Luisa Moreno explains why metallurgy is so important with critical metals projects

The Gold Report: With development capital still at a premium, are companies with critical metals projects getting financed? What typically gets financed and what doesn’t?

Luisa Moreno: The financing environment for the mining space is still difficult, and that is no different for the critical metals equities. Nowadays, the mining and related processing projects that are more likely to get financed are those that are close to production, have relatively low capital requirements, have competitive production costs, have offtake agreements or will be selling into metals markets that have seen prices stabilize and have solid demand.

TGR: In July 2011, you produced a tantalum and niobium primer for Jacob Securities Inc. Reading through that report again, little has changed. What makes these metals newsworthy now?

LM: Tantalum has major applications in electronics that are used in nearly all devices that we have in our homes. Niobium is a major metal in the production of high-performance steel. Tantalum mine production fell by more than 50% in late-2008 and 2009 affected in part by the recession, and it never recovered. More than 90% of the world’s niobium is produced in Brazil, and although Brazil is not considered a hostile jurisdiction for mining, niobium was listed by the European Union as a critical metal given its geographic risk profile. To mitigate potential risk, end users are eager to find stable niobium supplies in stable countries. Both tantalum and niobium are highly strategic, critical and relevant. It's important to continue to develop new projects.

TGR: The gorilla in the niobium market is Companhia Brasileira de Metalurgia e Mineração (CBMM). How does it affect smaller niobium players? Is it likely to play the role of acquirer?

LM: CBMM’s production accounts for more than 85% of niobium supply. The company is the lowest-cost producer; its grades are generally above 2% Nb2O5, whereas most other projects are at about 0.6–0.7% Nb2O5. I don't see CBMM playing a role as an acquirer because it has over 200 years of mine life left and its
costs are the lowest. It will continue having the leading position that it has in the market for a long time, I think. There is, as I mentioned, a need for new players in order to attain geographic diversification that end users would like to see.

**TGR:** Please provide us with an overview of the tantalum market.

"**Commerce Resources Corp.'s Blue River tantalum-niobium project in British Columbia is noteworthy.**"

**LM:** Tantalum witnessed a significant increase in demand in the late 1990s and into 2000. That was driven by a substantial increase in technology associated with the dot-com boom and the proliferation of mobile devices. Prices spiked during that period. Demand collapsed with the onset of the 2001 recession but then gradually went up again. After the 2008–2009 recession, prices fell but found the $140–150/kilogram ($140–150/kg) level again in 2010–2011. At the end of 2011 and in early 2012, we saw again a slowdown in commodity prices and demand, including many strategic metals. Currently, tantalum prices have stabilized at about $80–90/kg. Tantalum demand obviously moves with the ebbs and flows of the global economy, but it tends to be influenced by developments in the technology space. Niobium has been less volatile, but that has been sort of the pattern for some critical metals.

**TGR:** How do investors make money in this space?

**LM:** For tantalum and niobium, there are not many options. As I mentioned, the 2008–2009 recession brought with it the closure of the Wodgina tantalum mine in Australia and the Marropino mine in Mozambique. Those two mines contributed more than 50% of the world’s tantalum mine supply. When those two mines closed, we saw an increase in the number of early-stage tantalum projects. I followed a number of those projects. Today, those projects are still in the development stage.

A mine production shortfall remains in the tantalum market aggravated by the closure of Wodgina and Marropino. We saw an increase in mine production from the Mibra mine in Brazil, owned by AMG Advanced Metallurgical Group N.V. (AMVMF:OTC), from about 160,000 pounds (160,000 lb) a year to about 400,000 lb. But that did not cover all the supply that left the market in 2008–2009. Those problems are still there.

It’s the same situation with niobium projects. Many of the projects that have niobium also have tantalum. I followed a few niobium projects in 2011, and these projects are still being developed.

