The term project evaluation has very broad applicability within the mining industry. However, the fundamental concept—generating information to support decision making regarding a project—is the same for all projects or stakeholders.

The evaluation may take any form from an independent expert’s report in international arbitration to a due diligence report for a financial client, or the National Instrument 43-101 feasibility study the retail investor relies on. Most critically, to be able to undertake the most effective and efficient project evaluation, the purpose and strategy behind that evaluation must be understood: what will the project evaluation be used for and who will rely on it? Is the purpose to set a valuation in an acquisition or sale, to determine the viability of a project for a board’s development decision, to undertake a technical and risk analysis to support project financiers, to support a short-term public investment strategy or a long-term private investment strategy? Each interested party’s expectations differ and it is critical to be able to answer questions related to risk, opportunity, present value and future value, providing the best information possible within the scope of the review.

The mining industry has had more than its fair share of poor decision making in a number of high profile cases, where assets purchased just a few years ago have been sold for cents on the dollar, investments have been lost within a few years or months of being made, and share prices for some companies have reached all-time lows.

…continued
Each situation is unique and most result from a cascade of events, with falling commodity prices often the straw that breaks the camel's back.

Commodity prices are out of the control of most mining companies, investors and other stakeholders unless they are the dominant global producer or in a niche market where they can be price setters. However, other challenges are more under the companies’ and management teams’ control. These include cost overruns on development projects, underperformance of assets, improper assessment/valuation of qualitative risks (e.g. social, permitting) and technical errors, say, in resource and reserve estimates. Understanding past mistakes and incorporating these learnings into current evaluations is necessary to prevent making the same mistakes over and over. At SRK we never assume anything and strive to verify everything that could influence value.

SRK has always been good at understanding client goals and matching its product to client strategy. However, SRK is more explicitly expanding its strategic role by developing a Corporate Advisory group. This group is supporting companies, investors and others in setting strategy to meet long-term goals and helping to implement those strategies so they are executed as envisioned.

In early 2011 SRK was engaged by the potential lenders as the Independent Engineer for the Project Financing of the Kwale Heavy Mineral Sands project in Kenya owned by Base Resources (Base).

SRK put together a multi-disciplined team of engineers and scientists to review all technical, environmental, social and economic aspects of the Feasibility Study (FS) that Base had completed. Most of the review disciplines undertook a site visit in May 2011, and SRK concluded its initial review in June 2011 by issuing a full due diligence audit report to the potential lenders, including an assessment of the project against the Equator Principles.

Kwale is located approximately 50km south of Mombasa and some 10km inland. The FS envisaged a project mine life of some 13 years,
Project financing of the Kwale heavy mineral sands project, Kenya

mining a paleo-aeolian dune deposit using a dozer mining trap unit and processing the ore through a ‘wet’ plant to produce a heavy mineral concentrate. Further processing in a ‘dry’ plant would separate out the final products of ilmenite, rutile and zircon. Final products would then be transported by road to a newly constructed storage and ship loading facility for bulk shipments of ilmenite and rutile, while zircon product would be bagged or containerised for export through the Port of Mombasa.

During SRK’s review of the FS, risks were identified and recommendations made for further work to be undertaken to mitigate these, prior to finalisation of the loan facility being agreed and before construction started. SRK also recommended adjustments to certain assumptions in the financial model the lenders used in assessing the project for the loan facility. Following interaction between SRK, the lender group and Base, an initial loan facility of USD170M was agreed and formally signed at the end of November 2011.

Detailed design and construction of the project commenced in late 2011 and production commenced in Q4 2013. The lender group retained SRK to monitor the project through its construction and ramp-up of production and to assess the project against Completion Test criteria. This has involved regular quarterly site visits by a technical team and review of monthly construction and operations reports produced by Base.

Undertaking the role of Independent Engineer can be difficult and challenging but has its rewards. SRK is pleased to have worked on what has become the first large-scale mining project in Kenya.

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Nick Fox, MSc, ACA, is a Principal Consultant (Geology/Mineral Economics) with 15 years postgraduate international experience in resource geology, mineral economics, financial modelling and due diligence. Nick’s technical expertise includes authoring and reviewing mineral resource estimates and financial models for various commodities globally, in particular Africa and Russia and CIS countries, and including gold, iron ore, nickel, heavy mineral sands, potash, tantalum-niobium and china clay. Nick manages multidisciplinary commissions including stock exchange Competent Persons Reports on behalf of mining and exploration companies and also audits and due diligence studies on behalf of investment institutions or in support of mergers and acquisitions.

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Nick Fox

NICK FOX
SGRK was mandated to act as the Independent Engineer on behalf of the consortium of Lenders supporting a potential debt financing of the Gahcho Kué diamond project. Gahcho Kué is located in the Canadian North, approximately 300km northeast of Yellowknife.

The Gahcho Kué project is a joint venture between Mountain Province Diamonds and De Beers, who own 49% and 51% of the project, respectively. The debt facility was to help fund Mountain Province’s share of the estimated C$1,019M capital cost.

SRK assembled a multi-disciplinary team, sourced from various offices in Canada, as well as outside organisations. The initial desktop review and site visit were completed in September 2014, and SRK identified a number of risks associated with the project. A key risk for the project was logistical access to the site.

At the time of engagement construction had begun at the project site, but was still in the early stages (~5% complete). All major construction materials and fuel were to be transported to the site over an ice road from Yellowknife, which is only operational for roughly two months of the year, typically February and March. The life of each winter road season and maximum load weight depend on ice thickness, which is directly correlated with cold temperatures. As a result, a poor ice road season could have a
significant negative impact on the procurement, cost, and schedule of the project. SRK provided advice to the Lenders on how this, and other risks, might affect the project.

