

CRITICAL METALS

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Critical Metals

A collection of articles from Critical Metals Investing News
looking at the companies shaping the investment
opportunity

By Charlotte McLeod

Table of Contents

Investing in Rare Earth: Heavy vs. Light	2
Investing in Rare Earths: Restraint is Essential	5
Rare Earths: Common Applications	7
Types of Graphite: Amorphous, Flake and Vein	9
Introduction to Graphite Investing	13
Introduction to Tungsten Investing	16
Taking an Interest in Tungsten.....	18
Cobalt Applications	20
Cobalt: A Move For Green Investors?	22
What's in Your Apple Product?	24
Manganese Battery Technology	26
US Military and Environmentalists United in Magnesium's Development	29

Investing in Rare Earth: Heavy vs. Light

The 17 elements that make up the group of rare earth metals are as diverse in their applications as they are challenging to pronounce. They are often broken up into two categories according to their atomic weight on the periodic table: light and heavy rare earths. Some of the common light rare earths are of less value than heavies on the market, yet are in higher demand. While the heavies are of high value many of the elements have smaller markets.



The concern of those looking to invest in rare earth mining operations is the relative value of the various minerals in the ground. Often analysts focus on just one side of the equation, favoring companies with high levels of heavies or lights in determining relative value.

In an exclusive interview with Rare Earth Investing News, Ryan Fletcher Director of [Zimtu Capital](#) (CVE:[ZC](#)), and Chris Grove of [Commerce Resources](#) (CVE:[CCE](#)), explain the subtleties of investing in a market with 17 different metals.

Prospective investors simply looking at resource estimates of heavy and lights may be short-sighted as demand, and therefore value, for the elements fluctuates. "The rare earth market is dynamic. What is in demand right now, and what will be required in five years is constantly evolving," stated Ryan Fletcher.

Investors should look at the most in demand elements within the group, especially those that may face supply deficits in the coming years. Fletcher explained how attitudes toward the elements are changing. "At the International Rare Earth Conference in Hong Kong last year, the focus was on the 'Big Five' rare earths: neodymium, praseodymium, europium, terbium, and dysprosium." Yttrium should also be mentioned with these due to its use by the plastics industry, as well as its predicted supply deficit by 2015. This method of looking at the supply and demand levels for the various elements may be a more well-rounded approach.

Of the 'Big Five' elements, two are light rare earths: neodymium and praseodymium. The most important and in demand element in the light category is neodymium because of its use in magnets that are in high demand due to their applications in hybrid/electric vehicles and wind

turbines. Chinese trade policy reflects the importance of neodymium, and is another crucial factor to consider on the supply side of the equation.

"Look at Chinese trade policy since 2005. The rare earth elements that they have been exporting less and less of are the lights. The element China has been holding back the most? Neodymium. Chinese companies have also been active in trying to get a stake in neodymium rich projects outside of China," stated Chris Grove.

The use of neodymium in wind turbines and electric vehicle is of particular importance in China and will only continue to grow as the country urbanizes and tackles many lingering environmental issues.

"China is a huge market, and one of their most pressing problems is environmental degradation. China needs to electrify their transportation sector, and a significant portion of neodymium will go to electric vehicles and the wind power sector," stated Chris Grove. Of course these magnets are made with a combination of elements, Grove added, "dysprosium is the key heavy rare earth in the making of magnets."

Three of the 'Big Five' elements fall under the heavy category: terbium, dysprosium and europium, and to a lesser extent yttrium. "Dysprosium, terbium and yttrium are three of the heavy rare earths that are predicted to be in shorter supply, and have sizeable markets," stated Fletcher.

Dysprosium is used in tandem with neodymium in magnets that are vital to modern technology and renewable energy. Dysprosium oxide is also used in nuclear reactors to help cool fuel rods to keep the reaction under control.

Terbium is used in color television screens as well as solid state hard-drives for computers. Currently, computing speed is limited by conventional hard drives. Solid state hard drives are just now being used by companies such as Apple to dramatically increase computing speed. As production costs are decreased, solid state drives will undoubtedly become the standard.

Europium is used in TV screens as well as a doping agent for the plastics used in lasers, and has application for nuclear power.

Yttrium is used in a variety of application from TV screens to an alloying agent to increase the strength of aluminum and magnesium alloys. It is also used in the polymerization of ethylene vital to the production of plastics.

Investors looking to invest in mining operations should look at the stratification of elements in the deposit and take into account the current and future demand for the various elements, be they heavy or light.

"Investors shouldn't be looking only at the heavies or the lights, the rare earth market needs both. Some of the lights are in the highest demand, they are big tonnage markets, and will continue to grow. While certain individual heavy rare earths are of high value, an investor should be looking at both the heavies and the lights." stated Fletcher.

Any investor practicing due diligence should look into the concentrations of the 'Big Five' elements, as well as others in the group. Many of the other elements have large markets and steady demand. In a market that contains 17 elements all with different applications, taking a myopic view could be short-sighted.

Investing in Rare Earths: Restraint is Essential

Investing in the rare earth market poses challenges that are not common in other commodities markets. First, there are 17 elements in the rare earth bundle that are valued individually; essentially the 'rare earth' market is comprised of 17 individual markets. Many of these elements are found together in deposits, the percentage of certain elements in resource estimates should be considered



before investing in mining companies. Secondly, the drama of reducing export quotas from China, which accounts for over 95 per cent of world supply, has increased investment in mining companies, but also created what some fear is an unsustainable bubble in the market.

Companies like Molycorp (NYSE:[MCP](#)), and Rare Element Resources (AMEX:[REE](#); CVE:[RES](#)) have seen share prices jump with the increased interest in this market even though many of the exploration/mining companies have yet to produce or sell any product. Investors can make a healthy profit in this market, as demand for the material will only increase in the future. However, it is on the individual investor to do their homework before simply throwing money at stock hoping for short term gains.