One new project in the tantalum space that has developed in the last two years is **Tantalex Resources Corp. (TTX:CSE).** To my surprise the company has actually delivered on all it promises in a timely manner; it has achieved production and has already delivered product to the offtaker and has been paid. Tantalex’s mine is in the Republic of Congo, but the company also has contacts in the industrial areas of the Democratic Republic of Congo, where a significant percentage of the world’s tantalum and cobalt are produced, and in Namibia. The company is fully certified under the Electronics Industry Citizenship Coalition (EICC) Conflict-Free Smelter Program. Tantalex is expanding operations, which I believe will be greatly beneficial to shareholders.

**TGR:** From the few publicly traded companies that are developing tantalum and niobium projects, what do you want to see in a development-stage tantalum-niobium project?
LM: Brian, I appreciate the companies that are following an unconventional mining development path by focusing strongly on reaching, in as short a period of time as possible, production and revenues at the lowest possible costs, by building strong management and technical teams and establishing contacts and partnerships with end users as early as possible in project development. Defining a resource is important as the company grows, and the grade and the surrounding infrastructure are important too, of course, but, ultimately, if a company doesn't have the appropriate metallurgy program, that could become a major hurdle.

For projects that are still being developed and require some form of hydrometallurgy, it's really about optimizing the chemical process and achieving sustainable operating costs, thus a strong technical team matters. Another important aspect, as I mentioned, is agreements with end users. Tantalum and niobium are strategic materials with stable markets at the moment, so as long as a company can produce them economically and to end-users’ specifications, there is a good chance of project success.

TGR: In metallurgy, what are the common host minerals that are most amenable to known processing technology?

LM: The most common tantalum and niobium minerals are the columbite-tantalite (also known as coltan) group minerals. Technically when tantalum outweighs niobium the mineral is called tantalite; when niobium outweighs tantalum the mineral is columbite. Another important mineral source for tantalum is wodginite and for niobium is the pyrochlore mineral. Those are common minerals, but ultimately it's about the ability to extract these elements economically. Companies will use different chemical processes depending on the type of ore and mineralogy. It's not a linear situation. It must take into consideration the deleterious elements also. Some deposits have high concentrations of thorium and uranium, which could be a nuisance to separate and dispose. Recovery rates are very important, too. When there are equal distributions of tantalum and niobium it could be complicated to separate the tantalum from the niobium, in some cases, because their respective chemical properties are very similar.

TGR: What are some advancing tantalum and niobium projects that you continue to follow?

LM: In the case of niobium, there are a few projects such as the one owned by NioCorp Developments Ltd. (NB:TSX), i.e., the Elk Creek Carbonatite in Nebraska. NioCorp (previously Quantum Rare Minerals) changed management and its name in 2013. Mark A. Smith, the previous CEO of Molycorp Inc. (MCP:NYSE), joined the board in 2013 and then became CEO of the company; the idea I think is to make NioCorp a significant source of niobium for the U.S. and allies. The NioCorp team has completed a preliminary economic assessment (PEA), which yielded an after-tax net present value of $532 million ($532M) and an internal rate of return of 14%. Total initial capital costs amounted to $919M for the mine and plants. The study accounts for the production of tantalum and scandium as well, highly desirable elements.

Another niobium company is MDN Inc. (MDN:TSX), which owns the Crevier project in Québec. The project has 25.4 million tonnes (25.4 Mt) of Measured and Indicated...
resource at 0.2% niobium pentoxide and 234 parts per million of tantalum pentoxide. The company is working on optimizing its metallurgy and completing a feasibility study, all contingent on financing.

Commerce Resources Corp. (CCE:TSX.V; D7H:FSE; CMRZF:OTCQX) is the owner of the Blue River tantalum-niobium project in British Columbia.

All of these projects are noteworthy.

TGR: NioCorp’s Mark Smith raised a lot of money for Molycorp. What does it mean for a small company like NioCorp to have someone like that at the helm?

LM: If you look at where the stock price was when Mark Smith took over the company versus where it is now, it's a significant difference. NioCorp has been able to raise funds on relatively good terms, given the market conditions, and advance Elk Creek. I believe Mark Smith has made a positive contribution to the project. He was the CEO of Molycorp when the company raised billions of dollars and has been an important U.S. voice for critical metals. He seems to have made a smooth transition into the niobium space, where he has had experience previously. His support seems to have driven the stock higher. The PEA results may have affected the stock but Mark's team seems to be committed to the project.