After completing the initial review, a number of additional Lenders became involved in the potential financing. This increase prompted the need for a second site visit, additional review by SRK, and further interaction between the Lenders and SRK. This work was undertaken during the first quarter of 2015, during which time cold weather permitted the ice to become sufficiently thick for the ice road to open ahead of schedule, mitigating one of the major risks to the construction project. The additional review was completed and updated findings were delivered to the Lenders in March 2015.

Following interaction with SRK and the successful ice road season, the Lending group and Mountain Province agreed to and signed the US$370M facility, closing the deal on 2 April 2015. SRK continues to act on behalf of the Lenders by conducting ongoing construction monitoring and will ultimately conduct completion testing at the end of construction. SRK is pleased to be involved in what will become one of Canada’s next generation of diamond mines.

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Winter airstrip

STUART SMITH

Stuart Smith is a Project Manager with a Master’s in International Business. He has over 10 years’ experience in the mining industry. Prior to joining SRK, Stuart was involved in managing data and samples for geological investigations into diamond deposits. Since joining SRK in 2014, he has focused on managing multidisciplinary projects, with a particular emphasis on due diligence reviews. Additionally, Stuart is a member of the 11th International Kimberlite Conference Executive Committee.

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**Goderich and Cote Blanche salt mines**

Compass Minerals commissioned SRK to investigate various alternatives in salt mining extraction and material handling for their underground room and pillar Goderich and Cote Blanche Mines (in Ontario and Louisiana respectively). The goal was to identify a mining option that would reduce mine cost by improving operational performance and improve safety. At that time both mines were using conventional drill, blast and bench mining technology, extracting salt seams as thick as 18 metres at the Goderich Mine, and 23 metres thick at the Cote Blanche Mine.

SRK worked closely with Compass Minerals along with various continuous mining equipment manufacturers to explore a wide range of options with a view toward practicality, strong system performance, innovation and ‘out of the box’ thinking. Many of the options investigated had never been used in an underground salt environment. The benefits of an integrated tele-remote system were also investigated during this study.

In approaching this work, SRK collected data on-site to create a cost and performance baseline as well as data from other operations using other technologies and methods. This information was fed into SRK’s dynamic mine cost and performance model to compare over six different alternatives to their current mining process. The model incorporated daily shift cycles, labour rates, equipment performance (including operating availability and delays), equipment and infrastructure capital costs, mine operating costs, salt sales and revenue.

The results, in the form of comparative discounted cash flow, demonstrated that a continuous mining and conveyance system could significantly benefit the company through cost reductions, increased productivity and reduced diesel emissions.

SRK further refined the continuous mining option to achieve maximum panel extraction by optimising mining conditions as a function of panel configurations while improving pillar and roof stability. SRK has now been asked to incorporate mine simulation modelling to help choose the best panel mining pattern for extraction, cycle and sequence.

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**From December 2011 to July 2013, SRK carried out a prefeasibility engineering study for Andes Iron's Dominga Norte and Sur project. The study included resource estimation, geotechnics, mine design and production schedule, Iron (Fe)-Copper (Cu) mineral processing, power and water supply, a reverse osmosis plant and slurry pipeline for pellet feed, a filter plant, copper concentrate production, tailings dam and port facilities. SRK also provided a NI 43-101.**

The project, located 75km north of La Serena, Chile, in the Coquimbo Region, will pursue Fe and Cu through two open-pit mines. The combined proven and probable reserves for Dominga Norte and Sur are: 733 Mt at 25.6% FeT, 0.08% CuT and 0.01 ppm gold (Au). The 23 year mine life is estimated with 34 Mt/y ore and 95 Mt/y waste.

The project will be divided into six main areas: mine pits and waste dumps; process plant; power supply; slurry and water pipelines; main port infrastructure, and tailings dam.
Andes Iron’s Dominga Norte and Sur project

The north and south mine pits will produce 95 Ktonnes/day (34.4 Mt/year); the plant will produce 11.5 Mt/year of Fe concentrate and 120 Kt/year of Cu concentrate containing approximately 15 Koz/year of Au.

The plant area includes the primary crusher, stockpile, grinding plant, iron wet magnetic separation plant, copper concentration and filtration plant and infrastructure for thickeners, ponds and slurry transport. It contains Andes Iron’s administrative offices, construction camp, storage, laboratories, center for solid waste management, and a gas and diesel station. Power will be supplied by the Punta Colorada power substation.

In the piping area iron concentrate, water and tailings will be pumped into the process plant area, port area and tailings dam.

The port facilities consist of an iron concentrate filter plant, water dissipater stations, thickeners and pond conditioners, reverse osmosis plant and building, sea water ponds, treated water, brine and emergency ponds and general support facilities.

In the process plant area for example, the overburden was removed to construct the crushing area followed by assembling and filling the mechanically stabilised earth wall to its maximum elevation.

The iron magnetic concentration area was designed to bring together the particles of iron ore through low intensity magnetic concentration and reverse silica flotation. The copper flotation area was designed similarly to treat the tailings from the iron plant.

Key tasks included a pipeline to transport iron concentrate from the plant to the port, a pipeline to transport desalted water from the reverse osmosis plant, and a third to transport recovered water from the port to the plant.