The export quotas have created an interesting dynamic in the Chinese supply of the elements. The dynamic stems from the details of the export policy.

"With the current quota system, China does not distinguish between the individual rare earth oxides but limits the total tonnage of exports across the board. That has led to Chinese companies exporting as much as possible of the high-value heavy rare earths like dysprosium, instead of low-value light rare earths like cerium," reported [Julie Gordon](#), for *Reuters*.

While the prices for all of the 17 elements have gone up as a result of the policy, some of the prices for lesser used elements, like cerium have gone up at a faster rate than the widely used elements such as neodymium. The result of the quota system has not affected all of the elements equally; because no one is exporting lesser used elements the supply-demand fundamentals have disproportionately affected the market. Many analysts believe that China will

change the export policy to restrict the metals on an individual basis. The result of this change may be a surge of supply of the 'light' REE's which there is an abundance of in China.

The demand for elements such as neodymium and dysprosium will increase due to the true increase in demand for the products that contain them, creating a more stable price structure. Long term outlook for the 'heavy' REE's like neodymium, are strong due to their use in electronics and magnets for electrical generation.

"Magnets mainly use the so-called middle and heavy group of rare earths, including neodymium and dysprosium. Using iron- based magnets in a mobile phone would make it much bigger, like a briefcase," said [Damien Krebs](#), metallurgy manager of Australia's Greenland Minerals and Energy Ltd.

The increasing demand for products that contain REE's will continue to rise, and the supply shortages of some of the elements over the next few years are well documented. The share price increases of some rare earth mining juniors may not be sustainable, so much so that many analysts have been describing the recent market activity as looking much like the "dot-com bubble."

"Everybody's standing up, waving the flag and shrieking it's rare earths because that pushes the valuation up, a good sign that we're in something of a bubble. There comes a point where you've run out of all the arguments, and at that point you're into the Alan Greenspan 'irrational exuberance' range. We've reached that for some of these names," stated [Jon Hykawy](#), analyst for Byron Capital Markets.

The individual investor must put in their due diligence, and pay careful attention to the resource estimates of prospective mining companies as well as the production timeline for the mine. The urge for short term gains is powerful when looking at the share price increases for many rare earth mining companies; however many of these companies have no product to sell in the near future. Investors should be looking for returns in the long run, as many of the mines in development will not produce for at least two years and in some cases longer than that. There is a real potential for realized gains in this market, however, it is on the investor to show restraint.

Rare Earths: Common Applications

The world of rare earth elements can be confusing to the average investor. REEs are made up of 17 different elements on the periodic table, with markets as difficult to understand as the pronunciation of their individual names. Neodymium, Dysprosium, Ytterbium, and Praseodymium, are just a few metals in this dynamic market. With the recent reduction of export quotas from China, the prices for not only the metals, but the products that they are used in will undoubtedly climb until new sources are found, and mined.



The uses for these elements range from hybrid vehicle technology and wind turbines, to guidance systems for some of the most advanced military technology. The better an investor can understand the individual metals, and their uses, the better their ability to capitalize on each unique opportunity as it arises. This is a guide to understanding the various metals inside the rare earth market.

Neodymium

Neodymium's main application is for high strength magnets. Neodymium magnets are the strongest permanent magnets known. These magnets are used in a wide variety of products such as microphones and speaker systems where low mass, small volume and strong magnetic fields are needed. For larger industrial use, neodymium magnets are used in high power electric motors such as those found in hybrid and electrical vehicles. Each motor requires approximately 1 kilogram of neodymium. Also, the magnets are used in electrical generation in numerous new renewable energy technologies such as wind turbines, a market that is set for large growth through at least the next decade. In this application, about one ton of neodymium is needed for every megawatt of generating capacity from a wind turbine. This material is also used to color glass, and mainly used for infrared emitting lasers.

Dysprosium

[Dysprosium](#) is often used along with vanadium and other elements in the manufacturing of laser materials. The element's high thermal neutron absorption cross-section is ideal for making

neutron-absorbing control rods in nuclear reactors. Its high susceptibility to magnetization makes it ideal for use in various data storage applications including hard disks.

The dysprosium magnets are used in hybrid cars. "As much as 6% of this alloy may be dysprosium metal (substituted for neodymium). This amounts to over 100 gm of dysprosium oxide for each motor, which means that hybrid electric vehicles alone will require over 200 mT of dysprosium oxide by 2010, based upon Toyota's projected 2 million units per year...the requirement for dysprosium from a few very demanding applications such as this will exhaust most of the available supply," according to a study by [Dr. Peter Campbell](#).

While China currently controls over 95 percent of the complete rare earth market, almost 100 percent of the dysprosium and terbium market comes from China currently. However, there are a few projects in the very early, exploratory phases in North America, and Australia.

Lanthanum

Lanthanum is used mainly in nickel-metal hydride batteries, and other battery systems like lithium-ion batteries that are used in almost every handheld electronic device. "Every Toyota Prius [and similar hybrid vehicle] on the road uses one kilogram of neodymium and nearly 30 pounds of lanthanum in its lithium battery," reported [Aaron Levit](#), for *Investopedia*.

The metal is also used in a wide variety of industrial lighting applications, which consumes a large proportion of the material. Various oxides and compounds of lanthanum are used in a wide variety of products such as semiconductors and the production of carbon nano-tubes, which are some of the strongest and lightest compounds known to science; use of such materials, however, is still far off.

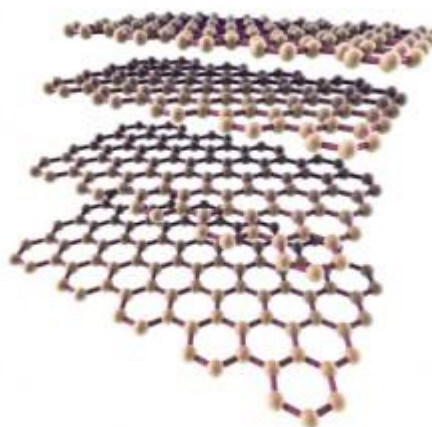
Terbium

Terbium is a critical ingredient in Compact Florescent Light (CFL) bulbs, which are taking over the standard light for almost all consumer applications for their low energy consumption. The use of terbium in CFL bulbs is by far the largest use of the metal worldwide. The metal is also used in naval SONAR systems.

