#TMS2013 Panel B: Experiences in Rare Earths Metallurgy, what works and what doesn't

It has been a challenging period for exploration companies worldwide and the rare earths sector, after attracting unprecedented attention, has been no exception. Nevertheless, there is continued demand for rare earths and current technological progress suggests that this demand will only be growing in the future. Meanwhile, China still maintains a virtual monopoly on rare earth production even as new sources are coming on line thanks to Molycorp and Lynas Corp. While it is true that a variety of new rare earth resources have been discovered, it is not enough to have the mineral, the commercial viability of a rare earths supply relies on having the necessary metallurgy to fully exploit a given mineral's characteristics.

The metallurgy required to exploit rare earths is, in the context of metallurgical history, very new. Metallurgy is a highly dense term, given its evolution, but it can be defined s the technical discipline which focuses primarily on the study of metals, their behavior and technical procedures related to obtaining and processing them. The technique originated in prehistoric context, formally with the Copper Age, but already by the Bronze Age (ca. 3500-1300 BC in the Middle East), scientists can point to the existence of metallurgical techniques. Techniques were developed and evolved to obtain higher purity and eventually with the development of chemistry – in particular – and science in general, elements have been discovered and processed, making a number of new technologies possible.

One of the very reasons that rare earths or rare metals are 'rare' is because the ores in which they are found require

complex metallurgical processes to separate them into the various elements. Indeed, before 1950, rare earths were still in what scientists consider a “Dark Age.” The 1970’s, in particular, saw rare earths metallurgy rise exponentially until the present. It has been in the past 30 years in fact that the most remarkable advances have been achieved in the field of rare earths. It is this very novelty of rare earths technology itself that holds much of their future promise. In turn, while economists ponder over the state of finance and money, science and technology have not yet fully grasped rare earths potential.

All commercial metals are produced through extractive or primary metallurgy. The minerals exploited commercially are mainly oxides, sulfides and silicates. The preparatory treatments start with the crushing of the rock to concentrate the ore. This increases the contact surface allowing for enrichment. In ferromagnetic minerals, this is achieved through a magnetic process. The flotation method is used when the pulverized material is immersed in an aqueous solution containing a foaming agent, whose bubbles envelop the ore and bring it to the surface. Electrostatic separation is used exploiting differences in electrical conductivity the various ore and gangue (that is the residue/waste) and gravity, exploiting the different sedimentation rate of the components of the excavated material. Sometimes the ores are treated using chemical-physical processes to transform the minerals into more easier to develop compounds, leading to the extraction process, which varies according to the type of energy used to separate the metal from the impurities. There are three main metallurgical processes: thermal, hydrometallurgical (chemical energy) and electro-metallurgical, using electricity.

There is the sense that we are still far from grasping the full potential of rare earths, because the technology for their extraction and development is so young – the youngest

perhaps of any mining sector. Despite, this ‘youth’, rare earths have already left an indelible mark on the world materials scene and they are allowing for very rapid technological change. The Soviets led the rare earths and critical metals field in the 1950s and their advances were the source of much concern in the circles of power in the West. Today, rare earths processing techniques have spread worldwide, even if they are still limited and still in a state of evolution. Moreover, each geological rare earth resource is geologically different and needing tailored metallurgical processes. Evidently, securing a resource encompassing both the necessary minerals and its ideal metallurgy – as has been the case with Stans Energy (TSXV: HRE) is a huge advantage, as it shaves many years of complex scientific work. Nevertheless, for those companies that invest in developing new processes, such as Lynas Corp (ASX: LYC), there is the incentive to use the latest science and achieve improvements or advancements over previous methods.

The main problem is the time needed to develop the metallurgy: to put it crudely, finding the mineral and getting it out of the mine is the easy part, the processing metallurgy are the really hard parts that ultimately separate the winners from the losers. One of main goals of future rare earths metallurgy is the quest to find as environmentally friendly a process as possible. New cracking technologies are being developed to maximize the removal of radioactive by-products from the concentrate. This is very important in order to facilitate rare earths technology from a social and political context as well. More efficient separation technologies also help a producer better address the needs of the market and the end user – allowing for ease of selection, whereby some elements are separated and others left in concentrate. In some cases the quality of the mineral itself is such that it lends itself to traditional and initially cheaper metallurgy. And herein lies the essence of the debate; is it better to have a superior mineral with average metallurgical capacity or an

average resource with superior metallurgy?