Eduardo Bastías is a Mining Engineer with 29 years of professional experience in the mining industry. He specialises in engineering and operations for underground and open pit mines, including mine design, mine schedule, mine equipment, mine OPEX and mine CAPEX. During the last ten years, Eduardo has worked as a mining consultant, conducting open pit and underground projects in Chile, Peru, Brazil, Mexico, Ecuador and Cuba. He has been project manager in several scoping studies and due diligence projects. Eduardo conducted the prefeasibility study for Dominga project, located in Chile during 2012-2013.

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Osborne underground headframe and winder

Ivanhoe Underground headframe and winder

There are plans to extend the underground workings of the Osborne gold-copper project to a depth of 560m, the company said.

Placer's Osborne mine, on which Placer was awarded a mining lease in 1979, began mining in March 1980 and ceased production in May 2002.

After operating for 22 years, Placer's Osborne mine, on which the company was awarded a mining lease in 1979, began mining in March 1980 and ceased production in May 2002. After three years of operations, the mine was closed due to market conditions.

The mining lease was granted to Placer in 1979, and the mine was active for 22 years, until 2002. It was then closed due to prevailing market conditions.

The mine was closed due to market conditions, and the mining lease was granted in 1979.
An overview of benchmarking capabilities

Sourcing benchmark data can be a time consuming task, and time is a valuable commodity in consulting. Benchmarking is essential for defining early stage limitations for estimating Mineral Resources and for informing clients of key areas for improving operations. Every deposit and operation has its own unique characteristics, so the challenge is to identify enough comparable data for a meaningful analysis. The greater the level of detail required and number of constraints placed on the benchmark data, the more challenging it becomes to generate a sufficiently large and reliable data population quickly.

SRK subscribes to database sources that provide a continually up to date and informed position for benchmarking; they complement our extensive in house experience and systems. For commodity price assumptions, this process extends to regularly updating the market consensus on metal price forecasts, for internal guidance and professional dialogue with clients.

It is important to understand the limitations of database sources, which is why SRK subscribes to a range of the best and most recognised products. In many instances these database subscriptions are not comprehensive enough to complete the full benchmark task the client requires so additional investigations and enquiries are needed.

Recent examples of benchmarking exercises completed by SRK include the following:

- Review of open pit iron ore and chromite mine technical and cost operational parameters such as design, equipment, labour, maintenance and energy consumption to provide an operator in India targets for future expansion.
- Operational improvement exercise for a client with multiple underground lead-zinc mines in the USA. The project covered due diligence, data collection and value tree analysis to determine key drivers for establishing improvement targets.
- Market research for a major distributor of mining equipment in Russia and a number of African countries to determine the future sales forecasts of open pit and underground equipment.
- On-going monitoring of a decline cover drilling and grouting program to prevent water inflow in Europe and comparison with the key performance indicators of similar projects to facilitate efficiency and reduced costs.
- Benchmark capital and operating cost breakdown analysis of underground copper-gold mines utilising sublevel caving and open stoping methods to assist with determining reasonable cost estimates for a developing project in Eastern Europe.
- Review of technical and cost parameters for mines utilising underground shrinkage methods to use as means of comparison on a due diligence commission for a potential investor.

SRK has a large global multi-disciplinary base of experienced mining professionals and associates who can typically cover all reasonable benchmarking requests.

When undertaking benchmarking assignments, SRK focuses on what needs to be achieved to develop an efficient approach and regularly communicate throughout our global network to access additional knowledge and support to complete the task.

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With mine project evaluations, the tendency is to focus on the potential resources and reserves followed by the mining and processing costs. But environmental issues related to project permitting, operations and closure can have a material influence on the overall valuation of a mining asset. Proper identification of environmental liabilities and risks, as well as the cost of ongoing environmental expenditures, need to be included in the overall cash flow model. Likewise, mine closure costs need to be included to determine the closure fund contributions from cash flow.

Before new mining can be initiated, properties with pre-existing, mining-related liabilities need to be assessed and included in the project valuation. The mine’s expansion, redevelopment, or reuse may be complicated by the potential presence of environmental issues, usually a hazardous substance or pollutant. Assigning responsibility to historical....
Don’t forget environmental issues

liabilities can be critical during early negotiations, as the full assumption of existing liabilities could lead to long-term remedial programs. Permitting mine projects has become increasingly challenging in some western jurisdictions. Prolonged permitting processes affect the investor return period. For this reason, most mine developers try to expedite the initial permitting process to ensure the project has obtained, or is close to obtaining, permits prior to market presentation. While initial permitting costs are usually borne by the development company, maintaining the permits, as well as the environmental and social management programs, should be considered in the overall project valuation. Environmental requirements associated with mineral rights, surface land uses, and water rights/appropriations also need to be considered during the evaluation.

Environmental capital costs provide for constructing or upgrading pollution control measures, such as stormwater diversions, settling ponds, water treatment plants, or air pollution control measures. Capital costs could also include provision for further investigations or for compensation payment to affected parties. In some cases, this extends to the purchase of neighboring properties, where land capability has been or could be affected by the mine. While generally not associated with “greenfield” projects, litigation resulting from environmental, labor, and health & safety claims need to be considered for operational or “brownfield” projects.

For years the mine evaluation process has ignored or given only cursory consideration to final reclamation planning and closure costs, as these issues can occur years into the future. At best, a Greenfield project may develop a conceptual closure plan espousing the virtuous nature of corporate reclamation and sustainability programs, with little detail to evaluate the true extent of necessary activities and associated costs. Experienced closure specialists draw on a breadth of site experience, facility and process design knowledge, known closure pitfalls, and post-closure commitments to guide the mine evaluation to realistic final closure cost.