These are just 4 of the most common rare earth elements. Look for more [updates](#) in the future on Rare.

Types of Graphite: Amorphous, Flake and Vein

Graphite is made up of carbon atoms bonded together in sheets of a hexagonal lattice. It is because of this unique structure that graphite has such a stellar combination of [properties](#): it is flexible, highly refractory, chemically inert and has high thermal and electrical conductivity. It is used across industries in refractory applications and crucibles (35 percent), foundry operations and steelmaking (26 percent), automotive parts (14 percent), lubricants (14 percent) and batteries (10 percent).



There are three principle types of natural graphite: amorphous, crystalline flake and vein.

Amorphous graphite

Amorphous graphite is [found](#) as minute particles in beds of mesomorphic rocks like [coal](#), slate or shale, and its carbon content depends on that of its parent material. When found in coal it is also referred to as meta-anthracite, the result of the thermal metamorphism of coal, the last stage of coalification; however, it is not used as coal as it is difficult to ignite. Amorphous graphite is the most abundant type of graphite and is usually lower in purity than other natural graphite, selling for about US\$700/t.

Uses

Amorphous graphite is used in the refractories industry to manufacture crucibles, ladles, molds, nozzles and troughs that can withstand the very high temperatures associated with molten metal, particularly the casting of steel. The electrodes used in many electrical metallurgical furnaces, including the electric arc furnaces used in steel processing, are manufactured from graphite. In the production of steel itself, graphite is used as a carbon raiser to strengthen steel. It is also used in blast furnace linings for the production of [iron](#) because of its high thermal conductivity.

Amorphous or fine-flake graphite is used in brake linings, gaskets and clutch materials. Foundry facing mold wash uses amorphous or fine-flake graphite in a water-based paint to coat the mold, thereby allowing ease of separation of the casted object from the mold after the metal has cooled. Low-quality amorphous graphite, mostly from China, is used to make pencil [lead](#).

Crystalline-flake graphite

Natural graphite demand is [shifting](#) from the amorphous variety to large, high-purity flake as emerging applications such as batteries and flexible graphite products begin to represent a larger portion of graphite market end uses, according to recent market research.

Flake graphite occurs as isolated, flat, plate-like particles with either hexagonal or angular edges and is found in metamorphic rocks either uniformly distributed through the body of the ore or in concentrated lens-shaped pockets. It occurs in a scaly form in certain metamorphic rocks such as limestone, gneisses and schists. While all graphite has a flaky morphology on some level, flake graphite demonstrates this structure regardless of particle size. Flake graphite has a carbon content of 80 to 98 percent, and though it can be found throughout the world, it is rarer than amorphous graphite.

There are three primary sizes of flake graphite: fine (-100 mesh), medium (+100 mesh) and coarse flake (+80 mesh). Most consumers prefer to use high-grade, large-flake graphite for their products. In fact, it's flake size and purity that determine price. Large-flake graphite (+80 mesh), with high carbon content (94 percent or greater) is the type [required](#) for use in [lithium-ion](#) batteries, and it fetches a premium.

Uses

Large-flake graphite, like amorphous graphite, is also used in the refractory and steel industries. High-purity, large-flake graphite is becoming an important material in anode construction in all major battery technologies, tying its future demand forecast to increasing battery demand. Lithium-ion batteries [use](#) 10 to 20 times more graphite than lithium carbonate. An average hybrid electric vehicle requires more than 10 kg of graphite, while an average electric vehicle requires 70 kg. "Annual flake graphite production will have to increase by a factor of six by 2020 to meet incremental lithium carbonate requirements for batteries," [states](#) a recent Canaccord research report.

Fuel cells use even more graphite than lithium batteries and are expected to replace combustion engines as a more efficient means of converting fuel to [energy](#). Fuel cells of all sizes are also making their way into the personal electronics sector and even into the utilities sector, where

they can be used to provide emergency power to hospitals or turn methane [gas](#) into electricity at wastewater plants.

Graphite is also an essential part of [vanadium](#) redox battery technology, with nearly 300 tons of flake graphite [required](#) per 1,000 megawatts of storage. The unique properties of vanadium and graphite combined allow for the long-term storage of an unlimited capacity of excess energy to be used during interrupted energy production.

Pebble-bed nuclear reactors, which use [uranium](#) embedded in fist-sized graphite balls, are another example of how important graphite is becoming to the energy sector. Just one 100 GW pebble-bed nuclear reactor [requires](#) 300 tonnes of graphite to start initial production, followed by an additional 60 to 100 tonnes per year for continual operation. According to a Mackie Research Capital [study](#), the flake graphite required to operate installed pebble reactors in the US by 2020 will equal today's global annual production.

Vein graphite

Vein graphite, or lump graphite, is believed to have hydrothermal origins and occurs in fissure veins or fractures, appearing as massive platy intergrowths of fibrous or needle-like crystalline aggregates. The fissures are typically between 1 centimeter and 1 meter thick, with a carbon content of 90 to 99 percent. It is believed to originate from crude [oil](#) deposits that through time, temperature and pressure have converted to graphite. Graphite in this form is found all over the world, but is [only](#) currently mined in Sri Lanka.

Uses

Vein graphite is used in advanced, thermal and high friction applications such as car brakes and clutches. It is also used in much the same way as flake graphite as it shows great performance in applications that require high thermal and electrical conductivity. Like flake graphite, vein graphite is valued by carbon content and particle size.

Up-and-coming junior graphite companies

China currently produces the majority of global graphite supply, but several junior resource companies are working on quality projects elsewhere. Graphite mines usually operate on a small scale with low capital requirements, making them well-suited to the junior resource space. The following are a few examples of junior resource companies on the must-watch list of most market analysts.