TGR: Commerce, as you suggested, has the Blue River tantalum-niobium project that it continues to explore. It also has the Ashram rare earth elements (REEs) project. Is this a tantalum play now or is this an REE play?

LM: It is probably a strategic metals play. It is advancing on both fronts, I think. Blue River continues to be an important project for it, as well as Ashram, the REE project in northern Québec. The company continues to advance that project, too.

TGR: What is the next key step at the Blue River tantalum-niobium project? Is Commerce learning about the metallurgy at Blue River?

LM: Yes, I would think so. The Commerce Resources team gets it. From my interactions with them it is my understanding that the company is focusing most of its resources on developing good processes for the production of the strategic metals in its deposits and in securing partnerships that could help advance its projects and sell the future products.

TGR: Meanwhile, vanadium is being talked about for its use in high-capacity storage systems. Is the emergence of the renewables sector enough to kick start vanadium demand?

LM: It could be quite significant if we see the growth of vanadium applications in battery storage systems. But it's not widely spread yet. A number of companies have developed vanadium redox batteries, including UniEnergy Technologies LLC in the U.S., Gildemeister AG in Germany and Sumitomo Corp. (8053:TKY; SSUMF:OTCPOK) in Japan. Some vanadium redox batteries are sold commercially but they have yet to reach the mainstream. If it really takes off, that could be significant for the vanadium space.

TGR: Is metallurgy as important with vanadium development projects?

LM: Metallurgy is generally an important aspect for many strategic materials. It will always be important for most metal processes, but the vanadium production process is not one that requires major new developments such as what we are seeing in the REE and titanium dioxide space.
There are very few primary vanadium developers or producers out there, but there are some. Are there catchy narratives?

There are a few vanadium mineral projects out there owned by public companies. For instance, Atlantic Ltd. (ATI:ASX) has had problems at its Windimurra vanadium project. The processing plant caught on fire early last year and that was unfortunate.

VanadiumCorp Resource Inc. (VRB:TSX.V) owns the Lac Dore vanadium project in Quebec and just released a new Inferred resource of 99.1 Mt at 0.43% V2O5. The company is also investigating the possibility of producing high-purity vanadium chemicals for the battery industry.

The most significant vanadium project at the moment is Largo Resources Ltd.'s (LGO:TSX.V) Maracás Menchen vanadium project in Brazil, which should achieve commercial production by Q4/15.

Is Largo expected to be a low-cost vanadium producer?

Yes, its costs are relatively low at below $3/lb. Maracás has relatively higher grades and the ore is amenable to standard processing methods. Largo is also looking at the possibility of recovering iron and platinum group metals as byproducts.

Are there any offtake partners?

Largo has an offtake agreement with Glencore International Plc (GLEN:LSE) for 100% of its vanadium pentoxide production for six years. It's a sweet deal for Largo because Glencore picks up the vanadium on site, so it doesn't have to worry about logistics, which, in any case, are excellent.

And this is now another Mark A. Smith story.

Yes. He was hired a few months ago as the new Largo CEO. Maracás is probably the strongest project that he has been involved with including and since leaving Molycorp. Largo has since raised $75M, supported by the long-standing shareholders of Largo, so it's well cashed at the moment. And it has a strong technical team. Mark Smith has a real project in his hands and a strong shareholder base. He has a high probability of success, I think.

You also cover the titanium market, a growing market and perhaps one of the most complex markets for investors to grasp. Please give us the essentials.

Titanium metal is used primarily in the aerospace and chemical processing industries. Titanium metal is most useful in corrosion-resistance applications. It has a high strength-to-weight ratio—the highest of any metal. Titanium is as strong as some steels, but almost 50% lighter. It should be noted, however, that only 5% of titanium is used in metal applications; 95% is used for the manufacturing of titanium dioxide. Titanium dioxide is most commonly used as a white pigment in a variety of applications, including paints and coatings, which account for about 60% of the market, and plastics, which account for 20%. The remaining applications are paper, inks, fibers, cosmetics, etc. It's a diverse market.

Where is the growth coming from?

