emphasized that China welcomes non-Chinese production of the rare earths into the world market, because China's domestic economic growth rate means that China needs more and more of its own domestic resources of all metals for its own use. Therefore, since China does not want to impede the growth of the world economy of which it considers itself a part, it must hope, both speakers said, that its best customer and biggest competitor, Japan, will be able to find resources of metals such as the rare earths from somewhere other than China.

After my talk Dr. Zhao asked me my opinion. I told him that I believe that China wants Australian, and/or American, and Canadian and/or South African rare earth mines to come into production so that, not only can China dedicate more of its own resources to its domestic economy, but also that China has the option to buy rare earth materials from non-Chinese suppliers, should the time come when Chinese demand outstrips Chinese domestic supply.

A key issue for the Chinese economy and the Chinese mining industry is a preoccupation with preventing commodity price inflation and preventing the Chinese currency from appreciating so fast, that Chinese exports become non-competitive. These pre-occupations are keeping the prices of all commodities produced in China from rising. In the opinion of the Chinese speakers, the low prices of the rare earth metals are a result of economic forces far beyond the industry's ability to control.

An old China "hand" (as we used to call men like him) who was at the conference, told me that the Northern rare earth mines operate at best with a 20% gross margin and the Southern ones, the so-called ionic clays from which the higher atomic numbered rare earths, europium, dysprosium, and terbium are produced, can run so that they have a 30% gross margin. These margins are too low for the amount of environmental remediation necessary to meet WTO and new stringent Chinese domestic standards for safety and health. At the same time that the Chinese rare earth industry is facing environmental challenges, it must also restructure to improve efficiency and to eliminate so-called artisanal mining entirely.

The end result is that China's mining industry as a whole and rare earth mining industry in particular, will be producing less material in the near term than was originally planned. Chinese high tech manufacturing industry, especially the alternate energy and other green industries, are swamped with business, and they don't care about the problems of the mining industry – just as would happen anywhere in the world.

This in my opinion is a fantastic opportunity for those rare earth ventures outside of China that can be brought into production as soon as possible. There will be a sorting out later in the decade, when the Chinese light rare earth mining industry has remediated its environmental and productivity issues, but until then there will be strong markets in both Japan and China for rare earths. (June 2010)

Upcoming

The 6th International Conference on Rare Earth Development and Application

August 2-6, 2010

Beijing, China

"As a main producer and supplier of rare earth raw material and products, China is always interested in what is going on in the field of rare earths around the world. The Chinese Society of Rare Earths (CSRE) has the pleasure to host ICRE'2010, which will be a great gathering of global rare earth scientists, engineers and business executives."

6th International Rare Earths Conference

November 9-11 2010

Hong Kong

“Metal Events Ltd and Roskill Information Services Ltd are once again returning to Hong Kong to hold their 6th International Rare Earths Conference. This is the international event for the global rare earths industry and last year attracted a record number of participants representing all the major producers, end-users, traders, investors and funds.”

http://www.metalevents.com/index.php?option=com_content&task=view&id=39&Itemid=1#Overview
w

4. Rare Earth materials substitution

What new materials could potentially be used? With regard to motors for automotive electric traction drives specifically, what new designs, re-designs and re-engineering could be used to reduce or eliminate Rare Earths, including game-changing technologies.

From the GAO report “Rare Earth Materials in the Defense Supply Chain:”

Government and industry officials told us that where rare earth materials are used in defense systems, the materials are responsible for the functionality of the component and would be difficult to replace without losing performance. For example, fin actuators used in precision-guided munitions are specifically designed around the capabilities of neodymium iron boron rare earth magnets... Many defense systems will continue to use rare earth materials in the future based on their life cycles and the lack of effective substitutes... Defense officials said that future generations of some defense system components, such as transmit and receive modules for radars, will continue to depend on rare earth materials. Moreover, in some cases, new systems in development will also rely on components that depend on rare earth materials. (June 2010)

See information below on research being conducted at Ames Laboratory on developing non-rare earth permanent magnets for automotive traction motors.