Northern Graphite (TSXV:[NGC](#)) is a Canadian company with a 100-percent interest in the Bissett Creek graphite deposit in Ontario, Canada. The large-flake, high-purity, scalable deposit is located close to infrastructure and is the only project outside of China with a completed bankable feasibility study. The company plans to be in production in 2014.

[Energizer Resources](#) (TSX:[EGZ](#),OTCBB:ENZR) holds a 75-percent interest in the Green Giant graphite project, located in Madagascar. The company believes the Molo flaked deposit may be the largest known graphite deposit in the world. Energizer expects to have a completed NI 43-101 resource estimate by the end of November 2012. It will be incorporated into a preliminary economic assessment that is expected to be completed by the end of the year.

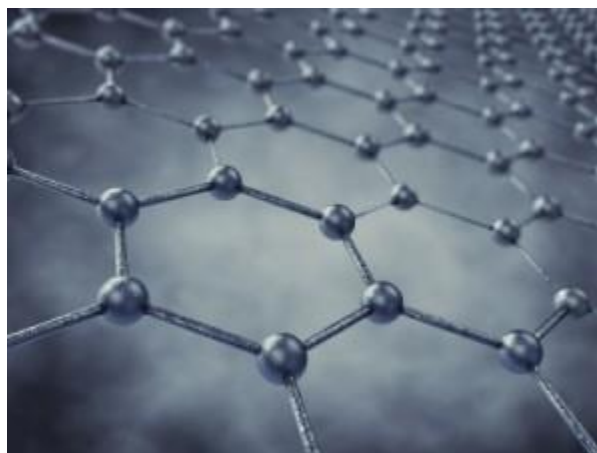
Syrax Resources (ASX:[SYR](#)) is an Australia-based mining company whose Balama project in Cabo Delgado, Mozambique reportedly contains multiple zones of high- to very-high-grade graphite of mainly medium to coarse flake. The property also contains vanadium deposits.

[Focus Graphite](#) (TSXV:[FMS](#),OTCQX:FCSMF) is a Canada-based company that wholly owns the Lac Knife project, located in the Côte Nord region of Quebec. According to the company, the project boasts the highest-grade (16 percent) technology graphite deposit in the world. Focus Graphite is also invested in the development of graphene applications and patents through Grafoid, soon to be a public company.

Zenyatta Ventures (TSXV:[ZEN](#)) is a Canada-based exploration company whose Albany graphite deposit in Ontario is the only new vein graphite mine under development.

Introduction to Graphite Investing

Graphite is one of two naturally-formed polymers of carbon. Unlike its carbon-polymer cousin [diamond](#), the semimetal is an excellent conductor of heat and electricity and has the highest natural strength and stiffness of any material.



The graphite market is quickly becoming one of the hottest emerging sectors in the resource industry, and has sparked investor interest and an exploration boom. Some of the most critical factors pushing the once-forgotten mineral onto the resource investment stage include everyone's favorite market drivers: China's ongoing modernization and the global shift toward alternative [energy](#).

Speaking of critical, the [European Commission](#), the [British Geological Survey](#), and the [US State Department](#) have declared graphite just that, in large part because it is important not only to traditional industries such as steelmaking, but also to emerging energy technologies – not to mention the fact that China has so much control over it.

Types and applications

The graphite market includes three principle types of graphite – amorphous, flake, and lump – each of which occurs in different types of ore deposits.

Historically, applications such as refractories, steelmaking, brake linings, foundry facings, and lubricants (and yes, pencils) have primarily used amorphous and lump graphite. The automotive and steel industries currently account for the majority of consumption; graphite is used to increase carbon content, which strengthens steel and allows it to withstand much higher temperatures. Demand from both industries is growing by five percent each year.

However, alternative energy technologies and applications - [pebble-bed nuclear reactors](#), [lithium-ion batteries](#), [graphene](#), [fuel cells](#), and [solar panels](#) - are also propelling demand for graphite, particularly the high-grade, large-flake variety.

One of the most promising market sectors for graphite is in the battery industry, specifically lithium-ion batteries and [vanadium redox batteries](#).

Lithium-ion batteries are now widely used in consumer electronics, such as cell phones, laptops, tablets, and power tools, and are replacing the [nickel](#)-metal hydride batteries used in electric vehicles, electric motorcycles, and scooters. Yes, [lithium](#) is an essential part of this technology, but what its name fails to show is the important role that graphite plays in the batteries' construction; 20 times more graphite than lithium is required in lithium-ion batteries.

As demand for consumer electronics and electric vehicles intensifies, demand for graphite for lithium-ion batteries is also expected to grow. Anticipating demand growth of 25 percent per year, analysts estimate that lithium-ion battery production could consume more than tonnes of high-grade flake graphite over the next decade. By 2020, annual electric vehicle production is expected to reach as high as six million units, and the battery system for each of these vehicles will require 40 pounds of graphite.

Graphite is also an essential part of [vanadium](#) redox battery technology, with nearly 300 tons of flake graphite required per 1,000 megawatts of storage. Vanadium redox battery production is expected to rise alongside of growing demand for alternative energy sources such as wind and solar. The unique properties of [vanadium](#) and graphite combined allow for the long-term storage of an unlimited capacity of excess energy, which helps to solve one of the inherent problems associated with this type of energy source: interrupted production.

The US government said last year that it would invest about \$185 million in deploying and demonstrating the effectiveness of utility-scale grid storage systems, [American Vanadium](#) (TSXV:AVC) said in [a report](#). And leading the way in new grid-scale renewable storage solutions are vanadium redox batteries.