The closure specialist can assist in identifying opportunities for alternative closure strategies, cost savings approaches, or closure scheduling to improve the overall cash flow model.
The client, based in Melbourne, Australia, commissioned SRK to review the mineral sands project following the previously prepared final “Definitive Feasibility Study” and available engineering studies, to then prepare a technical report, and to present our opinion and findings. The company develops and mines mineral sands deposits and produces a range of zirconium and titanium based products from mining interests in Australia and Africa. In China, the company finishes, sells and markets zirconium and titanium products; abroad, the client is a world leader in advanced zirconia materials for the refractory and ceramic industries.

In our scope of work, SRK reviewed the prepared mineral resource and ore reserve estimates; assessed mine planning and the proposed mining; technically reviewed the ore concentration and separation processes; and reviewed the project infrastructure in Australia; the project’s environmental, legal, and social aspects; and the project costs and financial model.

The mineral sands deposit is located north-west of Melbourne. The total Measured and Indicated Mineral Resource of the Australia deposit is estimated to exceed 800 Million tonnes (Mt) based on a cut-off grade of 1.0% heavy minerals. Proved and Probable Ore Reserves of about 460 Mt are presently estimated for mining zircon, rutile, leucoxene and ilmenite.

The open pit mine, operated by shovels and trucks, follows a model identifying optimised operating blocks with a semi-mobile screening unit located near the mining front to prepare the ore for pipeline transport. The mineral sands concentrate would then be shipped to south China for further processing to achieve marketable products.
During the second stage, shipment of heavy mineral concentrate should increase to 1.32 Mtpa.

Overall, the project poses some engineering challenges due to the complex mineral preparation process proposed for the relatively fine-grained mineral sands. With the proposed and proven technology available, it is considered possible to achieve a workable and satisfactory process solution.

A decision on implementing the project is expected early in 2016 after detailed design is complete and financing has been secured.

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It is planned to develop the mine in two stages. At the first stage, the mine should produce 9.0 Million tonnes of ore per year (Mtpa) increasing ore production to 179 Mtpa in the second stage. At full production during the first stage, about 18 Million bank cubic meters of overburden has to be stripped per year to expose the ore. The heavy mineral concentration plant will accommodate the mined ore and will use de-sliming cyclones and spiral separators for concentrating.

After full production during stage one, 660,000 tpa of heavy mineral concentrate will be shipped to China for processing in wet magnetic separators and spiral separators to achieve 90% heavy minerals. Further treatment in an electrostatic mineral separation circuit will complete the recovery process.
To better manage project complexity, processes are needed to guide the development of estimates and identify and mitigate related risks. The process should identify the various approvals required to renew an exploration permit or receive a mining permit. However, recent changes in public perception and sentiment have added a level of uncertainty. Simple compliance with legislation is not always adequate to ensure that a company retains its operating licence. The expectations of communities and governments have changed, and these changes must be captured in the host country’s permitting requirements. Previous operations or governments may have left a legacy that adversely affects the current project. Former owners may have made commitments that cannot be met. Companies might be tempted to continually focus on the best outcome to attract investors without considering that negotiations for fiscal incentives are not yet finalised. The larger the footprint of the operation, the more complicated this

Prepared a cash flow model to be used in project evaluation is not just an exercise in manipulating numbers in Microsoft Excel. There are numerous complexities in compiling such a model which require a thorough understanding of the project and the commodity, from geology to mining to processing to logistics to marketing the finished product. There are technical matters specific to product and commodity to be considered. Further, the terms of any off-take / marketing agreement or toll-treating agreement need to be used accurately and properly modelled.

In most projects, month zero (marking the start of the project) is not the same for the mining and the processing components. The mining ramp-up to steady state invariably takes much longer than that of the processing plant (see diagram). The time when the first ore can be fed into the plant needs to be carefully assessed, so the size of the run-of-mine (RoM) stockpile during construction does not get too large, compared to a plant that is brought on stream too early – only to be starved of RoM ore (reducing revenue and increasing unit costs).

This requires carefully modelling the movements of tonnages and contained metal into and out of the stockpile. A simple error is the incorrect use of terminology with respect to processing plants: with coal, industrial minerals and dimension stone, apply yield to RoM tonnage to describe the percentage of saleable product to be derived; with precious and base metals, apply recovery as a percentage of contained metal in the plant feed. With projects such as platinum group metals (PGMs), relationships exist between the head grade of the plant feed and the applicable recovery – the higher the grade, the higher the recovery. A further complication is that the distribution of the PGMs in the plant feed, or the prill split, varies from project to project, and the recoveries that apply to the various elements are different. Applying an average recovery tends to underestimate the recovery of the main revenue drivers, platinum and palladium, and overstate the Au (gold) recovered, with a general reduction in revenue.

This discussion introduces a few of the many important distinctions in calculating elements that can impact cost estimates and make the difference between success and failure. For instance: were capital cost estimates phased independently for each component? How were costs determined? Who has considered the effects of changing foreign exchange rates? Does the mining licence grant ownership of the surface? How about funding for the environmental closure costs? Are the evaluation models calculated in real or nominal terms? And what about inflationary effects?

The SRK study team looks closely at all of these eventualities, critically reviewing and validating them against historical operating statistics.

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Sustainable value creation

process becomes. This is as a result of combining the numbers of communities impacted by the operation, each with their own needs and desires, and the likely national strategic significance of the associated infrastructure.

Companies need to reconsider Net Present Value and Internal Rate of Return as primary measures of value in most projects, particularly “greenfields” projects. These measures can lead to unsustainable operations by favouring short-term returns over long-term sustained cash generation that would promote the ongoing development of the mine and the community. They can ignore the value of flexibility by rewarding lower capital costs and lower operating costs in the base case without considering the range of likely conditions over the life of the operation.