Patent Search (restricted to the past five years)

Magnet production (lowered cost or increased coercivity in rare earth magnets)

Number	Title	Inventor(s)	Assignee	Date	Link
7547365	Process for producing, through strip casting, raw alloy for nanocomposite type permanent magnet	Murakami, Ryo (Kobe, JP) Kanekiyo, Hirokazu (Kyoto, JP) Hirosawa, Satoshi (Otsu, JP)	Hitachi Metals, Ltd. (Tokyo, JP)	06/16/2009	http://www.freepatentsonline.com/7547365.html

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Number	Title	Inventor(s)	Assignee	Date	Link
7585378	Methods for producing raw material alloy for rare earth magnet, powder and sintered magnet	Odaka, Tomoori (Osaka, JP) Kaneko, Yuji (Osaka, JP)	Hitachi Metals, Ltd. (Tokyo, JP)	09/08/2009	http://www.freepatentsonline.com/7585378.html
7534311	R-t-b sintered magnet and rare earth alloy	Tomizawa, Hiroyuki (Osaka, JP) Matsuura, Yutaka (Kyoto, JP)	Hitachi Metals, Ltd. (Tokyo, JP)	05/19/2009	http://www.freepatentsonline.com/7534311.html
App # 20070137733	Mixed rare-earth based high-coercivity permanent magnet	Dong, Shengzhi (Shanghai, CN) Shei, Juliana Chiang (Niskayuna, NY, US) Wang, Jianmin (Shanghai, CN)		06/21/2007	http://www.freepatentsonline.com/y2007/0137733.html
App # 20100040501	R-T-B Based Rare Earth Permanent Magnet and Method for Production Thereof	Kato, Eiji (Tokyo, JP) Ishizaka, Chikara (Tokyo, JP)	TDK Corporation (Tokyo, JP)	10/01/2009	http://www.freepatentsonline.com/y2010/0040501.html
App # 20100021335	Method and machine of making rare-earth alloy granulated powder and method of making rare-earth alloy sintered body	Kuniyoshi, Futoshi (Osaka, JP) Otani, Tomoiku (Osaka, JP)	Hitachi Metals, Ltd. (Tokyo, JP)	10/05/2009	http://www.freepatentsonline.com/y2010/0021335.html
App # 12/708580	High Resistance Magnet And Motor Using The Same	Komuro, Matahiro (Hitachi, JP) Satsu, Yuichi (Hitachi, JP) Imagawa, Takao (Mito, JP)		06/10/2010	http://www.freepatentsonline.com/y2010/0141367.html

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Magnetic materials (improvements to non-rare earth magnetic materials)

Number	Title	Inventor(s)	Assignee	Date	Link
7524433	Ferrite material	Takane, Shin (Tokyo, JP) Aoki, Takuya (Tokyo, JP)	TDK Corporation (Tokyo, JP)	04/28/2009	http://www.freepatentsonline.com/7524433.html
App # 20100028195	Soft magnetic material, powder magnetic core, method for manufacturing soft magnetic material, and method for manufacturing powder magnetic core	Maeda, Toru (Itami-shi, JP) Maeda, Kazuyuki (Osaka-shi, JP) Mochida, Yasushi (Itami-shi, JP) Mimura, Koji (Itami-shi, JP)	Sumimoto Electric Industries, LTD. (Osaka JP)	10/09/2009	http://www.freepatentsonline.com/y2010/0028195.html

Alternate technology (motors using alternates to rare earth magnets)

The search turned up over 3400 patents and applications for induction motors in the past five years. They were all not reviewed, but review of a representative sample showed they are for variations in design (particularly in configuration of the stator and rotor), but none were for what could be termed “game-changing.” A good deal of the research centers around improving the motor controller or software used to manage the controller.

Research Efforts

There is little-to-no research underway on traditional permanent magnet materials. Dr. Brian Fifarek postulates the decline in research in the US is due to the rare earth industry moving off-shore. Dr. George H Hadjipanayis feels research into traditional permanent magnetic materials has all but ceased because there is little research which can be done on the subject. He points out the maximum energy product of NdFeB magnets has already reached 90% of the theoretical prediction the Nd₂Fe₁₄B compound. He also states “traditional permanent magnets with a single magnetic phase have nearly reached their limits, and there are not any new hard magnetic compounds on the horizon.”

Dr. Ralph Skomski agrees but points out that there may be some “element-specific optimization (Dy content)” possible. He also states that “multiscale nanostructuring is an option” for permanent magnets.

Nanomagnetics

Currently, most ongoing magnetic research is in the area of nanomagnetics, particularly nanocomposite magnetic materials. The majority of the research is centered around the following uses of nanomagnetic materials:

- Data storage
- Medical instruments and imaging
- Biotechnology
- Signal processing

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- Microwave source
- Magnetic refrigeration
- Water purification
- Semiconductors

Dr. Hadjipanayis sees a good future in hard/soft nanocomposite magnets, such as SmFeN / FeCo which may have a maximum energy product that is 232% of that of NdFeB magnets. However, he notes there are problems with obtaining a uniform nanostructure with the soft elements, difficulties with the crystallography of the hard phase and “Brown’s paradox, the discrepancy between the theoretical nucleation field and coercivity of the real hard magnetic materials.”

Nothing was found to indicate if the research into nanocomposites can produce magnets capable of providing the strength and durability required for use in traction drive motors.