Market outlook

The quality of flake graphite varies by grade and particle size, with most consumers [preferring](#) to use high-grade, large-flake graphite for their products. In fact, it's flake size and purity that determine [price](#). Large flake graphite (+80 mesh), with high carbon content (94 percent or greater) is the type required for use in lithium-ion batteries, and it fetches a premium. While amorphous graphite used in steelmaking has been trading at around \$850 per tonne, flake graphite is selling in the range of \$2,200 to \$3,000 per tonne depending on flake size.

Graphite demand is quickly growing, with some analysts anticipating a rise from the current 1.1 million tonnes per year to [2.6 million tonnes](#) by 2020. However, available supply is not witnessing the same level of growth – less than half of world production for graphite is of the flake variety, and this looming supply and demand imbalance is creating opportunities for explorers and producers alike.

"Annual flake graphite production will have to increase by a factor of six by 2020 to meet incremental lithium carbonate requirements for batteries," said a recent Canaccord research report. Other uses are expected to strain supply as well. The [US Geological Survey](#) has said that "[l]arge-scale fuel-cell applications are being developed that could consume as much graphite as all other uses combined," while researchers out of the University of West Virginia [estimate](#) that, once online, the next generation of pebble-bed nuclear reactors could use up the current total annual production of flake graphite – about 400,000 tonnes.

The China factor grips graphite market

Exploding demand isn't the only factor weighing on prices. China's "stranglehold" on global graphite supply coupled "with a generation of under-investment in mines around the world, is creating a very tight supply situation," [said](#) Simon Moores of Industrial Minerals.

China produces more than 70 percent of the world's graphite supply, dominating both the amorphous and flake graphite markets. China's near total control of the graphite market has left western consumers, especially the United States, which is fully dependent on imports to meet industrial demand, with slim alternative options. The [remainder](#) of the world's graphite comes from India, Brazil, North Korea, Madagascar, Sri Lanka, and Canada.

In an effort to further [control the market](#), as it has done with [rare earth metals](#), China has imposed a 20 percent export duty, a 17 percent VAT, and an export licensing system. Further tightening of supply out of the Asian nation is expected, and will no doubt push prices for graphite, especially flake, even higher.

Introduction to Tungsten Investing

The heavy mineral tungsten was discovered in 18th century Sweden and has since been applied to everything from shaping metals and alloys to lighting filaments.

In 1781, Carl Wilhelm Scheele [published the results](#) of an extremely dense mineral that had been dubbed "tungsten," which translates to "heavy stone" in Swedish. In his study, he found that the mineral contained lime and an unknown acid. A professor at Uppsalada University in Sweden, Torbern Bergman, suggested that reducing the acid could produce a new metal. Two years later, in Spain, Bergman and his student Juan José de D'Elhuyar heated the same mineral with charcoal, reducing the acid and producing what we know today as tungsten, though de D'Elhuyar called it "volfram". Today, though the metal still is commonly referred to as tungsten, it is represented by a "W" on the periodic table in reference to volfram, or "wolfram."



Tungsten is mined [all over the world](#), though China leads the way in production. Austria, Bolivia, Canada, Peru, Portugal, Russia, Thailand and several countries in Africa also are major producers of the mineral. Deposits [can be found](#) near orogenic belts — or areas where tectonic plates have collided to form mountains. These belts run through the Far East, the Asiatic part of Russia, the east coast of Australia, the Alpine belt, as well as the Rocky and the Andes mountains.

The supply of tungsten to be mined is extremely high, however much of it is not easily accessible. Therefore, the long-term view of tungsten prices is the main factor in whether or not the mineral will be economically viable. Additionally, fluctuating price differentials between concentrate and upgraded products as well as government restrictions affect the market prices.

The applications of tungsten are extremely varied, and the hardness of the mineral makes it valuable for shaping everything from metals to plastics and ceramics. About [two-thirds](#) of tungsten is used for cemented carbide and other construction and chemical applications. However, it is also used for [every-day purposes](#) like the vibration alert in cell phones, light bulb filaments, solar panels and window heating.

Woulfe Mining (TSXV:[WOF](#))

Junior minors have, in the past, seen some [huge rewards](#) by investing in tungsten, and real estate magnate Warren Buffett has gotten into the mix. In 2012, International Metalworking Companies — a holding company owned by Buffett's Berkshire Hathaway (NYSE:[BRK-A](#)) — signed a deal to buy a 25 percent stake in Woulfe Mining for \$80 million. Woulfe Mining is [currently working](#) in South Korea on the Sandong tungsten/molybdenum Project, where they are building a state-of-the-art processing facility. Commissioning for the mine was scheduled for 2014, however, the progress on the project remains to be seen following a [corporate update](#) from the company who is facing some liquidity issues following the resignation of its executive management in February.

[EMC Metals](#) (TSX:[EMC](#))

EMC Metals holds the Springer tungsten mine, a fully constructed underground mine and surface mill facility in Nevada. The mine historically owned and operated by General Electric and forced to shutdown due to APT prices. According to the company's PEA, the project's restart is economic and feasible. A five year mine life holds an NPV of \$22.8 million at a discount of 8 percent after tax.

[Largo Resources](#) (TSXV:[LGO](#))

This Canada-based strategic mineral company has several projects in Brazil and Canada. The company has been [commercially producing](#) tungsten since 2011 in their Brazilian Currais Novos Tungsten Project. The project initially set a target of 23,000 tonnes of concentrated tungsten for 2012, a number that will increase to 42,000 tonnes for subsequent years. The company recently acquired properties in the vicinity of the Currais Novos project, and there is currently a preliminary exploration program underway at those locations.

Taking an Interest in Tungsten

Currently trading at \$385-400 per metric ton unit, APT tungsten prices haven't showed any phenomenal price movements of late.

Tungsten is one of the world's most critical metals, which undoubtedly helps keep interest in tungsten projects alive around the world. Here are two companies that have recently acquired an interest in tungsten.