Companies should communicate frequently with all stakeholders to increase trust and facilitate effective engagement. They should be wary of closing a quick deal that does not provide for returns to the government until several years after commissioning. Governments need to hire skilled staff and consultants to complete the regulatory review of complex projects on time – areas such as customs, environmental, social monitoring and engagement come to mind.

Governments must ensure their negotiating teams include members and decision makers who can adequately cover all issues and are supported by skilled advisors who can ensure that technical, legal and financial risks are addressed. Companies may need to provide financial support to the government to retain such a team. It is essential to remember that in any bureaucracy, uncertainty leads to delay.

Governments can facilitate more sustainable operations by working to reduce the uncertainty investors face, effectively lowering the discount rate and increasing the value of later returns. Companies should avoid trying to ‘beat’ the government or the community in a negotiation. Collaboration and trust with all stakeholders and adaptable, cash generating operations are essential to create sustainable value.

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Andrew van Zyl, Partner and Principal Consultant, B Eng, M Com (Financial Economics), worked in production and project roles before 2006, when his focus shifted to strategy, business development and valuation. Recently, he was technical advisor to the government of Cameroon, negotiating the Sundance Iron Ore Convention and Concessions. Andrew has extensive experience in valuing metals and minerals. He lectures on exchange rate theory and corporate valuation at the University of Johannesburg, and has presented conference papers in economics, mining valuation and health economics, in particular on the economic impact of HIV/AIDS and Antiretroviral Therapy in mining.

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Andrew McDonald, CEng, MSc, MBL, MIMMM, FSAIMM, is a Principal Consultant with over 40 years’ experience in mining and associated light industries. His expertise covers supervision of due diligence audits and engineering studies, taking responsibility for project evaluations and valuation of mineral properties. Andrew has coordinated numerous Competent Persons Reports and Technical Reports for the Toronto, London, Johannesburg and Hong Kong Stock Exchanges. He has been actively involved for the past 3 years with the working group charged with revising the South African Code for the Reporting of Mineral Asset Valuation (SAMVAL Code).

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The valuation of exploration assets is required as a basis for the commercial terms of corporate transactions, but can also support a company’s exploration strategy when every exploration dollar must be carefully considered. In exploration it is generally recognised that while the investment risks are high, the financial returns of discovery are significant. Many parts of the globe, both mature and relatively under-explored, continue to deliver new finds.

Any valuation approach needs to take into account both the technical merits of a project and the market conditions, and will usually incorporate several different valuation methods. All statements by the company regarding discovery potential and possible outcomes for future exploration campaigns must be made on a reasonable basis. The valuer should communicate the project merits while satisfying the market regulators who are very cautious about forward-looking statements.

The guiding principles for any valuation should revolve around the materiality of the data, the competence of the valuer and the transparency of information. Materiality guides what data should be considered for the valuation. For example, if a historical or foreign estimate of mineralisation is known on the property, this is clearly material information, even though it may not be readily released in accordance with public reporting guidelines. A site visit is a key aspect of understanding the context of the information. Competence refers to the relevant previous experience of the individual who is conducting the valuation. Commonly, a number of technical specialists will need to take responsibility for their respective areas of reporting, rather than a single expert. Reports should be transparent with sufficient information, so that the reader can understand the approach and assumptions made in clear and unambiguous terms.
More questions than answers in expanded reporting codes

Protecting the environment and communities in and around exploration and mining projects is now a major issue in valuing mineral assets, with the media and society at large elevating the need for a ‘social license’ to mine into daily conversations and even protests.

The major reporting codes have recently recognised the importance of these issues, by adding ‘infrastructure’ and ‘social’ as additional modifying factors to be considered when converting a mineral resource to a mineral reserve (Figure 1).

The question posed recently – and the question for the project valuator – is how to measure the impact or cost of obtaining a social licence to mine on the financial feasibility of a project.

Previously, if applying for an exploration or mining permit, a reasonable expectation that the relevant government departments would issue it would be sufficient (community engagement and social and labour plans are required before applying).

However, in today’s world, government is not the only constituent to be considered. All interested and affected parties have to be engaged and they have to issue the social licence. To further complicate matters, this is not a one-off exercise; the social licence has to be obtained and maintained throughout all the phases of a mining project from early exploration to mine closure.

My first response to the question was that a comprehensive and multi-disciplinary risk assessment should be undertaken in all phases of a project – which recognises all the risks to the project and attaches some quantitative judgment to them.

While mitigating actions to ameliorate the risk profile should be managed on an ongoing basis, the valuator has to value the project at a particular point in time. There are levels of risk in all aspects of a project which can be estimated and a risk factor built into financial calculations.

However, the risks associated with environmental and social matters do not lend themselves to a mechanistic calculation; rather, they tend to be more qualitative in nature. The risk continuum ranges from project termination at the one end, to a sustainable mining operation where all stakeholders realise value from the project, at the other. This does not mean that the risks are any less serious. For instance, it would be interesting to know what risk was attached to social aspects in the case of the Pascua-Lama project on the border of Chile and Argentina – which has been stopped indefinitely under a court order on a matter concerning the water supply to local communities.

To consider all risks associated with a mining project, there is a need to apply a multi-disciplined team approach to mineral asset valuation; this is what SRK supports with its broad spectrum of skills and disciplines across the world.

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In Australasia, the release of the JORC Code (2012) and the update of the VALMIN Code, which is currently in progress, provide increased guidance to the industry in disclosing information in public reports. Both these committees have worked with international bodies in attempting to harmonise the requirements of a number of jurisdictions. In addition to the professional codes, each jurisdiction will have their own regulatory and reporting requirements that need to be considered. Adhering to these guidelines provides transparent and defendable valuations, offers comfort to the investment community and helps protect the reputation of the resources industry.