This and other issues related to Metallurgy will be addressed at #TMS2013 Panel B: Metallurgy Advantage: Debating competitive elements of tonnage, grade and mineralogy. The Panel will be moderated by **Robert Mackay**, BSc Mining, President, CEO and Director, Stans Energy Corp. Robert Mackay worked in various facets of mineral exploration (diamond drilling, geophysics, geological mapping & prospecting). In 1975 graduated from the Haileybury School of Mines. Robert has acquired extensive experience in mining, mine planning, surveying, grade control, industrial engineering, open pit & underground production. In 1980 graduated & obtained a mining engineering degree from The South Dakota School of Mines Technology.

Stans Energy knows quite a bit about the value of metallurgy, given that its project's main advantage is the fact that Soviet scientists has years to study the best way to develop the available minerals. Robert will lead the discussion focusing on the panelists' experiences in the success of processing individual rare earth minerals in rare earth production. The panelists include highly experienced engineers who have worked with the various rare earths minerals including monazite, xenotime and bastnaesite; they will then be able to talk about issues related to each individual mineral. The discussion will also feature the separation of silicates and any individual companies' metallurgical efforts – and successes – to date.

The panelists are:

Anthony ('Tony') N. Mariano, PhD, Founder – Mariano Consulting: Dr. Mariano is a recognized authority on rare earth element (REE) mineralogy and deposits at a world level. Dr. Mariano has nearly 50 years experience as a consultant, exploration geologist, senior earth scientist and adjunct professor. His rare earth – related field experience extends

to 52 countries in North and South America, Europe, Asia, Africa, and Australia. Dr. Mariano was instrumental in the original delineation of rare earth minerals at one of the world's largest rare earth deposits at Mt. Weld, Australia.

Richard Hammen, PhD, President -IntelliMet LLC. Richard has over 40 years of experience in the field of analytical chemistry. He is a former director of the NASA / Caltech Jet Propulsion Laboratory / Analytical Chemistry Laboratory. He is the President of IntelliMet LLC, a founding employee of Vestar Inc., and former CEO of ChromatoChem Inc and ChelaTech Inc. Dr. Hammen received a B.S. in Chemistry from Stanford University and PhD in Organic Chemistry from the U of Wisconsin, was a postdoctoral scholar at UCLA. Dr. Hammen is the inventor of Solid Phase Extraction ("SPE") technologies for the chemical separation of various materials, an innovative American technology developed in cooperation with the EPA and National Science Foundation. Dr. Hammen has been granted multiple US patents for these inventions and most recently has been focusing his research on the development of SPE products for the mining industry.

Randall J. Scott, President, CEO and Director of Rare Element Resources Ltd. Randall is a metallurgical engineer with over 30 years of experience in the industry. His experience includes leading performance teams in operations, administration, project development, program management, business development, and major improvement initiatives. Most recently, Mr. Scott was Vice President, Corporate Responsibility and Strategy, with Thompson Creek Metals Company. His prior experience includes Senior Vice President and Vice President of Cyprus Amax Coal Company with responsibilities ranging from Western Operations, including mines in the Gillette area of Wyoming, Appalachian Operations, and process management. He also worked for Cyprus Metals Company as Vice President and General Manager of the Bagdad Mine and also of the Sierrita Mine, both in Arizona.

Jean-Paul Tognet, Chemist & Nuclear Engineer Jean-Paul Tognet is a chemist and nuclear engineer (Toulouse and Grenoble – France) who spent his entire 35 year business career in the rare earths sector before retiring. Jean-Paul began his career with ore processing projects beneficiation and/or cracking in the Pechiney-St.Gobain research center just outside Paris where he had his first opportunity to study in detail different rare earth raw materials. In 1982, he started managing the chemical engineering department at the Rhone-Poulenc Rare Earths plant in La Rochelle France then as Industrial and Raw Materials Director from 1992 to 1999 he managed the development of Rhone Poulenc RE plants in France, USA, Japan and China. Rhone Poulenc changed to Rhodia Rare Earths (now a branch of Solvay), where he continued the global upstream management and was in charge of evaluating different outside RE projects while taking opportunity of his expertise for studying optimization between mining, beneficiation and hydrometallurgical aspects of different RE projects.

Month in Review: Lynas starts to shift the REE Balance

Lynas Corp ('Lynas', ASX: LYC | OTCQX: LYSDY) has no doubt been one of the headline leaders in February. After a protracted legal ordeal to confront environmental activists, at the end of February, Lynas started producing rare earth products at its LAMP processing plant in Malaysia. Lynas is expected to ramp up production by the second quarter of 2013 at a rate of 11,000 tons per year. The start of production and the preparations for the first official shipment have shifted have officially shifted Lynas' mode from development to production. This shift is reflected in CEO Nick Curtis'

decision to step down from his chief executive role to remain as Chairman. He will be replaced by Eric Noyrez at the end of March and whereas the news may appear as a bombshell, the change at the executive floor reflects a planned transition and Lynas' official switch from development to production. Indeed, Mr. Curtis, who will remain at Lynas as non-executive Chairman and who has led the company through a particularly challenging period, will leave on a high note in the wake of the start of production announcement. Eric Noyrez, , has extensive experience in chemical processing companies having held executive positions at Rhodia Group and Shell. Many will recall that Rhodia owns a rare earth processing facility in La Rochelle, France.

Lynas completed its initial commercial product samples, en route to nominal Phase 1 capacity (which is expected before Q3 2013). Lynas also announced that it would receive an AUD$15.2 million rebate payment from the Australian Taxation Office (for R&D expenditures generated in 2012) in March. Nevertheless, rare earths prices continued to suffer in February, reflecting the trend from January. Nevertheless, the scenario is more complex. Lower prices were seen in praseodymium oxide, yttrium, neodymium oxide, terbium oxide, rare earth carbonate, dysprosium oxide and europium oxide. The remaining metals in the index actually managed to post gains for the month with neodymium, lanthanum oxide, and praseodymium neodymium leading the list of gainers.

A combination of new supply and weaker domestic demand out of China is being viewed as the reason for the falling Rare Earths prices but it is important to look at individual examples in the metals index because these negative moves are not seen in all areas. Export numbers for Chinese rare earth products have been the subject of debate (as different sources have reported different figures and Hong Po's recent articles have highlighted some recent numbers), but all of the available data suggests that increased on-stream supply

continues.

Chinese producer Rare Earths Global (LSE:REG) released a statement saying it is unlikely 2012 profit forecasts will be met, and that “normalized” losses will be seen on broader downside price changes in the rare earths market. The company cited rapid industry changes and governmental uncertainties (the election of a new Chinese leadership body, changing statements from the Ministry of Commerce, and a recent white paper on rare earths). Rare Earths Global said the added uncertainty is creating major delays for the reception of its production quota (an export quota was not received in 2012).

These factors are seen inhibiting operations in the company’s trading divisions and separation plant. Rare Earths Global explained it is open to the possibility of joint ventures and believes demand for rare earths oxides will rise along with increased regulation and control of production. Meanwhile, Great Western Minerals (TSXV: GWG | OTCQX: GWMGF) entered its commercial production phase at its Less Common Metals subsidiary, with confirmation that specialty alloys have been sold to three existing clients. The program is set to ramp up production with its second strip casting furnace before the end of the current quarter. Tasman Metals (TSXV:TSM | NYSE MKT: TAS) released information relating to its Olserum heavy rare earth project in Sweden, saying the resource comes in at 4.5 million tonnes grading 0.6% TREO, with an inferred resource of 3.3 million tonnes grading 0.63% TREO (both with a 0.4% TREO cut-off).