A second tungsten investment

New Zealand's family-owned Todd Corporation added another tungsten company to its portfolio last week. In December of 2012, Todd Corporation scooped up a [19.9% stake](#) in Australian tungsten hopeful, [Wolf Minerals](#) (ASX:[WLF](#)) whose UK Hemerdon project is trucking along towards production. This time around, Todd has turned its focus to Canadian tungsten junior, Northcliff Resources (TSX:[NCF](#)). On October 3, Northcliff announced that in exchange for a direct interest in its Sisson tungsten-molybdenum project and shares in Northcliff, Todd would provide \$39 million in funding.

Per the [agreement](#), Todd will complete a private placement of \$5 million for 13,888,889 common shares at a price of \$0.36 per share. Following this transaction, Todd will become the largest shareholder of Northcliff with a roughly 15 percent interest in the company. Todd will maintain its stake in Northcliff until 24 months following the closing of the investment transaction.

As far as the Sisson project is concerned, Todd can acquire an initial 11.5 percent interest in the Limited Partnership through an investment of \$14 million in three stages. Todd will also be able to acquire a further 10 percent interest in the project by investing \$20 million in the Limited Partnership upon a final investment decision to start construction.

This year has been a busy year for Northcliff, an affiliate company of Hunter Dickinson Inc. In January, Northcliff released the results of its [feasibility study](#) which identified the project as having the potential to be a 27-year project processing roughly 30,000 tonnes of ore per day. Northcliff also submitted its [Environmental Impact Assessment](#) to the federal and provincial governments at the end of July. With these milestones in place, the \$579 million project is well underway to production.

A new tungsten acquisition

If there is one company out there that knows a thing or two about critical and strategic metals, it would have to be Tasman Metals (TSXV:[TSM](#)). The company is a well-known name when it comes to [rare earths](#), with several properties in Norway, Finland and its main project — the Norra Kärr — located in south-central Sweden. Keeping in line with a focus on European projects, Tasman recently [acquired](#) 100 percent interest in a portfolio of tungsten projects in the Bergslagen mining district, also in south-central Sweden.

Tasman's new acquisition is comprised of several of the largest tungsten occurrences in the Scandinavian region, including the former-producing Yxsjöberg mine, which once produced over 90 percent of Sweden's tungsten. Overall, the company has acquired 6 projects, with 7 exploration claims that cover an area of 3,680.4 hectares. Tasman purchased the properties outright for a total consideration of 100,000 fully paid common shares in Tasman as well as \$45,000. Furthermore, each of the properties is complete with historical data, including drill, production and metallurgical information.

With the European electronics market at its feet, Tasman has positioned itself to meet the growing demand for strategic materials in Europe. CEO Mark Saxon told investors in a company statement that while Tasman remains focused on its "globally significant Norra Kärr heavy REE project, tungsten is an essential industrial metal that faces the same resource security challenges to REEs, with a Chinese supply monopoly and strongly growing demand. Tasman shall continue to seek additional aligned opportunities during this challenging market for junior resource companies."

Cobalt Applications

Cobalt, whose name is derived from a German word meaning “evil spirits,” has been valued by humans since the Egyptians used it in [2000 BC](#) as a coloring agent.

The mineral is considered one of the world's essential elements. Its high melting point and ability to maintain strength even at raised temperatures make it useful in cutting tools, super alloys, surface coatings, high-speed steels and numerous other applications.



Cobalt in batteries

One of cobalt's main applications is in rechargeable batteries of all kinds. The mineral is essential to the manufacturing of these batteries because it gives batteries high [energy](#) density. Demand for rechargeable batteries in electronics has risen sharply in the last couple of decades. While in the mid-1990s, only 1 percent of cobalt was used in electronics, that has now risen to around [35 percent](#). This number is expected to continue to rise due to increased demand for cell phones, electric cars and other items that require rechargeable batteries.

Early versions of [nickel](#)-metal hydride batteries had problems such as a poor life cycle, internal cell pressure and corrosion. However, engineers have found that the addition of cobalt to batteries helps overcome many of these issues. Similarly, the first versions of [lithium](#)-ion batteries were found to be too reactive, resulting in battery fires. These batteries have been stabilized and now contain up to [60 percent](#) cobalt per cell.

Increased demand for cell phones, car batteries, laptop computers and other items that rely on rechargeable batteries has resulted in a huge jump in the price of cobalt in the last 10 years. As a result, there have been efforts to find an acceptable substitute for the mineral. Though early efforts tended to result in an inferior product, industry insiders believe that many of the problems that were initially faced are going to be overcome in the next several years. However, a substitute for cobalt in the rechargeable batteries that are essential to electric cars has not been found. Because of that, insiders are predicting that demand for the mineral [will increase](#) somewhat dramatically in the coming decade.

Other cobalt applications

Cobalt is used in many places aside from batteries. Its ability to stand up to high temperatures and its good oxidation resistance make it an essential alloying element for super alloys, which are used for casting airfoils and other structural parts of jet turbine engines. Cobalt alloys also have a fairly high tolerance for thermal fatigue and can be repaired easily. Most high bypass turbofan jet engines contain between 110 and 132 pounds of cobalt.

The metal is also an essential element in the metabolism of humans and other animals — those who cannot retain cobalt naturally have to be treated with B12 vitamin therapy. Cobalt is also used in soil dressings in cobalt-deficient soil to prevent "wasting disease" in grazing animals.

Cobalt: A Move for Green Investors?

When compared to other metals such as copper or [gold](#), cobalt is far below the investment radar, but this may change. In February 2010, the cobalt began trading on the London Metals Exchange (LME).

Furthermore, consumers are becoming more environmentally conscious and governments are reinforcing these concerns with stricter regulations. As a result, there is growing

awareness of how products are made and what they are made with. Cobalt is an important element in our daily lives and it is also one whose star power is likely to emerge with the green movement.



Reducing the use of fossil fuels and reducing the effects of using these materials are major environmental concerns. Now, take three of the common solutions for these problems—hybrid electric vehicles (HEVs), solar energy, and wind energy. The thing that all of these developing technologies have in common is that each involves the use of cobalt.