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**MINERAL RESOURCES**

- Inferred
- Indicated
- Measured

**MINERAL RESERVES**

- Probable
- Proved

Increasing level of geological knowledge and confidence

Consideration of mining, processing, metallurgical, economic, marketing, legal, environmental, infrastructure, social, and governmental factors (the “Modifying Factors”).
One of the sought-after services SRK Russia provides is harmonising mining projects to meet both Russian and international standards. SRK’s comprehensive approach to implementing mining projects has become essential as the recent acute deficit of investment in Russia’s mining industry necessitates the attraction of foreign capital. At the same time, foreign investors from Asia, Europe and America have been looking for mining projects at the initial stage of development. However, foreign investors do not have a clear understanding of Russian legislative requirements for preparing and developing mining projects, while mining companies do not always understand investor’s requirements and expectations.

SRK Russia has worked on several projects that demonstrate the necessity for attracting international investment, while knowing that a project implemented in Russia must fully comply with Russian legislative requirements.

SRK was commissioned by Masan Group Corporation, in Vietnam to provide an independent oversight of Masan Resources, Nui Phao project during construction and production ramp up. This work took place over a period of 18 months.

The Nui Phao project is a polymetallic deposit, located some 80km north west of Hanoi. A Reserve of 53Mt has been defined containing tungsten, fluorite, bismuth and copper mineralisation. Mining is designed to produce 3.5 Mtpa of ore for a multistream processing plant.

The project was designed to an international standard and was ably led by a multinational leadership team.

In late 2011, construction commenced on site with the processing plant earthworks, Tailings Storage Facility (TSF) earthworks and waste pre-stripping for the mine. The project delivery method selected was for an owners’ team to provide construction management, supported by an EP design contractor for the processing plant, design engineer for the TSF and a mining contractor. The owners’ team was responsible for sourcing and awarding all construction contracts for site works.

SRK’s initial role was to review the construction preparations and reserve. Following from that, SRK conducted monthly report reviews and quarterly site visits to review site progress and provide independent feedback to the Masan Group on project progress and ongoing updated project risks.

SRK has provided review coverage for geology/resource, mining, processing, tailings and environmental areas. During the review period, SRK has also provided support for the Masan Group in terms of seeking ongoing finance for the project by preparing specific independent reviews for financial institutions on the project progress.

This scope of work has demonstrated the value of carrying out an ongoing independent project review to satisfy both the parent owner’s and other stakeholders governance requirements. That, in turn, has allowed these entities to have a level of external oversight over the internal project team.

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**Nui Phao project review**

**SRK** was commissioned by Masan Group Corporation, in Vietnam to provide an independent oversight of Masan Resources, Nui Phao project during construction and production ramp up. This work took place over a period of 18 months.

The Nui Phao project is a polymetallic deposit, located some 80km north west of Hanoi. A Reserve of 53Mt has been defined containing tungsten, fluorite, bismuth and copper mineralisation. Mining is designed to produce 3.5 Mtpa of ore for a multistream processing plant.

The project was designed to an international standard and was ably led by a multinational leadership team.

In late 2011, construction commenced on site with the processing plant earthworks, Tailings Storage Facility (TSF) earthworks and waste pre-stripping for the mine. The project delivery method selected was for an owners’ team to provide construction management, supported by an EP design contractor for the processing plant, design engineer for the TSF and a mining contractor. The owners’ team was responsible for sourcing and awarding all construction contracts for site works.

SRK’s initial role was to review the construction preparations and reserve. Following from that, SRK conducted monthly report reviews and quarterly site visits to review site progress and provide independent feedback to the Masan Group on project progress and ongoing updated project risks.

SRK has provided review coverage for geology/resource, mining, processing, tailings and environmental areas. During the review period, SRK has also provided support for the Masan Group in terms of seeking ongoing finance for the project by preparing specific independent reviews for financial institutions on the project progress.

This scope of work has demonstrated the value of carrying out an ongoing independent project review to satisfy both the parent owner’s and other stakeholders governance requirements. That, in turn, has allowed these entities to have a level of external oversight over the internal project team.

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**Russian documentation**

<table>
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<th>Documentation</th>
<th>Details</th>
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<tr>
<td><strong>Preliminary assessment of mineral deposits at early exploration stages (TES, TED, TEO, TEP)</strong></td>
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<td><strong>TEO Konditsii</strong></td>
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<td><strong>Detailed project and project documentation</strong></td>
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<td><strong>Project of construction organisation</strong></td>
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</table>

**One of the sought-after services SRK Russia provides is harmonising mining projects to meet both Russian and international standards. SRK’s comprehensive approach to implementing mining projects has become essential as the recent acute deficit of investment in Russia’s mining industry necessitates the attraction of foreign capital. At the same time, foreign investors from Asia, Europe and America have been looking for mining projects at the initial stage of development. However, foreign investors do not have a clear understanding of Russian legislative requirements for preparing and developing mining projects, while mining companies do not always understand investor’s requirements and expectations.**

SRK Russia has worked on several projects that demonstrate the necessity for attracting international investment, while knowing that a project implemented in Russia must fully comply with Russian legislative requirements.
Harmonisation of mining projects according to Russian and international standards