Research labs

In testimony before Congress in March 2010, Dr. Karl Gschneidner, a senior metallurgist at the Ames Lab told members of a Congressional panel that “rare-earth research in the USA on mineral extraction, rare-earth separation, processing of the oxides into metallic alloys and other useful forms, substitution, and recycling is virtually zero.” He encouraged the creation of a National Research Center on Rare Earths and Energy and a National Research Center for Magnetic Cooling.

Dr. Gschneidner also displayed a new NdFeB permanent magnet alloy created at the Ames Laboratory using a new process that was also developed at Ames. The new alloy can be produced at half the cost of the standard alloys, and is a “green” technology with no by-products.

Ongoing research into new magnetic materials at the national laboratories include:

Argonne National Lab Center for Nanoscale Materials (<http://nano.anl.gov/research/electronics.html>) current research topics:

- Understanding complex magnetic order and coupling phenomena
- Controlling synthesis of materials with tailored electronic and magnetic properties

Ames Lab (<http://www.ameslab.gov/dmse/DMSEProjects.html>) current research topics:

- Extraordinary Responsive Magnetic Rare Earth Materials
- Correlations and Competition between the Lattice, Electrons, and Magnetism
- Nanoscale Structures and Ultrafast Correlations in Magnetic Materials

Ames is also involved in a project to develop permanent magnets for automotive traction motors. The project is projected to run through September 2014. One research question within this project is “Can high strength permanent magnets be made strong enough without the use of strategic rare-earth metals?” The researchers are looking both into improving existing magnetic materials (e.g. Alnico) and developing new materials which will meet specific performance metrics aligned with advanced motor requirements.

Corporate R&D

Research and development by US companies which produce magnets is centered around improving manufacture of magnets or improving the efficiency of currently available materials. Little evidence was found of efforts to develop new materials to replace current ones, with the exception of those noted elsewhere in this report.

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Hyundai Motors unveiled its Tucson/ ix35 Hydrogen Fuel Cell Electric Vehicle (FCEV) at the 2010 Geneva Motor Show. It uses an induction motor instead of permanent magnet-type motor for cost benefits. Even with the slight decrease in overall vehicle efficiency associated with induction motors, Hyundai feels its use will offset the cost risk associated with magnetic motors which depend on rare earth elements whose prices have soared in recent years because of their scarcity and high demand.

NovaTorque has developed a motor with conical hubs that use ceramic magnets and features aluminum foil windings instead of copper wire, lowering production costs. Currently it's available in a 3-hp motor but could be made more powerful.

NineSigma (www.ninesigma.com), "representing a Fortune 100 company," issued an RFP for "Permanent Magnet Materials with Reduced Rare Earth Content." Among other things RFP specifies the material must "provide at least a 35% reduction in rare earth content compared to existing rare earth based magnets, be robust at operating temperatures between -30°C and 150°C, and be compatible with recycling or repurposing at end of service life." The response due date for the RFP was June 4, 2010. The RFP can be found at https://www.myninesigma.com/sites/public/layouts/RFPs/NineSigma_RFP_65661.pdf. No further information on responses to the RFP was found. (June 2010)

Hitachi has launched a project to develop rare earth magnet recycling technologies. They are developing devices to recover rare earth magnets from motors and will explore technologies for recycling used magnets. They plan to launch this business in 2013. (May 9, 2010)

Research grants

Electron Energy received \$500k grant from NSF in February 2009 for two year project to develop a magnet using composite layers on a microscopic level with a potential to double the strength of the material's magnetic field.

A team led by the University of Delaware and which includes the University of Nebraska-Lincoln, Northeastern University, Virginia Commonwealth University, the Department of Energy's Ames Laboratory and the Electron Energy Corp. recently received a three-year, nearly \$4.5 million Advanced Research Projects Agency-Energy grant from the U.S. Department of Energy funded by the American Recovery and Reinvestment Act. They will be researching magnetic nanomaterials that do not contain rare earth metals. (January 26, 2010)

Andriana Heimann of East Carolina University received a USGS grant to "investigate the formation of granitic pegmatite deposits that contain lithium and rare earth elements... This study is expected to provide a clearer understanding of the conditions under which these types of deposits formed and help in identifying where these deposits may occur." (January 6, 2010)

Academic research

The bulk of academic research into magnetic materials deals with the physics of magnetism at the molecular level, primarily using rare earth materials. However, there are some projects which are exploring alternative materials.

- Virginia Commonwealth University (VCU) researchers have developed a graphene-based nanomaterial with ferromagnetic properties. (September 1, 2009)
- University of Texas Arlington researchers have developed a bottom-up nanocomposite of FePt nanorods and nanotubes and FeCo nanoparticles. (January 2007)

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