[Batteries](#) currently account for the largest portion of consumed cobalt and are also a primary focus of the role the metal will play in the green movement.

[Nickel](#) metal hydride batteries have been used to power most HEVs and these batteries require between 3 to 5 pounds of the metal. However, it is [believed](#) that the industry will shift to using lithium-ion batteries, which will contain up to 7 pounds of cobalt. Demand for electric cars is expected to continually increase at least for the next decade. According to a J.D. Power's [forecast](#), by 2013 over 100 HEV and PHEV (plug-in hybrid electric vehicle) models will be offered in the US and by 2015 global HEV sales will reach 2.7 million units.

Cobalt is also used in the production of solar panels and for the blades and magnets of wind turbines.

Anyone who underestimates the importance of cobalt should take a look at governments' attitudes toward the metal. China, for example, is a major processor of cobalt. The Chinese have reportedly been keeping more of the metal at home. Coincidentally, there are also notable amounts of money being poured into solar technology in that nation.

In a recent [interview](#) about green energy and cobalt, Gordon Monk, founder and principal of a boutique merchant/investment bank, Performance Capital Advisors, outlined China's strategy. "China goes in and talks on a government-to-government basis," he said. "They deal in straight cash and don't mind operating in high risk areas, and they want offtake agreements from early stage development projects in exchange for cash and infrastructure."

The [US](#) is not sleeping on the fundamental role of cobalt either. The Department of Energy is encouraging domestic mining of the metal to help ensure that the nation has access to the supplies that they need in their pursuit for clean energy. And, there are currently a number of mining and production projects underway.

The path from fossil fuels to cleaner, greener energy is one that will require cobalt, at least in the foreseeable future. There are those who question the longevity of the green movement. If clean energy were not heavily subsidized, if environmental issues carried less political weight, and if interest wanes in the marketplace, what will become of clean energy efforts and thus investments in them?

Investors pondering these questions should note that cobalt is already used in a wide range of applications including national defense, aviation, medicine and consumer electronics. Investing in this metal may be means of getting exposure to the green movement, but it is not an absolute gamble on its success.

What's in Your Apple Product?

Die-hard Apple (NASDAQ:[AAPL](#)) fans are always patiently waiting for the company's next big announcement.

Like other high-tech devices, Apple's products use a wealth of precious, industrial and critical minerals, including [gold](#), [platinum](#), [copper](#), tantalum and [rare earths](#). While most of those minerals can be sourced from safe jurisdictions, some — like tantalum — have become synonymous with the words "conflict minerals," as they tend to be sourced from conflict regions in the Democratic Republic of the Congo (DRC).



To promote supply chain transparency, the US Securities and Exchange Commission (SEC) required that companies that use tantalum, [tin](#), [tungsten](#) and/or gold sourced from conflict regions like the DRC file a Conflict Minerals Report by May 31, 2014 in compliance with Section 1502 of the Dodd-Frank Act. Though some companies were not too keen on submitting their disclosure statements, earlier this year Apple met with the requirements stipulated by the SEC and submitted a [Conflict Minerals Disclosure](#) statement. Apple has also taken it upon itself to provide the public with a quarterly smelter list that identifies the smelters it uses for its products and how they fit in line with the [Conflict-free Smelter Program](#).

It's not overly encouraging to see conflict minerals on the materials list of a large, well-known company like Apple, but the company is making a concentrated effort to clean up its supply chain and ensure that any materials or smelters it uses are conflict free.

That said, the company's commitment to recycling electronic materials has made it so the company has found a quasi-loop-hole in its disclosure report. As such, Apple's Conflict Minerals Disclosure states, "[b]ased on its due diligence efforts, Apple does not have sufficient information to conclusively determine the country of origin of the Subject Minerals in its products or whether the Subject Minerals are from recycled or scrap sources."

In its report, the company also notes that of the 205 smelters included in the report, 21 source minerals from the DRC or adjoining countries. Further to that, of the 21, 17 are compliant with the CFSP, while four have yet to undergo third-party independent audits. Further to that, as TechCrunch points out in a January 2013 article, Apple has been diligent with its supplier audits,

even facing criticism for doling out "corrective measures that seem rather toothless — most often putting suppliers 'on probation.'" That means that Apple will be watching its suppliers more closely.

Thus, while at first glance it might seem negative that the company has concluded that it does not have sufficient information to call its minerals conflict free, that could in fact be a point in Apple's favor.

Manganese Battery Technology

Batteries are undoubtedly one of the most important markets driving our technological world. The need for batteries in the emerging markets such as electric vehicles, renewable energy and consumer electronics hinges on two factors: the need for high capacity and low cost energy storage. To meet these needs, [lithium](#)-manganese batteries mark the next step in technology geared to reduce the cost of energy storage.



In an interview with Manganese Investing News, Jonathan Lee, Battery Technology and Materials Analyst for [Byron Capital Markets](#), discussed manganese batteries and the capabilities of this emerging technology.

The downside of lithium-ion

Currently, the standard for mobile electronics, traditional lithium-ion batteries use [cobalt](#), however, the [cobalt](#) component is slowly being replaced. "The lithium-cobalt batteries that are used in laptops and other mobile electronics will not be used in vehicles," said Lee. Lithium-cobalt batteries, as Lee explained, are less cost effective, as cobalt is an expensive metal in relation to others. Furthermore, the performance of subsequent battery technologies surpasses that of the first generation of lithium-ion batteries. The lithium-ion batteries, Lee noted, were impaired by a heat problem.

The heat problem associated with the lithium-cobalt batteries in the past has resulted in recalls when some Hewlett-Packard [laptop batteries](#) suddenly ruptured, causing fires.

Currently, the main market for manganese batteries is the hybrid/electric vehicle. "Lithium-manganese oxide batteries are being used right now in the Chevy Volt and Nissan Leaf," stated Lee, adding, "One of the major benefits of using these batteries is cost. Manganese is a fairly inexpensive metal, which keep down cost."

Prototype manganese batteries

There are other types of batteries utilizing manganese that are still in a developmental phase. "The other type of battery using manganese is the lithium-nickel-manganese-cobalt

battery. This is potentially the next generation and the [Argonne National Laboratory](#) is working on these," stated Lee.

The Argonne lab has stated that manganese batteries far outperform traditional lithium-ion systems. "[Manganese composite batteries] demonstrate outstanding cycling stability and can be charged and discharged at high rates, making them excellent candidates to replace [lithium-cobalt] for consumer electronic applications and hybrid electric vehicles," stated [Argonne National Laboratory](#).

One of the main obstacles facing electric vehicles is recharging time. Using a standard household plug, the Chevy Volt takes ten hours to charge the battery with a range of only 35 miles. However, researchers at the University of Illinois are developing batteries that have "a charging rate ten to 100 times higher than that of a normal, commercial battery (in one instance, the researchers created a lithium-ion battery that could be 90 percent recharged in two minutes)," according to an article from [The Economist](#).

Manganese supply chain

Last year, China produced 1.4 million tonnes of manganese. However, "there is only about 34,000 tonnes of electrolytic manganese production outside of China," stated Lee. This production comes from [Manganese Metal Company](#) in South Africa. Lee added, "With electric vehicles, our estimates are by 2020, we see a need for 80-90 thousand tonnes [of manganese] for electric vehicles."

The added demand from electric vehicles is small in comparison to the overall production of manganese. However, there are a few factors to consider in terms of supply and demand fundamentals going forward.

On the supply side there are reports that manganese ore bodies are [shrinking in China](#). It is reported that if no new resources are found, China may lose 500-700 thousand tonnes of capacity in the next 3-5 years.

Approximately 90 percent of manganese is consumed in steel production. Steel production is forecast to grow this year by seven percent. Recently [Lakshmi Mittal](#), the CEO of the world's largest steelmaker [ArcelorMittal](#) (NYSE:[MT](#)) stated, "Any substantial slowdown is still many years away." The added demand from the steel industry coupled with new demand from batteries will require significant tonnage to be supplied to the market.

As manganese battery technology improves it will bring down the cost, and increase the range of electric vehicles. This is where [Jevons Paradox](#) may come into play. The paradox states as efficiency increases, so grows the demand for the resource used because of reduced cost.

As these emerging technologies increase the efficiency of electric vehicles it follows suit that the market will demand even more electric vehicles. Also, the potential for these batteries to be used in mobile electronics could open a truly massive market, requiring additional supply of the metal. The future for manganese batteries looks bright.

US Military and Environmentalists United in Magnesium's Development

With [gas](#) prices showing no signs of coming down, hopes for more affordable fuel-efficient cars are rising ever higher. For magnesium producers, such expectations are particularly strong given the metal's potential to produce more cost-effective and lightweight magnesium for automobiles. In addition, magnesium producers may find more investors coming from the defense industry and green technology sector.



Magnesium and [rare earth](#) elements have the potential to "increase combat effectiveness," said Dennis, President of the [American Council on Renewable Energy](#) and retired Vice Admiral of the US Navy. Speaking at the [Technology & Rare Earth Metals Center](#)'s annual conference in Washington, DC last week, McGinn pointed out that portable military packs that currently weigh about 25 pounds could be reduced to about five pounds per pack with technological advancements, including making better use of rechargeable ion batteries.

Making greater use of magnesium in personnel armor protection, tanks, artillery, armored vehicles, and other military equipment has been strongly urged by many defense contractors and by the US military itself. The [Department of Defense](#) is the single biggest [oil](#) consumer in the US, which uses the most crude in the world. In 2010, the Defense Department [used](#) 125 million barrels of oil, and it is projected to spend about \$150 billion over the next decade on energy costs alone. The department has, however, pledged to draw 25 percent of its energy from renewable resources by 2025, and developing more energy-efficient defense equipment that will rely heavily on metals, including magnesium, is high on the research agenda.

Decreasing military dependence on hazardous fuel convoys could also lead to fewer deaths in combat zones. According to the American Council on Renewable Energy, twelve percent of army casualties in Iraq and 35 percent of army casualties in Afghanistan in 2007 were due to fire hazards. In short, not only is it in the military's financial interest to increase use of magnesium

and other metals, but such investments could also help the government better protect its soldiers.

"A vision must be developed for creating new ground and air vehicle structural applications in addition to new personnel protection and armor applications," according to a study on magnesium alloys in army applications by Heidi Maupin of the [US Army Research Laboratory's](#) weapons and materials research directorate, Eric Nyberg of materials processing at [Pacific Northwest National Laboratory](#), and Suveen Mathaudhu of the [US Army Research Office's](#) materials science division.

In its quest to make greater use of magnesium and other rare earth materials, the Department of Defense is finding an unlikely ally in many environmental groups that are looking to minimize damaging environmental impact through energy efficiency, as well as in the Department of Energy. Energy captured by wind turbines, for instance, is stored as hydrogen and uses magnesium as the metal and mineral oil as the liquefying agent. The blades in the turbines in turn may potentially use magnesium as a sturdy and lightweight metal that is a quarter of the weight of steel and a third lighter than aluminum.

It is "ironic," though, that the Department of Defense and environmentalists are taking the lead in developing magnesium and other rare earth in the US, said Carol Raulston, senior vice president of communications at the [National Mining Association](#).

After all, it was growing pressure from environmentalists concerned about the negative impact of rare earth mining, together with increased price competition, that led to a steep decline in magnesium mining in the US in the first place. China now dominates the magnesium market, cornering well over 90 percent of total global supply. Today, [US Magnesium](#) is the sole manufacturer of the metal in the country.

Jeff Green, President of industrial consulting group [J.A. Green & Company](#), agreed, stating that the US needs to define its strategy regarding rare earth supply instead of simply leaving it to the market forces that have led to China's overwhelming dominance in the industry.