<table>
<thead>
<tr>
<th>International documentation</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Conceptual study/Scoping study</td>
<td>Study of the deposit aimed at identifying key issues and the potential for deposit development. Determination of the efficient development options, feasibility and economic viability of the deposit.</td>
</tr>
<tr>
<td>Pre-feasibility study</td>
<td>Studies aimed at working out the uniform technical-economic parameters (options) for the deposit exploitation which determines the optimum and cost-effective methods of project development.</td>
</tr>
<tr>
<td>ESIA</td>
<td>Similar studies but each has its own requirements.</td>
</tr>
<tr>
<td>Feasibility study</td>
<td>Development of a project design consistent with the preferred deposit development option.</td>
</tr>
<tr>
<td>EPCM</td>
<td>Construction of the mine.</td>
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For the past few years, SRK Russia has applied a comprehensive approach to mining projects with a development strategy that satisfies both Russian and international requirements. This includes the completion of comprehensive studies that present parallel resource and reserve estimates and classifications that meet Russian and international requirements. Similar projects have been undertaken before, by SRK and other consulting companies, but with the current approach, SRK Russia takes the lead, supporting geological exploration and supervising the work of design organisations/institutes. SRK Russia assumes the intellectually-challenging responsibility for the business development strategy and the appropriate level of engineering, while the design institutes perform their work following the previously developed technical-economic solutions. Implementing the project successfully requires the joint efforts of all disciplines.

Within the framework of comprehensive studies, SRK Russia has developed an approach that includes the interaction of all stakeholders. A comprehensive approach to both Russian and international requirements require compliance with standards, such as these:

- Preparing input data at the earliest stages to avoid potentially faulty decision making;
- Conducting project studies: geology; hydrogeology; geomechanics; opencast operations; underground or open pit mining; production complex; infrastructure; environmental baselines; project execution schedule; capital cost estimate; operational cost estimate; economic assessment; risk and environmental impact assessments;
- Preparing reserves and resources estimates following GKZ and international Code requirements (JORC/CIM 43-101 etc.); and
- Preparing two packages of project documentation that do not contradict each other, based on a single set of technical-economic parameters and solutions.

Common elements of main project documents that meet Russian and international requirements are provided in the Table above. SRK specialists worked in close collaboration with other experts to define methods and practical approaches for single technical-economic solutions to meet Russian and International requirements.

SRK Russia has gained significant experience in project development and engineering, at, for example Udokan copper deposit and Agaskyr copper-molybdenum ore deposit.

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In 2012, Alexco Resource Corp. (Alexco) commissioned SRK to assist in completing an updated NI 43-101-compliant Preliminary Economic Assessment for their Eastern Keno Hill Silver District project. Located in a historic silver mining district in the Yukon Territory, Canada, there are approximately 30 known polymetallic silver-lead-zinc deposits in the area, many of which have been subject to small-scale mining operations over the last century.

In order to realise Alexco’s objective of unlocking the value of the silver-rich district, SRK undertook complete economic assessments for the operating Bellekeno mine and three of Alexco’s advanced exploration projects, all located within 10km of the Keno District Mill. Each assessment included a complete life of mine plan, schedule, operating and capital cost estimates.

This allowed the team to explore many scenarios to optimise the strategic business plan for the district, and focus on growth by advancing Alexco’s promising district properties to development decisions. The final result of these strategic planning exercises was used to create the combined Life of Mine plan for the Preliminary Economic Evaluation.

A number of challenges and opportunities were explored through the course of the assignment:

- The Keno Hill Silver District is well known for the challenging conditions experienced underground – many of the deposits feature graphitic and sericite schist packages at or near the contacts. Historically, the deposits were mined using square set stoping, shrinkage mining, or cut and fill mining methods. In the last two years the Bellekeno mine has successfully implemented small-scale longhole mining and started moving away from the mechanised cut and fill methods. The small size, challenging ground conditions and the tendency for veins to be saturated when new levels are exposed, limits the productive capacity of individual deposits, thereby requiring several deposits to be operational in order to ensure the district mill is operating at capacity;
Feasibility studies are only as good as the attention paid to data collection

SRK has been involved with multiple projects in India that involved feasibility studies. These projects included advising on requirements, preparing studies and reviewing earlier studies.

SRK has recently completed a feasibility study for Balasore Alloys’ underground chromite mine in Orissa that will sit below its existing Kaliapani open pit operation. SRK has added multiple dimensions to the feasibility study of their underground plan. For example, understanding the structural complexity due to multi-phase tectonic deformations, SRK advised generating subsurface rock mass data from oriented cores. With this, SRK could capture and visualise rock defects to develop more precise models. Also, groundwater investigation characterised different aquifers intersecting open pit and underground areas.

SRK has been involved with multiple opencast coal projects that required engineering analysis or review of feasibility studies done by other organisations. With the easy blocks already targeted and exploited, most new blocks are either deep or structurally complex. Some mines face the lack of available space for waste dumps. Another confronted a river flowing through the lease that was simply diverted without appropriate study of hydrology and geotechnical considerations. SRK recommended generating robust geotechnical data to support a large open pit and backfilling option, and a study design on hydraulics, hydrogeology and geotechnics to divert a significant river flowing across the block.

In general, SRK’s experience shows that such studies were conducted mainly at the desktop level for permitting purposes, whereas significant engineering study and design efforts are required for implementation. While some commissions have been challenging, a few projects are encouraging for the Indian mining industry, especially start-ups. With regards to OPGC’s Manoharpur opencast coal block planned for Orissa, OPGC is reviewing multiple business models suitable for the coal blocks. While this takes time, OPGC wants its mine to meet international standards for safety, environment, productivity and quality.