Titanium dioxide is the most significant market for the element, which strongly
correlates with gross domestic product growth. If we see a recovery in the world economy in the next two or three years, we should see an increase in demand for titanium dioxide.

**TGR:** What do companies that are developing titanium projects need to have to attract investment capital?

**LM:** There are established titanium dioxide companies with large market caps such as DuPont (DD:NYSE), which is the largest producer in the world. Other names include Tronox Ltd. (TROXW:OTCMKTS), Kronos Worldwide Inc. (KRO:NYSE) and Huntsman Corp. (HUN:NYSE). Actually, we saw some consolidation in the space recently with Huntsman acquiring Rockwood Holdings Inc.’s (ROC:NYSE) titanium division.

**TGR:** What did you make of the Huntsman purchase?

**LM:** These companies have been struggling with costs and decreasing margins, so consolidation was something that had been discussed for a while. Rockwood was an easy target as the rest of the company was also for sale and was acquired by Albemarle Corp. (ALB:NYSE), mostly for its lithium division, I think.

**TGR:** Are there micro-cap titanium plays with promise?

**LM:** A few. You could look at it from two fronts. You have the titanium companies that are developing titanium feedstock like the mineral sands companies, on one side, and then you have those that are focused on titanium ore processing technology. We have two titanium technology companies listed in Toronto. One is Argex Titanium Inc. (RGX:TSX.V). Argex has what it calls the CTL process, which it believes will provide lower operating costs versus the existing sulfate and chloride processes. This is a project that was quickly advancing to construction, but poor financing decisions have led to project delays. Argex has a 10 kg/day pilot plant that it has been operating but will need at least US$325M for a full-sized plant with a 50,000-tonne capacity, but a lower capex if Argex decides to build a smaller plant first.

Another emerging company is Nevado Resources Corp. (VDO:TSX.V). It has a completely different process that does not use solvent extraction but rather a relatively simple crystallization approach, and it owns an innovative acid-recycling process, which the company believes will allow it to produce titanium dioxide at significantly lower costs. It has proven the technology on the same scale as Argex, essentially 10 kg/day, but it is in the process of expanding that to 1 ton per day, to further derisk the project. Nevado recently added Dr. Krzysztof Borowiec, one of the inventors of the Rio Tinto Plc (RIO:NYSE; RIO:ASX; RIO:LSE; RTPPF:OTCPK) QIT (Quebec Iron and Titanium division of Rio Tinto) process, which also uses hydrochloric acid. Dr. Borowiec believes that Nevado’s technology has great potential.

The processes for both Argex and Nevado will ultimately and naturally be fully proven once they build full-scale plants and run them for a few years at a profit, as was the case for the existing processes. I believe that the titanium industry, end users and producers alike, are very eager to adopt more economic and environmentally friendly processes, and would certainly welcome a low-cost green alternative to the existing processing methods.

**TGR:** Do they have offtake partners?

**LM:** Argex has secured offtake partners for at least 75% of its original target
production of 50,000 tons per annum. Titanium dioxide has a well-established market; the impact of the Argex and Nevado plants will be small relative to the total market.

**TGR:** You cover the REE space. As of late June, the U.S. no longer had an REE mine after Molycorp filed for bankruptcy protection. The other major player, Lynas Corp. (LYC:ASX), also continues to struggle. What are some lessons for investors?

**LM:** Investors have realized that REEs are not that rare. But it is important to recognize that what is really rare is an economic REE deposit. There was a belief that companies that got to production first were going to be the winners, but there were so many hurdles along the way. Those hurdles ultimately caused trouble for Molycorp and Lynas because they were performing in a space in which they had limited knowledge and it was highly volatile. Being first is not always best and is not a guarantee of success.

Another lesson for investors is that the metallurgy of industrial minerals deposits is perhaps the most important component in project economics. The other important lesson is to not overvalue grade. With strategic materials, and REEs in particular, high grade is not everything. Lynas' Mount Weld mine runs at an average of about 7% total rare earth oxide elements (TREO) with some super-grade zones, and Molycorp's Mountain Pass mine has grades around 8% TREO, and they're struggling. In contrast, the ion adsorption clays in China grade less than 0.1% TREOs yet they supply nearly 100% of all the world's heavy rare earths. Of course, the ore, processing conditions and approach are different.

**TGR:** How would you convince skeptical investors that they can still make money in the REE space?

**LM:** It's important for investors to remember the reasons why folks got interested in REEs in the first place, back in 2010. It was in part because China was restricting exports, but ultimately the incident between China and Japan, where essentially China threatened not to sell any more REEs to Japan over territorial disputes, led to a market frenzy for these elements. China controlled and still controls most of the supply, close to 100% for some elements. The other reason was that we realized the importance of REEs in the green agenda that continues to move ahead in Europe and North America. But nothing has changed. We still don't have REE production outside Asia and the green agenda continues to take hold. Will the West always depend on China and the rest of Asia as a source for the most strategic rare earths elements?

**TGR:** Are there any REE plays that you continue to follow?

**LM:** I continue to follow the space but because of limited funds available from the markets most companies have limited cash positions and cannot advance their projects as planned. I do, however, receive updates from companies like Tasman Metals Ltd. (TSM:TSX.V; TAS:NYSE.MKT; TASXF:OTCPK; T61:FSE), Frontier Rare Earths Ltd. (FRO:TSX), Medallion Resources Ltd. (MDL:TSX.V; MRD:FSE; MLLOF:OTCQX), Ucore Rare Metals Inc. (UCU:TSX.V; UURAF:OTCQX) and GéoMégA Resources Inc. (GMA:TSX.V). Ucore and GéoMégA in particular are focusing on REE recovery technologies. As I mentioned throughout our dialogue, metallurgy is extremely important. Many companies in the REE space probably should have spent less money defining REE mineral resources and more on understanding and optimizing the metallurgy.

**TGR:** Tell us about those technologies.
LM: I have visited the GéoMégA laboratory where the company is working on two recovery technologies. One is for the production of a mixed REE chemical concentrate. I am under a nondisclosure agreement, so all I can say that I was fairly impressed with the company's approach and positive laboratory results. There is a good chance that GéoMégA will be able to produce an REE concentrate at relatively low costs. It has filed for patents for that technology. GéoMégA has a second technology, an electrofluorosis-based technology, with which it has achieved encouraging lab results also. The company is now moving to pilot plant-scale testing.

Ucore is also investigating a different process for the recovery of rare earths, which is known as molecular recognition technology (MRT), and was developed by IBC Advanced Technologies Inc., a private company. MRT is currently used to recover bismuth, antimony and other metals. It is proven on a commercial scale, but not for the recovery of REEs. Ucore recently announced that it is commissioning a pilot plant for the production of REEs using MRT; lab tests were extremely encouraging. From my discussions with the technical team of IBC, it seems that the company is usually comfortable with only performing lab scale tests before building a full scale plant. However, Ucore has insisted in proving the process at a larger pilot scale before advancing to the construction of a full plant, which in my opinion is prudent given that the REE plant may be a larger plant than the ones currently in operation. The pilot plant results will support the future economic study.

With a successful MRT process for rare earths, there are different business possibilities for Ucore. Ucore could potentially use tailings from other mine and metal operations to recover REEs and/or it could still use the Bokan Mountain deposit in Alaska, which it is still advancing. Bokan has support from the Alaska Senate, which has committed to supporting the project with up to about 70% of the capital costs for an REE processing plant in Alaska, based on Ucore's preliminary economic estimates.

TGR: Would what happened with Molycorp give the Alaskan government pause on its commitment to Ucore?

LM: On the contrary, the Alaskan government should be more motivated because it could become the domestic source of REEs in the U.S. Now that Molycorp may not be there anymore, I think there's more urgency.

TGR: Thank you for your insights, Luisa.

Luisa Moreno is managing partner and analyst with Toronto-based Tahuti Global. She covers industry metals with a major focus on technology and energy metal companies. She has been a guest speaker on television and at international conferences. Moreno has published reports on rare earths and other critical metals and has been quoted in newspapers and industry blogs. She holds a bachelor's degree and a master's degree in physics engineering, as well as a Ph.D. in materials and mechanics from Imperial College, London.

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