There are no precise practising guidelines in India governing how a company should develop a feasibility study. Instead, many companies rush through the steps to quickly secure statutory permits and hand over the project to the contractor, but this potentially has negative consequences and also sometimes means missing opportunities. Mining companies need to approach feasibility studies in a deliberate linear fashion. The weakest link remains the quality and quantity of data. Often, there is no clear understanding of where to obtain data, how to use it, and how to include it in reports.

SRK recommends careful design of data collection to ensure that the results can be defended. The temptation to take shortcuts can have exactly the opposite effect: producing a dataset that cannot provide scientifically defensible conclusions. Skipping steps can ultimately delay projects and increase costs. Beyond the actual monetary cost, what is lost is the opportunity to allocate resources to more worthwhile projects.

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• Consideration was also given to the drop in the spot price for silver during the course of the assignment and the tight capital markets, making it difficult for junior mining companies such as Alexco to raise the funds to put a new mine into production; and,

• With Alexco temporarily suspending production at the Bellekeno mine, a number of opportunities to restructure the operating costs, including shifting from contractor to a company mining workforce and establishing an owner operated equipment fleet, were incorporated into the PEA.

The completed Technical Report entitled “Updated Preliminary Economic Assessment for the Eastern Keno Hill Silver District Project – Phase 2, Yukon, Canada” is now available on Sedar.

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Cerro Lindo, owned and operated by Compania Minera Milpo S.A., is the largest underground mine in Peru, currently mining more than 20,000 tonnes per day. The mine profitably develops seven volcanogenic massive sulphide (VMS) ore bodies.

To begin mining the secondary stopes in Ore Body 5, and realise the optimal dimension and stope support design while tackling excessive dilution from the walls and roof, SRK conducted a series of field and laboratory investigations to establish a reliable geomechanical model. This included installing 46 geomechanical monitoring stations, three detailed geomechanical transects and re-logging four strategically selected diamond drill holes, comprising a total of 410m.

Dr Antonio Samaniego, founder of SVS Ingenieros S.A. (now SRK Peru), is a Corporate Mining Consultant and an experienced specialist in Rock Mechanics. He focuses on mineral appraisal and feasibility studies, underground mine design and mine planning, slope and underground geomechanics and mine waste management. He is responsible for all geotechnical studies related to rock mechanics in mining and civil engineering projects in Peru.

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Strength factor A for December 2015

The frequency of the discontinuities was carefully recorded to estimate the RQD values, and the body’s RMR was also estimated. A total of 104 samples were taken from all lithologies and various mine levels and assigned for laboratory tests to determine the physical and mechanical properties of the intact rock.

Structural mapping and logging allowed for the creation of a new model of the in-situ stress field and for the calculation of the principal stresses using kinematic analysis of faults as well as in-situ stress measurements.

Following dilution reconciliation across different stages of mining, using the equivalent linear overbreak slough (ELOS) criteria, SRK conducted a back analysis of these stopes to establish the optimum stope geometry as well as the key dilution controls.

Using the results of those analyses, SRK developed a mine extraction sequence and a numerical model to ensure that optimum mine stability was attained.

Further back analysis of past fill strengths allowed for the identification of a series of alternate strategies and opportunities.

Finally, SRK oversaw the installation of blast monitoring instrumentation to assess on-going effects and allow for the control of the rock mass behaviour.

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The high-grade Yaramoko underground gold project, located in Burkina Faso, West Africa, is wholly owned by Roxgold Inc., a Canadian-based gold exploration and development company.

In 2013, Roxgold commissioned SRK to lead a team of multi-disciplinary consultants from SRK and other independent consulting firms in preparing a bankable feasibility study for a proposed underground mine and on-site concentrator.

Three SRK offices shared the scope of work:

- SRK Toronto was responsible for project management, geological modelling, mineral resource estimation, underground mine planning, financial modelling and compiling the 43-101 technical report.
- SRK Vancouver undertook the rock geotechnical design of the underground mine.
- SRK Cardiff’s scope included hydrogeology and water management, social and environmental management, geochemistry, and mine closure.

This article focuses on the geological modelling, mineral resource evaluation and mine planning aspects of the feasibility study.
At Yaramoko, the mining target is the gold-bearing 55 Zone, a narrow shear zone, which varies in width from a few centimetres to more than four metres. Based on detailed on-site structural geology investigations, the reverse shear zone, which defines a low-grade resource domain, was modelled geologically. Within the shear zone, most of the high-grade gold mineralisation is associated with low-sulphide quartz veins developed within dilational zones. High-grade gold resource domains were modelled with a shallow west plunge, consistent with the structural geology interpretation.

Using a geostatistical block modelling approach, SRK estimated the mineral resources for the 55 Zone. This approach was constrained by geologically-defined low- and high-grade gold mineralisation wireframes and informed by capped and composited core borehole data.

The underground mine plan is based on longhole open stoping on 17m sublevels, using cemented rock backfill (CRF). A dual ramp system will provide access to the underground mine from a single portal. Ore and waste rock will be hauled to the surface by 25-tonne capacity trucks. Probable ore reserves of 2.0 Mt at 11.8 gpt Au will be mined at 750 tpd over a 73 year mine life.

Key features of the mine include:
- High-grade gold veins with regular geometry and excellent grade continuity;
- Fast development access planned from the portal to the upper vein area that hosts some of the highest gold grades;
- Full up-hole retreat recovery of planned sill pillars to be located below high-strength CRF; and
- Contractor-operated mine startup with mid-life transition to owner mining.


Roxgold expects to begin production in Q2 2016.

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Specialist advice for mining projects in all global environments.

To learn more about SRK and how we can help you with your next challenge, visit our website: