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Front cover image – aerial view of tailing ponds in Utah, USA.
(Photo credit – Ron Chapple Studios/Getty Images)
Introduction

Welcome to Willis Towers Watson’s Mining Risk Review for 2016. In a world where the pace of change is constantly increasing, the mining industry has to respond to challenges which would have been difficult to anticipate only a few years ago. Global demand for minerals is still stagnant, and the growth horizon remains largely dependent on the expanding economies of Asia. Here, while many of the younger economies are looking positive, a cloud of uncertainty continues to cast a shadow over China and consequently the prospects of an overall recovery in demand.

There has therefore never been a greater need to gain and maintain stakeholder support for the industry, and this goes far beyond the need to simply return value to shareholders. Governments, NGOs, employees, regulators, neighbours and host communities are no longer passive observers of the sector; the need to positively promote the benefits of mining is crucial in the new era of social media and rapidly changing public opinion. It’s no wonder that our recently published Natural Resources Risk Index points to geopolitical instability and regulatory change as the megatrend that most concerns the c-suites of the world’s leading natural resources companies.

In general terms, operational excellence has replaced simple cost-cutting as the dominant trend in the industry. Simple cost cutting without vision was never going to be a sustainable strategy for the mining industry; what we are seeing now is companies undergoing a thorough transformation in order to survive. The days of simply getting more out of the ground are over; new mining companies will have to be specifically geared to survive the current sustained depression in prices.

This transformation process is taking place in an environment where investors are cautious. Utilizing techniques and strategies from other sectors is starting to become more common, as investors look for new reasons to invest in what was seen as a sector needing a re-vamp.

Meanwhile rigid labour and over-priced suppliers are being replaced by flexible work practices and suppliers that integrate more effectively into new cost models. The sector is undergoing a qualitative change in the management and managers required; the leaders of the sector will look a lot like leaders of other sectors and the industry will need to compete for them.

Within this process, innovation is a central theme. Disruptive technology, the use of remote controlled equipment, robotics, drones, underwater mining and 3D printing are the buzzwords of the new economy permeating the mining space.

In the meantime, the new world will still be characterized by risk but the risks are changing. Automation reduces exposure to death and injury but increases breakdown risk and the potential for process bottle-necks. All of these developments are taking place in the aftermath of the tragic events at the Samarco tailings dam last year; it’s clear that conventional risk transfer alone cannot be the only way to manage mining companies’ potential exposure to environmental disasters such as this.

We do hope you enjoy this Review, now in it’s 7th edition, and as ever we would welcome any comment or feedback that you may have.

Nick Dussuyer is Willis Towers Watson’s Global Industry Leader for Natural Resources.
Willis Towers Watson Natural Resources Risk Index 2016 – key findings for the mining industry

Megatrends ranked in order

Geopolitical instability and regulatory change
- Mining markets increasingly politicized with a relentless focus on regulation
- Rise of resource nationalism

Risks resulting from digitalisation and new technologies
- Cyber attacks on mining infrastructure increasing in frequency and severity
- Technological innovation unlocking new resources

Complex operating models in a global business landscape
- Expansion into multiple jurisdictions – encountering new legal and regulatory environments

Business model and strategy challenges
- Volatility of mining prices
- Companies using diversification to future-proof their business

Workforce management and talent optimization
- Talent depletion following lay offs – leaving a skills gap and lack of succession plan
- M&A risks loss of key personnel

Top 10 megatrend risks ranked in order

1. Vulnerability to reclamation obligations
2. Increased complexity of regulation
3. Environmental policy uncertainty
4. Increased political risk
5. Reputation risk arising from social issues

1. Increased cyber security and data privacy risk
2. Technology opening up market place to disruptors
3. Risks emerging from new technologies
4. Inability to capitalise on automation of processes creating competitive disadvantage
5. Speed of change / slow innovation strategy

1. Operations in more technically challenging physical environments
2. Natural disasters and epidemics
3. Supply chain complexity and vulnerability
4. Increasing threats to stability of operations & trade
5. Workplace safety concerns

1. Currency and interest rate fluctuations
2. Increasing environmental pressure on business model
3. Volatility and depression in commodity prices impacting growth / investment
4. Increasingly complex asset portfolios & ecosystems
5. New entrants challenging traditional models of delivery

1. General shortage of industry specific skills
2. Difficulty attracting and retaining key talent
3. Lack of international mobility within workforce
4. Inability to maintain competitive compensation
5. Lack of safety culture

6. Resource nationalism
7. Regulatory approval for projects
8. Intellectual property and patent breaches
9. Active penalty culture
10. Bribery, collusion and corruption

6. Outdated legacy IT systems & infrastructure
7. Cost and operational impact of IT implementations
8. Insurability of unproven technologies
9. Third party security vulnerability
10. Increased usage of (own) mobile devices (“BYOD”) / Internet Of Things

6. Issues arising from operating in fragile ecosystems
7. Capital portfolios and projects suffering overruns in budgets and timelines
8. Risk of incident at facility that causes outage (e.g. fire, explosion, blow out)
9. Cost cutting causing increased risk
10. Ageing assets leading to risk of outage

6. Falling profits prohibiting investment
7. M&A and industry consolidation
8. Failure to deliver business transformation and / or diversification
9. Disruptive change to global supply-demand dynamics
10. Unmanageable increase in funding, liquidity and debt requirements

6. Unethical behaviour of workforce or direct representatives
7. Lack of potential business leaders and robust succession planning
8. Increasing difficulty complying with local employment laws
9. Ageing workforce and related health issues
10. Difficulty ensuring workforce security

Top 10 Metals & Mining risks ranked in order of importance / impact (across all megatrends)

1. Currency and interest rate fluctuations creating uncertainty
2. Increased cyber security and data privacy risk
3. Operations in increasingly technically challenging physical environments
4. Natural disasters and epidemics
5. Technology opening up the marketplace to disruptors
6. Vulnerability to reclamation obligations
7. Uncertainty over climate change and environmental policy
8. Lack of international mobility within the workforce
9. Difficulty in attracting and retaining key talent and skills for the future
10. General shortage of industry specific skills
Part one
Mining industry issues
Private equity and the mining industry

Despite another difficult year for the mining industry in 2015, Private Equity (PE) activity in the sector finally started to come to the boil. The reluctance of the equity markets to provide financing to mining companies in the face of a sustained slump in commodity prices has seen several specialist private equity firms step into the breach. With the trend likely to continue this year, mining companies are now actively looking to private equity firms as an alternative source of funding.

According to research by Berwin Leighton Paisner (BLP), investments totaling almost $3.2 billion were placed into mining projects in 2015, spread across 119 deals. This represented an increase of 57% compared to 2014 levels.

Firstly, we take a look at how and where this investment was spent in 2015 before getting to the bottom of the reasons lying behind this increase. We then evaluate what the PE sector can bring to the table for mining companies when investing, before offering some concluding remarks as to what the future development of this burgeoning relationship might look like.

Figure 1 shows recent examples of specialist mining PE firms building up significant resources of dry powder. So which commodities did PE firms prefer in 2015?

- **Gold** was the most popular commodity accounting for more than a third of the 119 deals.
- However, by amount invested, gold stood only at number three with **copper** attracting nearly $868 million of investment. These also tended to be higher value deals, as copper was the second most popular commodity by number of deals with 17%.

And which regions did PE investments fall into?

- **North America** saw the largest number of deals, with 40 deals (35%) raising $758 million, yet the value of these deals decreased by 25% in comparison to 2014.
- **South America and Africa** saw significant increases in levels of investment, suggesting that there was a determined focus on the emerging markets in 2015.
- **Europe** was somewhat of an anomaly, with just one major deal representing a massive increase of investment into this region.

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**Figure 1 – recent selected PE investments**

<table>
<thead>
<tr>
<th>PE Firm</th>
<th>Investment preferences</th>
<th>Fund value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2 Resources</td>
<td>Coal Assets</td>
<td>$5 billion</td>
<td>Mick Davis founded X2 in 2013 with other former executives of Xstrata. He raised about $5 billion from backers including Noble Group, private-equity fund TPG Capital and other sovereign-wealth and pension-fund investors in 2014.</td>
</tr>
<tr>
<td>Appian Capital Advisory LLP</td>
<td>Select Mining Projects and teams</td>
<td>$375 million + $800 million</td>
<td>Appian Capital manages $375 million in the main fund and determine a similar amount in co-investment. The company recently announced another $800 million fund</td>
</tr>
<tr>
<td>Denham Capital Management Ltd</td>
<td>Natural Resources Deals</td>
<td>$1 billion</td>
<td>Denham Capital Management has invested $3 billion in natural resources companies overall and $1 billion specifically into mining projects, as of December 2015</td>
</tr>
<tr>
<td>Waterton Global Resource Management</td>
<td>Precious metals projects and companies in North America</td>
<td>$1 billion</td>
<td>Waterton, a Toronto based PE firm received capital commitments of $1,016 billion in 2014. It plans to use that money for acquisitions, joint ventures and partnerships in the precious metals sector. The fund will focus on North American assets that are either in production or close to it.</td>
</tr>
</tbody>
</table>
Figure 2: Most favoured deals by base metal type

![Bar chart showing number of deals by metal type.](source)

*Assumption: Out of 119 deals which took place in 2015, 37 deals were refinancing and restructuring deals as such not included in this chart.

Figure 3: Deal region value by region y-o-y 2014-2015

![Bar chart showing deal region value by region y-o-y 2014-2015.](source)
### Figure 4: Selected 2015 PE Investments in the Mining Sector 2015

<table>
<thead>
<tr>
<th>PE Firm</th>
<th>Mining Company</th>
<th>Deal Value</th>
<th>Description</th>
<th>Type of Finance</th>
<th>Metal/Project</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterton Global Resource Management</td>
<td>Barrick Gold Corporation</td>
<td>$110 million</td>
<td>Waterton Global Resource Management reached an agreement whereby subsidiaries of Waterton Precious Metals Fund II Cayman, LP purchase Barrick Gold Corporation’s 70% interest in the Spring Valley project and 100% of the Ruby Hill mine for a total of $110 million in cash.</td>
<td>Acquisition</td>
<td>Spring Valley Project – 70% Ruby Hill – 100%</td>
<td>12 Nov 2015</td>
</tr>
<tr>
<td>Kohlberg Kravis Roberts (KKR)</td>
<td>Oz Minerals</td>
<td>$72.3 million</td>
<td>KKR’s acquired 10% of Oz Minerals for over AU$100m in October 2015.</td>
<td>Acquisition</td>
<td>NA</td>
<td>Oct 2015</td>
</tr>
<tr>
<td>EMR Capital &amp; Lighthouse Minerals</td>
<td>Aditya Birla Minerals</td>
<td>$10.75 million</td>
<td>Aditya Birla Minerals Ltd, a subsidiary of Hindalco Industries, sold its closed copper mine in Queensland, Australia, to Lighthouse Minerals Holdings Pty for A$15 million (Rs 70.5 crore) in cash and another A$41.7 million (Rs 196 crore) in rehabilitation bond costs.</td>
<td>Acquisition</td>
<td>Copper</td>
<td>21 Sep 2015</td>
</tr>
<tr>
<td>Audley Capital</td>
<td>Anglo American</td>
<td>$300 million</td>
<td>Anglo American sold two Chilean copper mines to investment firm Audley Capital for $300 million.</td>
<td>Acquisition</td>
<td>Copper</td>
<td>24 Aug 2015</td>
</tr>
<tr>
<td>Emerging Capital Partners</td>
<td>Central African Gold (CAG)</td>
<td>$15.2 million</td>
<td>Emerging Capital Partners (ECP), focused on investing across the African continent, invested U.S. $15.2 million in CAG.</td>
<td>Acquisition</td>
<td>Gold</td>
<td>20 Jul 2015</td>
</tr>
<tr>
<td>Magris Resources Inc.</td>
<td>IAMGOLD Corporation</td>
<td>$530 million</td>
<td>Magris Resources Inc. in partnership with CEF Holdings Ltd and Temasek, completed the acquisition of the Niobec mine from IAMGOLD Corporation for a total consideration of $530 million.</td>
<td>Acquisition</td>
<td>Niobec Mine</td>
<td>22 Jan 2015</td>
</tr>
</tbody>
</table>

Source: Willis Towers Watson
Reasons for increased PE investment

So what are the reasons behind these trends?

Slowing Chinese growth, now headed for its weakest pace in 25 years, has precipitated the end of the commodities super cycle. China was the main source of demand growth for industrial metals over the past 15 years and many mining operators had taken on crippling levels of debt in order to feed the Chinese appetite for raw materials. However, China is now switching to a consumer-led economy, causing commodity prices to drop as their demand declines.

Consequently, the mining industry is having a very difficult time keeping its head above water. In 2015 alone, oil prices halved, coal prices slumped dramatically and most commodities declined in value. The resulting cost pressures have meant that industry players have universally had to adapt to a new reality and has left some struggling to keep afloat. As a case in point, Anglo American over-extended itself during the super-cycle to such an extent that commentators suggest that it is now left with too much debt and too little money to sustain itself during leaner times. In December 2015, CEO Mark Cutifani said that Anglo American will eventually employ 50,000 people – 85,000 fewer than at its peak – and will control a maximum of 25 assets, down from 55. Among the potential casualties is Minas Rio, a Brazilian iron-ore mine where spiraling costs and collapsing prices turned a $14 billion project into the embodiment of the company’s difficulties. Other major companies have experienced similar problems. In 2015, BHP Billiton shares were down more than 60 percent and at seven-year lows, whilst Rio Tinto’s stock tumbled more than 40 percent. The combined market cap of 95 major mining firms around the world has dropped below $400 billion – a far cry from the peaks of $1.8 trillion hit in April 2011.

Mergers and Acquisition (M&A) levels in mining are consequently at a record low. The value of completed transactions across mining and steel fell to about $54 billion last year, from $98 billion the year before and as high as $224 billion in 2006, according to data compiled by Bloomberg. EY reported that only 358 mining deals were completed in 2015, representing a decline of 34% on 2014.

With all this turbulence and uncertainty in the sector, the public markets are no longer willing to fund the mining industry. All of this – the highly leveraged balance sheets of mining companies, China’s economic slowdown and the volatile commodity prices – has meant that mining companies are finding it extremely difficult to use the public markets as a source of funding. With the downturn in fortune for the industry, conventional mining investors are looking to alternative sectors, leaving a void of funding in the industry.

It seems that capital market investors just don’t have the time to wait out the downturn. For example, in 2013, the mining sector raised an estimated $2 billion on the public markets in Canada according to the Canadian Imperial Bank of Commerce (CIBC), down nearly 80% from the five-year average. Overall, capital raised across the sector was down by about 10% year-on-year. The decrease was primarily due to a sharp drop-off in loan finance to the sector, which fell to $44 billion in 2015 from $122 billion in 2014.

As we have seen earlier in this feature, PE firms are stepping into the void and mining companies are increasingly looking to them as necessary alternative forms of investment.

What do PE firms bring to the table?

Not only do PE firms represent a vital source of new funding for mining companies, but several commentators have argued that they offer several advantages over traditional sources of investment:

PE provides long term capital that matches up with the long term requirements of the mining industry.

Many present issues for mining companies are driven by the lack of access to long term funds, which can result in business decisions that are geared towards creating short term benefits. However, unlike asset management firms or retail investors, PE brings access to long term capital. With a fund life that can span 7-12 years, PE firms can afford to wait out the downturn in the commodity markets, providing capital across the business cycle and allowing management teams to dedicate their time to developing projects rather than on investors, public relations and fundraising. Long term funding also allows management to make decisions that may have a short term negative impact - such as shutting down a mine - in favour of creating long term value.

Another factor at play is that during a period of significant change in the mining industry, the investor base behind PE firms tends to be large pension funds and other institutional investors rather than retail investors, who are in turn are able to commit to funds for the longer term and can afford to be patient.

In addition, PE firms that invest in mining tend to have flexible investment models that are different to the traditional private equity leveraged buyout model. According to BLP there has been an increase in complex private equity deals in the mining space, with 11% of transactions having exposure to the underlying commodity, through mechanisms such as royalties in 2015.
PE firms therefore have a full range of financing and structuring options available to them, allowing them to make many different types of investments such as joint ventures and asset purchases, as well as equity investments or structured financing. There is a current preference within the private equity space for later stage developments; however, niche players exist that focus on earlier-stage projects or distressed assets.14

**PE firms can help with operational and productivity improvements in the new mining landscape.**

According to a McKinsey report, worldwide mining operations are 28% less productive than 10 years ago, which was a period of high demand and an expansion in production of over 50%. This drop in productivity is affecting the profitability of the mining industry; as such, there is a distinct focus on raising productivity across the sector as a whole.15

Beyond capital access, private equity also has the ability to support businesses with their growth strategy, providing input into management teams. A PE firm may take an active role in the company by taking on a board level position;16 in addition, PE firms can offer invaluable support through their network of portfolio companies.17

Mining companies’ management teams can also benefit from a private equity firm’s financial and operational skills to make changes to their operations.18

**PE can help secure a Social License to Operate.**

PE firms are also starting to buy more into ‘ethical investing’. While they have generally perceived to have lagged behind public companies when it comes to recognising the importance of successfully managing environmental, social, and governance (ESG) issues, they are now incorporating these matters into their business model.19 In a recent survey by PwC, 90% of respondents from the PE industry believe that “ESG activities can create value” and 94% think their attention to these issues will rise over the next 5 years.20

This new found attitude can be useful to mining companies for whom it is imperative to secure a ‘Social License to Operate’ (SLO) – the ‘level of acceptance or approval by local communities and stakeholders’ mining companies and their operations should attain before it starts to operate.” 21 Indeed, private equity has seen an increased focus on “identifying and mitigating ESG risks through the industry’s granular due diligence process and by installing hands-on governance and oversight practices.” 22

This has similarly been fuelled by the availability of experienced management teams. Where once a lack of expertise in the ESG arena was a reason for mining companies to be wary of PE investment and a barrier to entry, private equity now has access to talent that understands the complexities of a mining project and the important need of securing a SLO.

**However, a few reasons for caution remain when mining companies are thinking of accepting PE investment.** Historically, PE firms have chosen not to invest in mining companies as they lacked the technical expertise required to add value and see any real investment returns. Indeed, the complexities involved with evaluating the merits of a ‘good’ mining investment have long been a barrier to entry for private equity firms, who are reluctant to invest in a sector they know very little about.23 While many have recognised this weakness and promptly recruited specialists from the mining sector (particularly given the opportunities made available by low commodity prices), mining companies might encounter PE firms without the required level of knowledge to properly evaluate and accurately value a mining investment.

Another reason why mining companies might want to pause for thought before embarking down the PE route is that their approach can be very hands-on. Usually, PE firms will hold a seat on the board of their portfolio company.24

In addition, PE firms are clinically focused on their bottom-line and commit to this level of involvement with the aim of maximising returns. This can lead to frustration from management of the mining company, who, used to a high degree of autonomy, are not accustomed to so much interference.25

According to a managing partner at Brookfield Asset Management, the “direct relationship between a portfolio company and private equity can be intense,”26 which highlights how both the private equity firm and the portfolio company must work towards meeting the objectives of their respective stakeholders, which can cause clashes of opinion. The way forward is for the two entities to embrace their different working styles, as mining investments have the potential to offer rewarding opportunities.

**The future outlook for PE investment in mining**

So what lies in store for the future outlook for PE investment into the mining industry? Three key themes can be identified:

**PE firms will build on their mining portfolios by investing into juniors.**

PE financing and junior mining companies appear to be a particularly good fit. The high-quality managerial skills that we have seen PE firms can offer are useful to juniors who lack the time or expertise to realise value in the current environment of low commodity prices.
As one commentator puts it, “Securing PE funding for the long-term enables the junior miner to balance out short-term risk of market volatility and to take the asset up the value curve through a systematic and structured development and implementation plan, without the fear of funding shortfalls.” 27 The fact that several PE firms have hired geologists can only help matters when it comes to investing in early stage assets.

There will be a focus on the emerging markets. PE investment is also very well suited for the emerging markets. Africa is especially ripe for deals to be made, given the large number of prospects available for investment alongside a long-standing dearth of financing opportunities for mining companies.28 Of the five largest global diversified mining companies, only one has a major share of its production in Africa. With the help of PE, junior mining companies are set to continue to play a significant role in developing the continent’s resources.29

Mining companies will become more adept at specifically marketing themselves towards PE investment. Given that numerous sources of PE funding now exist, and given the severe financing problems that parts of the mining industry are facing, PE investment looks set to become more of a fact of life for the industry than ever before. Mining companies, especially juniors, will start to adapt their business models further and actively encourage the PE firms to invest. While some companies will remain reticent to sell to PE30, those who do adapt might well have the best opportunity to build sustainable businesses through the commodities slowdown.

Silvi Wompa Sinclair is based in London and is responsible for Willis Towers Watson’s Private Equity and Corporate M&A client development across the UK, EMEA and Asia Pacific, including new and cross-sales generation, value proposition development and production of thought leadership.

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The Social License to Operate (SLO) and the mining industry

Why the need for an SLO?
Over the past few years the mining industry has attracted concerns over environmental and social matters. Particularly in developing regions such as South America and Africa, where mining is prevalent, the industry is seen to be having a “negative impact on human rights, communities and the natural environment.”¹ In response to this, the sector has adopted the concept of a ‘Social License to Operate’ (SLO), which “refers to the level of acceptance or approval by local communities and stakeholders of mining companies and their operations.”²

What is an SLO?
A SLO is not a formal agreement; rather it can be more broadly thought of as a more established form of Corporate Social Responsibility. Companies operating in the mining sector have discovered that if social and environmental matters are managed appropriately, and with a community focus, they are far more likely to obtain Government agreement to carry out activities with a minimum of interference.³ A mining operator therefore has a responsibility to act ethically by limiting environmental damage and creating social and economic opportunities for the local community, rather than acting in a way that might continue to dampen the mining industry’s reputation.⁴

The benefits
Operating in a sustainable manner has clear benefits for investors, while the potential consequences of not obtaining a SLO can be very expensive. For example, research shows that community conflicts over environmental and social concerns can incur costs up to $20 million a week in operating expense for large-scale operating mines.⁵ Inadequate management of both environmental and social impacts can incur fines for mining companies, but this is nothing compared to costs associated with suspended permits, a very real probability if operators decide to ignore their impact on the local community.

The importance of sustainability
In a recent study, more than 80 percent of companies in the mining sector reported that they are changing their business model due to concerns over sustainability, while 96% said that sustainability was a permanent topic on their management agenda.⁶ Institutional investors are realising the importance of a company’s sustainability strategy and how they respond to environmental threats. This is not limited to socially responsible investors, with many mainstream institutions using sustainability performance as a key indicator of business value.⁷ For example, 7 out of 10 institutional investors interviewed by PwC say they would decline to take part in a private equity fund raising or would turn down a co-investment on environmental, social and governance risk grounds.⁸
The emergence of “ethical investing”

‘Ethical investing’ has now become a reality; Private Equity firms, who are generally perceived to have lagged behind public companies when it comes to recognising the importance of successfully managing environmental, social, and governance (ESG) issues, are now incorporating these matters into their business model. Investors have seen that recognition of ESG issues can bring cost-saving potential, an enhanced competitive position and regulatory benefits. In a recent survey by PwC, 90% of respondents from the PE industry believe that “ESG activities can create value” and 94% think their attention to these issues will rise over the next 5 years.

More effective risk management

A key feature of private equity is that the firms have the capability to identify and manage risks much more effectively than others, which is why those investing in the mining sector have responded with solutions such as a SLO. Indeed, private equity has seen an increased focus on “identifying and mitigating ESG risks through the industry’s granular due diligence process and by installing hands-on governance and oversight practices.”

This has similarly been fuelled by the availability of experienced management teams; where once a lack of expertise was a barrier to entry, private equity now has access to talent, meaning they base their project selection on an understanding of all the technicalities involved with these sorts of complex risks.

The significance of emerging markets

Effective management of ESG issues are most pertinent when investing in emerging markets, as investments have the ability to impact local communities on a larger scale than in developed economies. Developing markets tend to place a much higher significance on environmental and social factors and mining activities have historically operated in areas where these matters are of extreme importance to local communities.

As private equity investors have access to financial resources where they would otherwise be scarce, they can generate a real social impact in emerging markets. Using industry best practice and by improving management and operational techniques an investor is much more likely to attain a SLO and to gain the trust of the local community.

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3D printing and the mining industry

Introduction – what is it and how does it work?

Additive manufacturing (AM) technologies are quickly moving from theory to reality for many industries, and mining could be the next in line for transformation.

Perhaps better known as “3D printing”, AM is the term used in the manufacturing industry for the process of adding metal layer by layer, then fusing the metal together to create a part or component. Initially used for fast prototyping, AM is now also being used to manufacture parts on-demand as well as scanning and printing hard-to-find or obsolete replacement parts.

Put simply, additive manufacturing is a method of producing a component layer-by-layer from a digital 3D model and a flowable material. A simplified illustration of the process can be seen in Figure 1.

The 3D model is transferred to a different file format, in which it is “sliced” and sent to the AM machine one layer at a time to be built. Once the part is built and removed from the machine, only the post-processing stage is left to be completed before the final product is good to go.

Technological advancements in recent years mean that many different materials, in either liquid or powder form, can now be printed. These materials include plastics, ceramics, resins, metals and even human cells.

Applications and benefits for the mining industry

The biggest benefits that the mining industry could derive from additive manufacturing come from efficiencies and cost savings in its supply chain in three areas: component design, on-site manufacturing, and lean process.

1. Design freedom

Traditional manufacturing constraints no longer apply when AM is employed, giving designers a freedom in their work that was previously unavailable both geometrically and chemically. This new freedom at the design stage means that not only can existing parts for mining operations be optimised, but entire components can now be completely reinvented to create more efficient solutions.

Complex designs including lattices (see Figure 2 overleaf) and parts with moving components can be built in AM machines from a controlled mix of metallic powders to create alloys that would otherwise be very difficult to produce. Existing designs can also be modified in digital file format to print customised products without changing the manufacturing process. These modifications provide the opportunity for design optimisation through efficient designs and the weight reduction of parts using, for example, a honeycomb structure. This is particularly beneficial for equipment with rotating parts, such as pumps and compressors, where a reduction in weight leads to a reduction in the fuel required.

Taking advantage of the additive manufacturing process capability at the design phase can result in the production of parts using less material but without compromising integrity, and an increased product complexity, functionality and efficiency.

Figure 1 Generic AM process

![3D CAD model → .stl file → 3D printer → Post processing → 3D object](image)
2. On-demand manufacturing

The transport of replacement parts to remote mining sites combined with inventory requirements onsite can be extremely costly. These are costs that can be reduced, and in some cases entirely eliminated through on-demand additive manufacturing of parts and tools. The shortened supply chain - due to fewer manufacturing process steps - reduces the lead time from weeks or days to hours, lowering the required inventory level on-site.

An example of this is of agitator seals in autoclaves. These are currently commonly made from titanium, and are fast wearing. In extreme circumstances the titanium could catch fire, leading to catastrophic failure. Tantalum is metal much better suited for this purpose, as it is corrosion resistant and isn’t combustible. Using traditional subtractive manufacturing methods (i.e. machining to create the desired geometries from solid materials), a tantalum seal would be cost-prohibitive to make, as not only is a tantalum block expensive, but it is also hard to source. Using AM, a seal could be printed using tantalum powder, or using stainless steel clad with tantalum.

Other components to be positively affected by the evolution of AM might include catalytic reactors, heat exchangers and valves.

3. Lean process

Compared to subtractive manufacturing, the material required for the manufacturing of components is much reduced. Not only can the amount of material be minimised through designing for AM, but waste is also kept to a minimum with much unused material being recycled/re-used. This material efficiency, the reduction of manufacturing steps and the potential for printing in different material types will result in a leaner, greener method of manufacturing.

4. AM Powder

AM also introduces the ability to produce components from alloys which have been previously impossible to work with using traditional manufacturing methods. In fact, in some cases these alloys have not even been able to be produced previously.

The powder is one of the most important parts of the AM process and can have a significant effect on the quality of the final product. For this reason, robust controls at every stage of the process are critical to prevent non-conforming parts entering the supply chain.

At the moment only 1-2% of the total metal powder production is utilised for additive manufacture. The increasing use of AM will mean that the requirement for powder will start to grow strongly and will represent a significant opportunity for mining companies.
Ongoing AM research (mining):

- South Dakota School of Mines & Technology is focusing their research on laser powder deposition/DED at their Additive Manufacturing Laboratory
- Colorado School of Mines has recently been awarded a $2.5 million grant that will be used in a new laboratory focusing on understanding and optimizing nickel and titanium 3D printed parts.

Challenges and limitations

Currently, the largest barrier preventing this technology from reaching its full potential is product safety assurance. The development of standards to assist with the certification of safety critical AM produced parts is in progress, with several ISO/ASTM standards already in use. LR, jointly with TWI, has published the first edition of goal-based Guidance Notes for Additive Manufacturing, helping to bridge the gap whilst standards are still in development. While research and development continues in this area, there is now an established pathway to certification to prove product safety through tailored test plans.

Other limitations concern AM machines, which are currently fairly costly. The size of the machine also dictates and limits the maximum size of components it can make. Post-processing, such as hot isostatic pressing and heat treatment, may also be required after manufacture. The surface finish too may require extra work should the product specification require a smoother finish than can be achieved on the AM machine used. Furthermore, the raw material supplied is to be carefully handled, with tightly controlled parameters in order that the final product properties are sufficient, creating a challenge for powder suppliers. However, as with all technologies these limitations are becoming less of an obstacle, as sophistication around the subject is increasing and the available equipment is now more varied and cheaper.

Lack of knowledge and a fear of exploration into new technologies are factors that still hold back many manufacturers from using AM. As with any technology, it takes time to upskill personnel and to introduce the technique into all industries.
AM in the near future

Self-contained AM facilities in shipping containers and on-site manufacturing is not far away, disrupting industrial processes and revolutionising supply chains. New designs and alloys could be in use over the coming years and the potential cost savings could be significant in the long term.

Meanwhile, standards committees (particularly ISO and ASTM) are in the process of developing standards specific to AM. LR and TWI’s joint industry project to certify AM parts, will investigate the requirements that must be met for approval and help assure end users that printed parts are safe.

This is a fast moving technology, impacting all areas of industry. Globally, companies and institutions are investing in research into all aspects of AM; governments have given funding towards projects and there are numerous conferences and events for companies to showcase their expertise on the subject and attract interest throughout many industries. It is anticipated that even more capabilities will be discovered and enhanced, which will broaden the range of applications even further, allowing more industries such as mining to benefit from this new technology.

Conclusion

Overall, since AM is fast becoming the most economical and efficient option for various parts across many industries, the question turns from if AM will be incorporated into a company’s manufacturing processes, to when it will do so.

This technology presents a fantastic solution for the mining industry to allow for design freedom and improvement efficiency in manufacturing with material use, time and cost. It can be seen from this analysis that 3D printing may significantly lower not only the chances of an accident materialising at a mine but also the financial consequences of an accident, including lower replacement costs, shorter replacement times and consequently lower Business Interruption claims.

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Part two
Managing mining industry risk
Managing tailings dam and open pit risk – when things go wrong

Mining is all about safely extracting and processing minerals from the earth’s crust to profitably recover the metals and minerals we need to sustain our way of life. The emphasis here is on safety but the very process of mining is hazardous if not done properly. Moreover, the mineral recovery process generates waste products such as tailings that need to be disposed of and, unfortunately, the mining industry has repeatedly shown its inability to do this safely. While this article will mainly focus on the risks and issues associated with manmade structures designed for storing tailings it will also attempt to illustrate what can go wrong when we fail to understand the nature of the rockmass in which open pit mines are excavated.

What are tailings?
Tailings typically refers to a fine grained slurry of gangue particles which are left after the valuable components of ore have been extracted. Water content is typically in the order of 50% by volume with particle sizes varying according to the minerals being processed and the processing methodology used. Typically, tailings particle sizes range from less than 1mm down to, in some cases, less than 50 microns. Tailings are most commonly disposed of by impoundment in dams where, unfortunately the high water content required for hydraulic transport from the processing plant to the storage facility also contributes to the challenges of safe storage.

It is not normally an economic proposition to dry tailings before transport to a storage location (although they are sometimes dewatered and converted into a paste for underground disposal or where water use restrictions or the physical nature of the site make conventional impoundment impossible). Putting aside the less commonly used storage methods of dry stacking and underground disposal, let’s consider some aspects of conventional tailings storage in purpose built dams.
Although the database is incomplete, there is sufficient public domain information available to recognize that historically, the mining industry’s record on tailings dam construction and operation has been poor. In fact, it is likely that the industry’s historical performance prior to the advent of the internet was even worse than available information suggests because of inconsistencies in reporting requirements and reluctance in some jurisdictions to broadcast bad news.

According to an article in the December 2010 issue of Geotechnical News, during the 50 years to 2010 there were 193 recorded major tailings impoundment failure events, or an average of almost 4 per year.1 However, during the decades of the 1990’s and 2000’s there appear to have been improvements in the management of tailings disposal with average annual failure rates declining by half.2 Despite this apparent improvement, a US based research organization predicted in July 2015 that during the current decade there will be 19 major failures categorized as catastrophic and the estimated total cost of these failures is put at USD6 billion, most of which will be unfunded or unfundable.3 This cost estimate is based on court records and other official documentation which describe government efforts to collect clean-up and recovery costs from parties who walked away or were unable to pay for the damage caused.

While the cost to industry of cleaning up the mess has been large, there has also been an unacceptable loss of human life; about which more later.

Causes of failure

What about the causes of failures? Impoundment failures are sometimes the result of events that have their origins months and even years before the failure event. Therefore, the causes are not always easily or confidently determined. Moreover, and not surprisingly, mine operators and owners may be reluctant to release information about a failure and its causes, particularly if the matter is subject of ongoing legal action. The Geotechnical News article referred to earlier stated that of the 20 failures that occurred between 2000 and the end of 2009, 40% were due to unusually high rainfall, 30% could be attributed to management issues and 10% each to slope instability and seepage. One failure was attributed to a structural failure.

For cost reasons tailings impoundments are typically constructed to take advantage of topographic features such as depressions, existing drainage channels and valleys which can be closed off by means of one or several retaining dam walls to create a basin in which tailings can be deposited and stored. Also for cost reasons, retaining walls are rarely, if ever, constructed of concrete as would be the case, for example, of an hydroelectric dam. Rather, retaining walls may be constructed as free-standing structures made of carefully compacted local borrow material and mined waste rock. Alternatively, an impoundment may be created by passing the tailings stream through a cyclone and separating the coarse fraction which is then used as wall building material. In this case the building process is continuous with the coarse fraction being used to create and progressively raise a carefully designed embankment behind which the finer “slimes” fraction is stored. (This is sometimes referred to as “upstream” construction because the crest of the retaining wall progressively moves in an upstream direction as cyclone tailings are added to the upstream side of the crest).

For cost reasons, retaining walls are rarely, if ever, constructed of concrete as would be the case, for example, of an hydroelectric dam.
While the use of coarse tailings to build retaining structures offers a practical and economic solution to tailings disposal, it is not without its risks. Having removed the coarse fraction for construction, the remaining, mostly fine tailings may take years and even decades to settle and consolidate. Since this timeframe may extend well beyond mine closure there will be an on-going, long term requirement to monitor and manage the tailings storage facility long after cash flow from mining will have ceased. A retaining wall made of coarse tailings may also be susceptible to seepage and careful monitoring will be required to prevent surface and groundwater contamination and possible degradation of the impoundment's integrity. The quality and strength characteristics of an impoundment built with coarse tailings will depend on keeping the particle size split within tight design parameters; hence the quality and diligence of human control brings another important dimension to dam construction.

Seismic risks should not be overlooked and unless carefully designed, an impoundment constructed of coarse tailings may be susceptible to liquefaction and instability during an earthquake event.

Now, back to the causes of failure.

Unusually high rainfall as a cause of dam failure. Because tailings storage basins generally have a large areal footprint it is important to control the additional water that enters the basin either as direct rainfall or as surface run-off from a surrounding watershed. In an extreme storm event the rate of water level rise may exceed the ability of a spillway or pumping to prevent the dam overtopping. In the case of an earthen dam or retaining wall constructed from coarse, cycloned tailings, overtopping can lead to erosion and eventual failure of the retaining wall with potentially disastrous consequences.

Recognition that climate change is causing an increased probability of occurrence of exceptionally high rainfall events has resulted in changes to dam design criteria that were not considered necessary 20 or 30 years ago. Another consequence of more frequent, high rainfall events is that water balances calculated more than a decade ago may now be unrealistic. Put another way, the risk assumptions that provided the framework for design and management of older dams may now have been invalidated by changing weather patterns and as a consequence risk profiles will have changed.

The human factor
The statistics show that a significant number of tailings dam failures can be attributed to the way the dams are operated and managed. From experience and at the risk of generalizing, there is a tendency for tailings to receive less management attention than other mining and mineral processing activities.
This may be because tailings storage facilities are perceived to be the unexciting culmination of a more interesting and often challenging mineral recovery process. Additionally, because tailings storage facilities are often remote from the main centres of mining activity and designed for long life, they are at risk of being forgotten about until a problem arises, at which point and albeit too late, they tend to focus the attention of everyone from Boards of Directors to mine management and the media.

An example of mine management apparently paying insufficient attention to tailings storage relates to a base metal mining complex in Eastern Europe that has been using the same tailings facility for over 40 years. With less than 3 years of storage capacity remaining and additional mining capacity coming on stream, management belatedly realized it had a problem. In this case there was no provision, either in terms of location, cost or time to permit, for the construction of the urgently needed additional tailings storage capacity. A further complicating factor was that population encroachment had resulted in potentially suitable alternative sites being not only far from the process plant but also located in environmentally sensitive areas. The risk was that a hastily and inadequately engineered solution would be quickly implemented and environmental protection measures short circuited in a last ditch attempt to keep the mining complex operating, thereby preserving thousands of jobs.

In another case, investigation into a very large and environmentally damaging tailings dam failure in North America found that there had been indications of potential problems nearly 18 months before the failure but a long standing shortage of labour had prevented the necessary regular monitoring of the facility. Had the proper monitoring and inspection been done by suitably trained technicians the mining company might have saved itself significant reputational damage, sanctions, restitution costs, penalties and fines.

Investigating the relationship between market cycles and tailings dam incidents, Davies and Todd suggested in their 2009 paper that some tailings dam incidents may be attributable to the indecent haste of certain mine owners/developers to bring new mines into production or to reopen old ones to take advantage of a commodity price boom.4

The increased demand for design consultants driven by strong commodity prices resulted in less competent but enthusiastic players picking up the slack that the limited number of more experienced and competent design specialists and consultants were unable to satisfy. The net result was in some cases, overly optimistic design assumptions, leading to sub-standard dam design exacerbated by inexperienced tailings dam operators.
Consultant engineer error

Tailings dam design is generally the domain of expert consulting engineers who will utilize their experience and latest technology to design fit-for-purpose structures that can safely contain the planned tailings loads and remain stable for many decades after mine closure. (In some jurisdictions the stability timeframe criterion may be as much as 10,000 years though it is difficult to imagine anyone being able to plan with any degree of confidence for conditions a century from now, let alone 100 centuries hence).

Because they are human, consultants are not immune to making mistakes and, as an inquiry into a recent major tailings dam failure in North America determined, the fact that the mining company relied upon a consultant to design and build the dam does not liberate the mining company of responsibility for a failure. In this example, it was determined that the consultant had failed to identify the presence of a clay layer below the retaining wall foundation. As the retaining wall was progressively raised in line with design and standard operating procedures, so the weight on this underlying clay layer increased. The clay layer gradually deformed and eventually suffered sliding failure which ruptured the retaining wall. A small initial breach was rapidly enlarged by the flow of escaping slurry which eventually resulted in the release of about 7 million m$^3$ of tailings slurry causing massive environmental damage, a large fine and huge reputational damage. This event provided the industry with some salutary lessons which it would be wise to apply.

Construction of a large open pit copper mine in the Andes was about half way complete when a significant geotechnical feature was discovered in close proximity to what would be the retaining wall of the future tailings storage facility. Reasons for the late discovery may have been unfounded optimism during the pre-feasibility study and failure to adequately investigate the site in the feasibility study planning stages. The consequences included significant, unbudgeted expenditure for additional detailed geotechnical drilling, extensive re-design and, most expensive of all, project delay.

Earthquakes

Many mines are built in seismically active areas and it might be assumed that earthquakes are a significant cause of tailings dam damage. In fact, during the period 1910–1999 earthquakes accounted for about 14% of recorded failures whereas no failures were attributable to earthquakes in the period 2000–2009. This apparent improvement can probably be put down to improved understanding of seismic dynamic loading and liquefaction phenomena combined with more stringent design and operating criteria than in the past. The use of state of the art modelling and simulation techniques has certainly been a significant factor in design improvement.

Figure 3 – An aerial view of the retaining wall failure at Mt Polly in British Columbia, Canada, taken from inside the basin. Tailings slurry flowed through the breach towards the top of the image and continued downstream stripping vegetation in its path and contaminating a lake and a many kilometres of river system. (Photo credit: Screenshot from Cariboo Regional District video)
While earthquake damage remains a risk, recent events in Chile suggest the absence of earthquake induced failures is the result of improvements in tailings dam design and operation. Chile has, of course, some of the largest mines in Latin America producing correspondingly large volumes of tailings.

In 2010 a magnitude 8.8 offshore quake south of Santiago caused a tsunami, widespread damage to property and infrastructure and killed an estimated 500 people. No damage was reported to any of the several tailings dams in the area where the earthquake was felt though a number of smaller municipal water and waste storage facilities suffered seismically induced damage.

In 2014 a magnitude 8.2 quake, again offshore and in this case close to the port of Antofagasta in northern Chile caused extensive damage, created a state of emergency as large numbers of people were evacuated to high ground and resulted in 5 deaths. Despite the devastation to the city and its infrastructure no damage was reported to any of the tailings impoundments located at the mine sites in Antofagasta’s hinterland. Between these two major events there have been frequent lesser magnitude earthquakes and no reported quake related damage.

Improved design and operating procedures have no doubt reduced the risk of seismically induced liquefaction but risks remain from seismically induced geotechnical failures. Examples of such risks may include rock mass displacement on a deep seated geological fault that weakens a retaining wall; or, a seismically induced landslide that causes debris to flow into the dam creating a slurry surge that overtops the retaining wall. These examples underscore the need for holistic risk assessment including thorough geological and geotechnical investigation, not only in the immediate area of the impoundment and retaining walls but also in the wider, surrounding area.

**Lined tailings impoundments**

Thus far we have considered the causes and consequences of failure of impoundment retaining walls which result in the sudden release of large volumes of slurry. Tailings impoundments may also suffer from slower and often invisible releases of contaminants to the environment which can be equally damaging and sometimes take many years to reveal themselves. Tailings are made up of not only valueless gangue but also contaminants that have been removed from the valuable component of ore. These contaminants will vary according to the ore being processed and may contain acid generating sulphides, iron and various oxides, aluminium, arsenic, mercury, heavy metals and residual amounts of mineral processing reagents. Over time these contaminants may leach and go into solution which, if not carefully contained, will find their way into groundwater.

In the past, tailings dams were rarely lined but as environmental controls became more stringent the use of impermeable liners has become more widespread and today it is rare to find a new tailings basin that is not lined. Liners may take several forms including the use of a carefully placed and compacted inert clay layer. A widely used form of lining is a chemically inert, UV-resistant, flexible membrane. Typically made of HDPE plastic, membranes vary between 1.5 – 2.0mm thick and are generally supplied in rolls up to 3m wide.
The membrane is flexible and can be rolled out onto a smooth, pre-prepared surface which must be free of any sharp protrusions that could pierce the membrane and cause a leak.

Sheets are welded together, edge-to-edge by running a portable electric thermo-welding device along the edges to be joined to create a continuous, impermeable double welded seam. Given the large areas involved, the cost of lining a tailings basin is significant and since even a small leak can render the whole exercise useless, surface preparation, liner placement and welding must be carefully quality controlled. It is worth noting that although the consequences of a leaking liner may be significant, tailings will tend to settle and consolidate over time, effectively becoming self-sealing.

There is little information and few statistics in the public domain about leakage from tailings storage facilities that cause groundwater contamination yet it would be reasonable to assume that increased, indeed sometimes mandated use of impermeable liners will have helped reduce this risk.

Some sobering statistics

It’s not just the larger mines
Public domain information shows that tailings dam failures are not restricted to very large, high tonnage operations. A recent paper by Bowker and Chambers (2015) suggests that in the period to 2020 high impact, high volume failures are likely to occur at mines originally commissioned in the 1970's and 1980's that are now operated by smaller mining companies. The reasons for future failures are likely to include; old storage facilities being pushed beyond their original design parameters, lack of operating expertise and a shortage of funds that causes operators to stretch the risk envelop (and hope to get away with it). We should not think that tailings dam failures only occur in less developed countries.

It’s not just the third world
According to Azam and Li writing in the December 2010 issue of Geotechnical News, of the 20 recorded major failure events between 2000 and the end of 2009, 25% occurred in North America, 30% occurred in Europe, another 30% occurred in Asia and 5% in Africa.

It is worth pointing out that with roughly the same number of mine sites as Asia and Africa combined, no failures occurred in Australia during this period. Azam and Li do not offer an explanation but it could be because of Australia’s stringent regulatory framework which governs both design and future operation of tailings storage facilities and which consequently is making designers cautious and is keeping mine operators honest! A possible explanation for the high proportion of failures in Europe is given, due to the improved level of reporting from former Soviet Bloc countries which now fall under EU regulatory and environmental reporting rules. To put the North America statistic into perspective, 25% represents 5 events which occurred in a population of over 8,500 mine sites where tailings are stored.

Over the last five years (2010 – end 2015) there have been two very large failures with related deaths in Brazil; one non-fatal event in Mexico that affected about 800,000 people; and the Mt Polley breach in Canada mentioned previously which caused massive environmental devastation. There were also two large scale, non-fatal failures in the US. During the same period there were at least another half dozen failures that resulted in relatively minor damage and no fatalities.

The following table summarizes the effects of some of the more destructive failures over the last 10 years.
<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Samarco Mineração SA, Minas Gerais, Brazil</td>
<td>At least 17 dead, 35 million m³ of slurry released inundating of 660 km of river and 15 km² of agricultural land.</td>
</tr>
<tr>
<td>2014</td>
<td>Herculano Mineração Ltda., Minas Gerais, Brazil</td>
<td>At least 2 workers killed.</td>
</tr>
<tr>
<td>2014</td>
<td>Buenavista del Cobre, Cananea, Mexico</td>
<td>River contamination that affected 800,000 people.</td>
</tr>
<tr>
<td>2014</td>
<td>Mount Polley, British Columbia, Canada</td>
<td>21 million m³ of tailings released into local river and lake. No fatalities.</td>
</tr>
<tr>
<td>2013</td>
<td>Obed Mountain Coal Mine, Alberta, Canada</td>
<td>760,000 m³ of coal waste and slurry released into local creeks and the Athabasca River.</td>
</tr>
<tr>
<td>2012</td>
<td>Philex, Benquet, Philippines</td>
<td>About 13 million m³ of copper tailings released as a result of exceptionally heavy rain.</td>
</tr>
<tr>
<td>2012</td>
<td>Talvivaara Mine, Finland.</td>
<td>Hundreds of thousands of cubic meters of uranium tailings released into environment.</td>
</tr>
<tr>
<td>2010</td>
<td>Kolontar, Hungary</td>
<td>700,000 m³ of caustic red mud released causing extensive flooding and contamination over 8 km² with 10 fatalities and 120 injured.</td>
</tr>
<tr>
<td>2009</td>
<td>Magadan, Russia</td>
<td>About 1.3 million m³ of gold tailings released which destroyed 11 homes and killed at least 1 person.</td>
</tr>
<tr>
<td>2009</td>
<td>Huayuan, Xiangxi, China</td>
<td>A land slide caused failure of a manganese tailings impoundment which resulted in at least 3 deaths.</td>
</tr>
<tr>
<td>2008</td>
<td>Tennessee Valley Authority, Harriman power plant, USA</td>
<td>Failure of the retaining wall of a coal fly ash storage dam released 4.1 million m³ of ash slurry, destroyed power lines, ruptured a gas pipeline and damaged homes. No fatalities.</td>
</tr>
<tr>
<td>2008</td>
<td>Taoshi, Shanxi, China</td>
<td>Collapse of an illegal iron ore waste storage facility resulted in at least 254 deaths.</td>
</tr>
<tr>
<td>2007</td>
<td>Mirai, Minas Gerais, Brazil</td>
<td>A bauxite treatment residue pond failed after heavy rain spilling 2 million m³ of red mud and leaving about 4,000 local residents homeless.</td>
</tr>
<tr>
<td>2006</td>
<td>Zhen'an, Shaanxi, China</td>
<td>Gold tailings dam failure damaged homes and resulted in at least 17 local residents reported missing and about 5km of a major river being contaminated with potassium cyanide.</td>
</tr>
</tbody>
</table>

Source: Willis Towers Watson
Globally, environmental groups, NGOs and environmental protection agencies are increasingly playing an important and often obstructive role in determining how and where mine operators may dispose of and store their tailings. For this reason mining companies and mine developers will be well advised to engage with these groups at the earliest possible stages of planning not only to accommodate legitimate concerns but also to smooth the permitting process which invariably requires extensive consultation with an often uncertain timeframe.

**Difficulties of assigning accurate failure risk**

Although the public domain database of tailings impoundment failures and their causes is incomplete the internet and availability of satellite imagery have made it difficult to “hide” a failure. Nevertheless, the relatively infrequent occurrence of failures means there is insufficient data for any sort of actuarial assessment of whether a particular impoundment will fail (unless, of course, specific design flaws or signs of failure are detected by inspection and monitoring). As a result it is not yet possible to reliably assign a risk of failure to an individual tailings storage facility though we are able to estimate the economic and social consequences if it should fail.

Having discussed tailings let us now turn to pit slope stability which is another aspect of mining where the consequences of getting it wrong may be disastrous.

**Open pit slope stability**

Safe open pit mining relies on the sidewalls of a pit staying in place despite the effects of blasting and external influences such as earth quakes and heavy rainfall.

**Bingham Canyon mine, USA – successful prediction**

As pits get bigger and deeper the consequences of a failure become potentially more devastating as demonstrated by a spectacular slope failure that occurred in 2013 at the Bingham Canyon open pit mine in Utah, United States. The mine has been producing copper ore for more than 100 years and is currently about 1.2km deep, 4.5km across and covers an area of about 770 Ha. Every day about 330,000 tonnes of waste rock have to be removed to expose 150,000 tonnes of ore which are mined and delivered to a processing plant several kilometres away. In 2013 a massive failure occurred on a geological feature known as the Manefay fault which resulted in 65-70 million m³ of rock sliding into the bottom of the open pit, bringing operations to a standstill. Although there was extensive material damage and a lengthy business interruption there were no personnel injuries. Indeed, the story of the remarkable recovery and return to full production could be the subject of a good book in its own right; but let us focus on the events leading up to the failure.

The geological fault system on which the failure occurred was known to be problematic as failures had occurred on it in the past. Recognising the potential risk, the mine owner had installed an elaborate system of slope stability monitoring instrumentation including a high definition radar system, that in the months leading up to the failure had picked up increasing signs of a large scale rock mass displacement. Anticipating an imminent failure, equipment working in the bottom of the pit was relocated to what was thought to be a safe distance from the predicted danger zone and all manned work was stopped and men withdrawn from the pit. As it turned out, the instrumentation successfully predicted the time of failure but the speed and distance that failed material flowed into the bottom of the open pit was miscalculated with the result that 13 very large haul trucks, three 56 m³ electric rope shovels and associated pit bottom infrastructure were destroyed along with the main access haul ramp into the pit, and a large haul truck maintenance facility located at the pit rim on the edge of the failure. Fortunately the advance warnings were sufficiently timely to prevent any injuries. The Bingham Canyon failure is an example of successful prediction of an inherently difficult-to-predict occurrence.

**Grasberg open pit mine, Indonesia – less successful prediction**

A less successful prediction occurred in 2003 when a massive failure and collapse on the upper levels of the Grasberg open pit mine in Indonesia resulted in 2.3 million m³ of material collapsing into the open pit, killing at least 11 workers and destroying several pieces of heavy mining equipment. Press reports at the time suggested there had been clear warnings of an imminent failure at least 2 days prior to the event. Management had reacted by moving some equipment but because there was an expectation that the failure would be contained within the safety berms built into upper levels, the size and extent of the danger zone was under-estimated. In this case the total volume of material involved was smaller than in the Bingham Canyon event but the consequences were equally devastating in terms of business interruption, reputational damage, political repercussions and significant recovery costs and most devastating in terms of loss of life.

**Other examples**

There are, of course, other examples of pit failures, some of which were successfully predicted while others took operators by surprise. The writer’s own experience goes back some 30 years when, as a junior engineer armed with a total station, a bunch of pentaprisms mounted on bits of pipe from the scrap yard and graph paper he was able to predict the time of a slope failure to with 24 hours. Importantly, it was the receptiveness of mine management to a junior engineer’s warnings that ensured all equipment and mine personnel were withdrawn from the danger zone with the result that there were no injuries, no equipment damage and only a minor interruption to production.
Conclusions

- Changes to global weather patterns and an increasing frequency of abnormally heavy rainfall events are likely to cause operators of older tailings impoundments problems in as much as the parameters to which those dams were designed may now be outdated.

- Low commodity prices coupled with scarcity of funding for capital projects can be expected to continue for some time to come and therefore it may also be expected that there will be an increased risk of failure of some older dams as operators try to push the limits of performance of those dams (in terms of tailings storage capacity) rather than build new ones.

- The way in which tailings storage facilities are operated and managed will have a material impact on the risk of failure and therefore this should be a focus of risk assessment surveys. In his 2002 paper Davies offers a particularly scathing insight to the causes of tailings dam failures. “If one becomes a student of tailings dam failure case histories, a single conclusion arises. These failures, each and every one, were entirely predictable in hindsight. There was a lack of design ability, poor stewardship, or a combination of the two, in each and every case history” (Davies, 2002)

- It is not realistic to think a plausible risk of future failure can be ascribed to a dam based on its design (unless there are clear design flaws); however, it is possible to assess the downstream consequences of a failure which might in themselves be a good reason to change the location and design of a tailings dam.

- Given the potential consequences it would be prudent to avoid constructing tailings storage facilities upstream of centres of population; equally once an impoundment has been constructed it is important that population encroachment is prevented into any area that may be effected by a breach.

- A mine owner may not be able to abdicate responsibility for a failure to the specialist engineer that designed the tailings storage facility. Investigation into the Canadian example mentioned previously suggested that the owner had a responsibility to ensure the design engineer had adequately taken all aspects of the design into account; this could have been done by engaging another specialist to undertake an independent, detailed design review.

- The causes of an impoundment wall failure may originate several years before the signs of impending failure become apparent. Similarly, it may be several years before leakage of pollutants to groundwater is detected.

- The consequences of an open pit slope failure are sometimes disastrous in terms of loss of life, equipment damage and production losses but for mine operators willing to invest in them, there are systems, hardware and human capital available that can be used to monitor slope stability and provide a reasonably reliable prediction of when a failure will occur. A challenge to mine management is when to stop production and withdraw men and equipment when a failure is predicted. Prediction methodology is still not precise therefore being overly cautious could cost valuable production whereas there are obvious risks of delaying precautionary action.

- Unlike a tailings dam, nature rarely offers any options as to where to construct a mine. A mine must be built where the economic mineralization has been deposited whereas we are able to select the best location for a tailings storage facility. In both cases mining and geotechnical engineers have to learn how to deal with the geological and geotechnical conditions they encounter. Once built, and assuming appropriate design, continued safe operation will depend on the diligence of ongoing condition monitoring, adherence to designed operating procedures and the ability to make timely risk mitigation decisions.

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Managing geotechnical risk

The construction process only finishes at closure for civil engineering structures that form an integral part of the mining and processing operations. Many years will usually pass between mine development and closure, and during this timeframe the only certainty is that changes will take place. Designs will change in reaction to changing factors such as the grade and ore price; operational personnel will come and go, owners may change and regulations too. New technologies will be introduced, sometimes pushing at the frontiers of established science.

There are many mines that operate successfully and adapt well to changing circumstances. They maintain production and deal from time to time with occasional serviceability issues that will occur with the perpetual temporary works that is mining in the civil engineering sense. Major failures – the tailings spills and pit slope failures that occur when a major structure crosses the ultimate limit state line – are in the minority, but do make headline news.

Engineering is a constructive profession, and no one in mining could seriously want to be involved in an engineering failure. Engineers are problem solvers and enjoy the challenge of developing solutions to complex problems, so when things go wrong it could be said that the road to hell is paved with good intentions. But what precisely is meant by that saying? Is it a failure to spot the consequences of an action, failure to act on an intention, or an apparently good intention masking malicious intent?

Assuming malicious intent can be discounted, risk management processes can be used to identify the possible consequences to actions, assess the probability of failure and to implement risk mitigation measures or design changes if needed. Design of significant structures should not be a one-off event populated by a series of discreet deliverables that lie on the shelf in some far off data room.

This article looks at the geotechnical risks associated with construction projects in the mining sector. The scale of mining operations is such that slopes and earthworks structures on mines can be associated with some of the largest structures likely to be encountered in the engineering world.

Failures can be equally massive. The serviceability and ultimately the stability of these structures belongs to the field of geotechnical engineering, and predictions regarding field performance on these major structures can stretch the science to the limit when new technologies or new methods are employed. Slope engineering and earthworks are part of the design of open pits, tailings dams, heap leach pads, ROM pads, waste dumps, water dams and solution ponds.
Case histories

A selection of case histories is provided below to illustrate the type and scale of geotechnical problems and failure incidents that can occur.

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Description</th>
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<tr>
<td>The failure of the tailings dam did not result in injury or loss of life. Initially, the mine viewed the failure as a serious health and safety incident, but such was the scale and visibility of the failure the rest of the world viewed it as a catastrophe.</td>
<td>The subsequent investigations identified particular issues that on their own would not necessarily have caused the failure but in combination had an adverse impact on stability; notably that a discharge consent had not been agreed that resulted in more water being stored in the dam than originally intended, the original design passed from conservative to less safe in a few key aspects during the mine development stage, in one key area the specification was not implemented as rigorously as it should have been during construction, and key geotechnical personnel were absent during dam raising stages to sign off works. The tailings dam concerned was closed and a new dam designed and built at the mine to a different specification to the structure that failed.</td>
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Slope failure occurred in an abandoned open pit as an underground block-caving operation matured beneath it. | The cave zone modified the stresses surrounding the pit and subsidence was identified in one of the pit walls. Cracking seen on surface as far away as 250m from the pit rim. This movement compromised several areas of critical infrastructure associated with the mine, including a haul road, railway line, power lines and a water supply. These components were relocated prior to total failure but the subsidence also threatened the underground ventilation shaft, production shaft and service shaft. This case history pioneered new technologies and methodologies, and was heavily researched and monitored. However, it emphasises how an unforeseen hazard has the potential to impact on the existing landform, place critical infrastructure at risk in areas previously considered stable and have knock-on effects on the current operation. |

The heap leach pad had been built to the design under a rigorous quality assurance programme, yet solution break out indicated liner failure had occurred during operations, resulting in loss of product and environmental impact. | Investigations revealed major tears in the geomembrane liner, and also tellingly, that tracked machinery had driven directly on the liner. The careless actions of an operator would take but a few moments to destroy the liner integrity locally, but the scale of the failure suggested that other factors were involved too. This uncertainty cast doubt on the suitability of the original design to the ground conditions and to operational practices. Design changes were implemented on subsequent pads, involving more robust solution collection pipework layout and decant pipework arrangements, and better subgrade protection measures. Operational procedures had to be improved as well, and the stacking process was revised. |

Natural hazards can also play a role in the stability of engineered structures on a mine site. | At one particular project the stability of several mine components was affected by a fossil landslide formed in geological times. The presence of the landslip only became apparent during mine development which took place rapidly following initial studies. No significant failure took place, but serviceability was affected. The fossil landslide was too large to be stabilised completely and in this case it was necessary to live with nature. The landslide affected the process plant, leach pads and solution ponds. Where it was not possible to avoid construction over an area affected by landslide, movements were managed by special design, careful operational practices, mitigation measures – commonly drainage – and close monitoring. |

Source: Willis Towers Watson
Although the above case histories illustrate the complexity and range of geotechnical issues in the mining context, it is still largely possible to put your finger on single areas where improvements in design and operational practices would have prevented failure or limited the scale of the problems. The effect of hindsight cannot be completely discounted with this statement, and failure investigators will have much more time and resources to consider factors controlling stability than would commonly be available to operators or auditors. On the whole the failures described above were not new to the subject of geotechnical engineering, nor were possible design solutions.

**Planning, openness and communication**

The construction industry has developed technical tools to do the job and recognises the value of key factors such as the importance of good quality investigations and testing, where the best is not necessarily the cheapest. Planning, openness and communication are important from the start of a project, whereas split design responsibilities and poor allocation of time and resources are factors that can contribute to failure.

**Geotechnical investigation**

Certainly it is important to have site inspections, data and geotechnical investigations on which designs are based. Geotechnical investigation plays an important role in the design of engineering structures at mine sites. The scope and scale of the investigation work can even be far more comprehensive than that used in civil engineering outside mining, and the methods differ so that geotechnical parameters relevant to the design of the structure in question can be obtained. Detailed and complex analytical methods are now commonly used to predict performance.

**Long term risk management process**

The long construction timescale in mining means that investigations are part of a long term risk management process, and data acquisition takes place through monitoring, sampling, testing and inspection as the mine evolves. Equally quality assurance is important during construction, as are independent audits during operation. All these measures were implemented in whole or in part on the case history sites. The problems weren’t spotted, or if they were, they weren’t acted upon, which leads to the conclusion that all these usually beneficial best practice measures were, when taken in isolation, impotent in preventing failure.

**The circle of design**

Design and successful implementation are not one-off activities undertaken in isolation and delivered to the mine operator as a single work package. The concept of the circle of design has been described by Professor Dick Stacey in the context of rock slope excavations, and his approach is illustrated in the figure opposite.1

The process drills down into the individual components of a design and involves the acceptance of geotechnical risk, which is a fundamental in mine design. Review and monitoring are also part of the process and should take place at each stage, allowing for moving back to earlier steps if necessary.

The design of an open pit slope is used as an example of how views on risk might change during the mine life, and where review and monitoring could provide value. The design is established during the feasibility study phases using targeted geotechnical investigations which results in a final design that satisfies economic constraints, stability requirements and the mine operator’s appetite for risk. Note that the design process includes initial stages where the level of acceptable risk is identified, something that is not at the sole discretion of the design engineer but which involves regulatory and operator input to the process. More aggressive (steeper) designs offer a greater cost saving but at increased geotechnical risk.

**Modification of mine risk profile**

The risk profile presented by the mining house at the mine development stage is often modified throughout mine life. Once into development, a different team of professionals take responsibility for the mining operations. The feasibility study is seen as a good starting point but opportunities are often sought for cost savings or to optimise the mining operation.

Wall steepening projects provide an opportunity to reduce waste stripping or increase pit depth without adding significant cost. However, wall steepening can increase geotechnical risk and the probability of wall failure. The assessment of the probability of failure addresses the variability of the ground and takes into account the worst combination of circumstances identified from geotechnical investigations and ongoing monitoring and inspections. Probability of failure can be an uncomfortable concept for non technical personnel, but it is broadly comparable to a factor of safety.

Prior to commencing a wall steepening project, the opportunities and risks are presented to the stakeholders. In many cases, the risk profile is modified and more risk is accepted for greater reward. While the stakeholders may accept the higher risk profile, care must be taken to ensure that those who actually underwrite the risk are aware of this change and maintain their presence in the project.
Greater risk is presented by site-based, localised decisions where the new, increased, risk profile has not been communicated to corporate management. Here, small gains are made with minimal recognition but wall failure can have far-reaching effects. Is the insurer aware of the changes to the agreed slope design? Risk and reward were both increased; was the increase in likelihood of failure reflected in the insurance premium?

**Some designs are better than others...**
Looking at the wider geotechnical context and the case history examples of failures, it is apparent that not every design element, where something could go wrong, has an associated measurable safety factor. Some designs are just more robust and better suited to operational factors than others. The timing of a failure event is often discussed when investigators try to unravel the sequence of events that contributed to failure. Monitoring may have revealed that changes were taking place, but the significance of the changes was not always recognised until serviceability was significantly affected or the structure failed completely in a sudden manner. Designs, or changes to designs that ultimately lead to failure, may not immediately ring any alarm bells unless the monitoring and review process of the circle of design is fully and regularly instigated.

Stakeholders need to know how liabilities are being dealt with so that insurances can be defined from the start, and be reviewed regularly during the life of the mine. From an underwriting perspective, care must be taken that all facets of the operation are understood to manage exposure to the financial risk of failure. In effect, the insurer should be made aware of the outcome of review and monitoring stages. Without understanding site changes, changes to the risk profile cannot be quantified.

**Reference**
Optimizing human capital in mining

By its nature, a cyclical industry swings from a high to a low and back again from a low to a high. Imagine the force of mining economics as gravity, always present, drawing commodity prices through a cycle which is accepted, periodic, symmetrical and rhythmic. If that cycle is interrupted and a hand stays the cycle, it then becomes fitful and, thrown into chaos, the whole system becomes disrupted.

After a long high, we have now endured a deep low, evidenced by historically low commodity prices across a number of key and bell weather commodities. In our Energy Review earlier this year we referred to the Darwinian need for survival following a sharp readjustment in oil prices but mining has been enduring this correction over a much longer time period and it really does seem to be a question of the survival of the fittest.

In the global markets the copper price, a bell weather of the industry, is down from a five year high of around USD 10,000/t to the recent low of USD 4,241.04/t and iron ore from over USD 210/t to a recent low of USD 54.11/t. Even precious metals are not immune and have experienced significant volatility, from a 52 week low of USD 1050.80/oz to a 52 week high of USD 1364.90/oz; contrast that to 2010/2011, when prices were nearing USD 1900/oz.

To survive this downturn, companies have reacted by ruthlessly reducing costs and debt, managing return on investment/mines and cash, and seeking a lean operating model. But what’s the future:

- Innovation and creativity to continue to reduce costs and deliver value for shareholders?
- Reduction in the number of companies in the industry – mergers and acquisitions along with asset sales?
- Continued balance sheet and capital management with the right balance for when the market returns?

By being proactive, companies can better ensure survival through human capital cost management, and need to consider the continuing operational ability of their organisation, as well as the talent need for the long term health of the business and the industry. From a human capital perspective, whilst managing and retaining talent is critical, the continued realities of survival are paramount.

Not all companies will be affected in the same way, and the economic landscape is fraught with complexity.

How deep is the low and what’s the business reaction?

Overall commodity prices are stated to have dropped by 25% year on year, with over $53 billion of impairments in 2015. A Moody’s report in early 2016 refers to a fundamental shift in the operating environment and a new norm with an unprecedented change requiring a recalibration.

Currently the mining market is still oversupplied compared with demand, due to the four year recession. Companies with low production costs will want to continue to produce (or even increase production) to maintain revenues and market share, which might especially be the case within economies dependent on revenues from mining. While closing a mine can be costly, re-opening a mine can be even more expensive and, depending on your view of the timing of turn in the cycle, it may be better to keep some loss-making mines producing.

A PwC report looking at the top 40 global companies identified a combined £297 billion loss in market value across these 40 companies. Given that operating costs in 2015 continued to reduce for the fourth year in a row, how deep must the cuts continue to be to impact supply and start to align the market to demand? It seems the predications for growth from China and India at around 7% will not be the driving factor in any near term recovery. Impairments continue to materially impact profits; for some companies that have taken difficult decisions and deep cuts early to reposition and restructure their business and strengthen the balance sheet, bottom line financial improvements may be seen earlier than top line growth.

Technology affects all our lives and mining is no different. Expected changes in mining operations include the use of renewable energy, rail systems, robotic systems, enhanced drill systems and tyre management, along with more future potentials such as genomics, 3D printing and airships. This automation reduces costs through efficiencies, from energy to maximising ore extraction to overhead costs. Companies are now enhancing lean practices and optimizing both processes and production through creativity and innovation.
Expense management – optimizing human capital

In a normal cycle you could say we have been here before and begin to make the plays from the playbook for dealing with these aspects, including attention to human capital.

The playbook focusses on people costs within the organisation, reducing or freezing low lying fruits first. These include:
- travel costs
- employee perks
- hiring
- merit increases and bonus awards

However, given that the industry has already reduced related people costs over each of the last four years, can the industry really continue to realign headcount and people costs to reflect the historical commodity lows? Certainly, today’s discussions remain less about a war for talent and more about restructuring, right sizing, and sustainable workforce planning, agility and managing both performance and people costs.

HR departments are under pressure to provide new ways of operating in this new reality, and will have to take the following into consideration:
- realigning the organisational structure with new reality and shift
- workforce planning and agility
- talent management
- a new employee value proposition
- cultural impact and values
- supporting creativity, technology and innovation
- succession planning
- Diversity and Inclusion
- reward design and incentive plans
- performance metric calibration aligned with financial realities
- internal development of skills
- recognizing critical talent and “Hipo” individuals
- using analytical tools for big data discussions
- maintaining behaviours that support the business and HSE
- leadership assessment
- executive pay and shareholder communication
- tactical retention and motivation
- retirement planning and costs
- ensuring physical and mental health and welfare of staff
- M&A readiness or development
This involves continue to reach ever deeper in providing value to the business at an appropriate cost while attracting, retaining and motivating talent. It’s a very challenging proposition from anyone’s perspective but critical to:

- providing agility to the organization
- adapting a continuing response to survive over this continued lengthy period of Industry stress
- grasping the opportunities to grow that may arise in the future

Human capital issues

Before looking at some of these human capital interventions in more detail we will reflect briefly on the differences in the life cycle and value chain of the industry, the impact of the current economic environment and some considerations as companies plan for continued uncertainty and low commodity prices. The life cycle broadly reflects: licence to operate, available land, exploration, assessment, construction – mine and supporting infrastructure/energy, operation of the mine – processing and refining as well as transportation, sales and marketing and finally closure and rehabilitation of the mine.

While the macro challenges of price volatility and the balance of supply and demand remain the same across the industry life cycle and value chain, the impact of these challenges are deeper in some areas and influence how companies manage their human capital in different ways within the mining life cycle. Outlined below is our perspective on the current operating environment in a number of core sectors and how this will impact the workforce and the way companies manage talent going forward.

Exploration and Resource assessment – skills surplus and lack of new mine investment poses fundamental challenges

The exploration part of the cycle has increased the pressure on mining companies, given the existing over-supply and low commodity prices, requiring a higher grade and tightened capital/finance within the industry and each company. Companies’ focus remains on efficient production from current assets, and although they are acutely aware of the long term nature of the industry, they will still want to put in operation efficient, productive mines and establish reserves for future use.

A strategic shift of this magnitude has affected the entire workforce within this sector. This moves the debate away from the cliché of old - that there is a “War for Talent” - into a period which now features a relative skills surplus. If we combine this with an aging technical workforce and a rapidly expanding need for innovation and technology, then it becomes clear that the sector is faced with a number of challenges, including:

- **Cost-cutting with an eye on the future.** As we have seen in the past, cutting in haste at the bottom of the cycle hampers a company’s ability to respond quickly when the market stabilises, investment increases and projects come back on stream. Assessing total workforce costs in the sector will therefore be key to understanding where efficiencies can be achieved without damaging future growth prospects. As such, whilst we expect further cost cutting, we see companies looking to optimize workforce spend across the full Employee Value Proposition (EVP) rather than simply on compensation.

- **Efficient resource deployment.** Making the most of a company’s human capital will be key as resources are spread thinner, particularly in larger mining companies where operations span geographies. Deployment of skills across a company’s footprint will play a key role in weathering the current storm and we have seen many companies turning to a more analytics-based approach in order to achieve optimum human capital deployment. Using more local talent rather than expatriates may in itself produce savings and efficiency benefits.

- **Knowledge transfer and new skills.** The natural resource industries as a whole have been struggling to adapt to an aging workforce and the risks this brings. Now, more than ever, there is a risk that increased turnover of technical professionals will result in the loss of key/critical knowledge and skills. Companies will need to mitigate this risk, with a focus on tighter talent management, development and succession planning across the exploration stage. Alongside this challenge, new skills will be needed, as efficiency is driven by technological advances. Assessing – and on a targeted basis, investing in – human capital strategies now will help maintain the intellectual capital skills needed and drive growth when the market recovers.
Construction and Development – reduced capital finance available impacting talent
The Construction and Development story is similar to that of Exploration - a focus on core operational assets, relentless cost-cutting and tight management of capital. The available finance for construction and development of mines and related infrastructure has therefore been under the microscope. Mines in development have been put on hold if they do not meet the return criteria under the new realities of the commodity price, unless there is a strategic plan to gain market share.

We see the sector going through a number of distinct phases, ultimately aiming to position for growth of market share in the longer term:

- **Cost reduction.** From a human capital perspective, the Construction and Development part of the mining cycle sector has been one of the first to reduce employee costs and headcount as they responded to demands to cut costs. Even where construction continues, there is tight project management of the costs and project plan, placing even more value on construction project managers and leaders that can deliver within budget and on time.

- **Innovation.** Reducing costs for customers places companies that adopt new efficient technology into the construction of the mine in a better market position to produce at a lower cost, win business and stay ahead of the competition. Innovation, technology and the rate at which companies move into the world of this technology will be key to securing market share, both now and once prices stabilize and recover; construction of such mines and infrastructure with new technology will need new skills.

Operation – mining, processing and transportation
Companies fighting for survival continue to manage both debt and efficiency; as well as disposing of assets, they are also closing or divesting mines that are not in line with their strategic goals. Depending on the company and the extent to which they stretched themselves in the boom times, the focus is either critically on survival or, given that this is a short term perspective, they may alternatively have one eye on the future.

Developing and delivering more efficient mining processes and mining operations directly flows through to the company’s bottom line and creates value for shareholders.

This may include organisational assessment, operating lean and increasing use of technology:

- **Building for the future.** Whether through consolidation, acquisition or optimisation, it is likely that there will be much further change in the sector given the fundamental shift and lower for longer commodity price. Companies will need to be prepared for the repercussions that this will have on the workforce, including organisational change, redefining job structure and roles, the impact of further right-sizing, retaining key/critical talent and strategic investment in new technology and critical skills.

- **Innovation and Technology.** While there have been large workforce cuts in the mining industry, developing the organisational structure and establishing a culture of creativity and innovation – including implementing and embedding new technology, building an appropriate skill base and retaining those key/critical employees that can drive more efficient processes – will be important to future growth. This must be done whilst retaining the required employee focus and behaviours for HSE.

- **Health, Safety & Environment (HSE).** A key pillar of sustainable growth in the mining industry, HSE is usually embedded throughout a company’s culture and values. However, the current enhanced focus on costs can put significant pressure on HSE and therefore represents a significant risk. Reward can play a key role in mitigating this risk; we see companies incentivising the very top of organizations to make ‘continuous improvement’ in HSE metrics (which are now moving from lagging to leading indicators of HSE performance) all the way through to embedding HSE as part of a company’s scorecard covering all roles. Our recent 2015 survey of the mining industry found that around two thirds of participants now measure HSE performance as part of their annual bonus arrangements and a growing number measure performance over the longer term as well; indeed, over a third apply safety metrics in their long-term incentives to executive leadership.

- **Mergers and Acquisitions.** Small or large companies which are highly geared will struggle to weather the storm and may end up as acquisition targets from their larger peers looking to expand their footprint, market share, geographical spread and skill base.

Closure and Rehabilitation
An important part of the life cycle of a mine, right from the key early stages of pre-feasibility and financing, is the closure and rehabilitation of the mine site. At this stage, the mine is either declining in its income earning ability or not earning income at all and a material cost to the business. The closure of a mine is important to the company as part of its social licence to operate other mines, but pressures across the whole life cycle will no doubt mean that this will be done much more efficiently with a leaner operation.
Key Aspects for Human Resources - how to prosper in a time of protracted commodity weakness

Operational efficiency
Operational costs will continue to be closely managed. Expectations are for low merit increases and continuing reviews of organisational structures, benefit costs, governance and administration to ensure efficiency and value for money. Survival, through profit and balance sheet management, continues to be the keyword for some companies and this will impact and present the tone for many HR interventions. Assessments of costs and organisational structures, job architectures, benefits reviews and alignments with the new market may all yield cost savings.

Employee Value Proposition (EVP)
Our talent management and reward research shows that companies that have adopted an overarching EVP are:

- Three times more likely to report that their employees are highly engaged
- One and a half times more likely to report that they have achieved a financial performance significantly above their peers
- Less likely to report having difficulty attracting and retaining employees — particularly in key employee segments

However, given the extended and historically low commodity prices, there is now a priority shift in business strategy towards cost savings.

When commodity prices drop, employers need to find the right balance between managing costs and having the necessary people to drive the business forward. Any inability to strike this balance of cost reduction and protection of the employment brand may put a company at a serious competitive disadvantage. Decisions like these are difficult to implement in times of favourable commodity prices and are made more ambitious in times of industry, geo-political and price uncertainty. In the wildly cyclical industry environment, how can employers maintain the workforces they need to both weather the extended downturns and be competitive when the market heats up?

Performance
In such times of deep economic stress, how can a company incentivise and reward top performance when merit budgets are slashed? Some companies indicate bonuses that don't accurately reflect overall company performance, simply because variable pay plans aren't that variable. On the other hand, some employers are asking how they should adjust their plans for commodity fluctuations and realities of profit and shareholder value. Many companies make such adjustments, but not without pressure to defend the decision.

Data on rewards show that when funds become scarce and the bonus budget is lean, employers become much more disciplined at rewarding high performers. At the very top of the house the relationship between pay and performance, as well as the programmes that support this strategy, may need to be reviewed and explained to shareholders.
Attraction and retention

Our research tells us job security is one of the most important factors affecting employee attraction and retention in any industry. But for most workers, job security doesn’t mean having a job they won’t lose, but rather having one that will lead to a long-term career in the industry and provide financial security. And as the employment market becomes more uncertain during a downturn, that security becomes more important to employees — at a time when most employers can’t offer the traditional type of job security. Employers in the mining industry should also consider segmenting the workforce; some are already starting to do so according to types of roles, such as critical skill and hard-to-fill roles, and diverting more funds to pay and reward people in those roles. For those that they need to transition or make redundant, the approach may impact the brand and potentially employee relations and licence to operate.

Engagement

It’s very difficult to build or even maintain employee engagement when you’re in a cost-reduction or employee-reduction phase. But during down times, companies that continually work on fostering engagement have an advantage; they can have “high engagement levels in the bank”. Being in that position of strength gives the employer time to develop a strategy calmly without the immediate threat of plunging engagement. However, if the company has low engagement going into a down period, it has no credit built up with employees — just when it needs people to be really productive to bring the business up to the required level.

Training and Leadership Development

One thing companies in the mining industry need to do through a downturn is keep investing in career and leadership development. During the financial crisis, high-performing companies continued to do just that; it helped their people to know that their employer took a long-term view and recognized the need to keep developing people and providing them with opportunities.

Brand

A company’s reputation is very important to employees in this industry. When the market eventually swings upwards, prompting a scramble for talent, company reputations will matter a lot. If an employer has damaged its reputation by handling downsizing clumsily, it will have a hard time attracting the right people and its compensation costs will be high as a result. Of course, you’ll need to make some critical decisions about scaling back in some areas, but it’s important to resist cutting into the muscle or vital organs of your career and leadership development programmes. Those types of cuts could help you in the short term from a cost perspective, but cause much pain for the organization in the long term.

Conclusion – embracing opportunity within a stressed market!

While the industry and market remain in the doldrums, mining remains a big contributor to many economies. In the US, a 2014 report suggests mining is a large contributor to the nation’s economic, industrial and technology success, supporting nearly two million jobs and generating annual revenues in excess of $100 billion. Indeed, over the next 5-10 years US mining operations will need approximately 55,000 new employees to meet demand and to replace retiring employees.4

As in most other instances, opportunity lies in adversity. Mining is here to stay, but likely with a new shift to a lean model as companies reduce debt and maximise value. Through HR interventions that focus not only on cost, companies have the ability to act in ways that can yield short term value and long term competitive advantage. Values, culture, agility and engagement can help with difficult messages in troubled times to deliver a supportive workforce that innovates, delivers efficiency and is in a ready state for recovery.

John Pymm heads the Natural Resources sector group for Talent and Reward at Willis Towers Watson. He is a Director based in the Executive Compensation practice in London and has over 25 years’ consulting experience. John also has M&A and IPO experience designing executive remuneration plans and long term incentives in change situations as well as experience in all employee share arrangements.

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Managing environmental risk

Today’s global society places demands upon the supply of raw materials needed for the provision of everything from major infrastructure to consumer goods. A large proportion of these materials are supplied by the mining industry.

New mines are being established in increasingly remote and environmentally sensitive areas. Although many countries have well developed legislation in order to mitigate the impacts of mining, the regulatory landscape is constantly evolving. This changing landscape in environmental legislation and scrutiny means that mining companies face considerable challenges with regard to the management of environmental risk and liabilities, both from legacy sites and ongoing operational activities.

These risks are not restricted to developing countries where improved regulations are being instituted and enforcement actions are taking place. Increasingly stringent regulations are also apparent in more developed jurisdictions. Additional environmental and social requirements and considerations are emerging and the resulting liabilities may continue to increase as a result. This article explores changes and trends in environmental regulation, discusses emerging environmental issues, highlights additional risks and liabilities associated with these trends and outlines strategies for risk mitigation.

The changing landscape of environmental legislation

The impact of this changing landscape is illustrated in the following paragraphs by way of examples in Latin America and the United States (US). The former illustrates the impact of developing environmental regimes which are imposing regulations similar to that of the US and European Union (EU), and the latter, a mature environmental regulatory regime that is enforcing ever stricter standards.

The increased potential for environmental liabilities to be realised in Latin America

Although many countries in the region have had environmental regulation for some time (for example a World Bank report from 2002 stated that Bolivia, Chile, and Peru all have “modern mining codes and all mines must follow modern environmental laws, undertake environmental impact assessments, and undergo inspection by representatives of the central government”)

Although many countries in the region have had environmental regulation for some time (for example a World Bank report from 2002 stated that Bolivia, Chile, and Peru all have “modern mining codes and all mines must follow modern environmental laws, undertake environmental impact assessments, and undergo inspection by representatives of the central government”), there have been recent developments which extend the potential liabilities faced by mining organisations. For example, the recently enacted Mexican Federal Law on Environmental Liability (Ley Federal de Responsibilidad Ambiental, LFRA, 2013) represents a potential watershed event. Similar to the Natural Resource Damage Assessment (NRDA) requirements in the US and the Environmental Liability Directive (ELD) in the EU, the LFRA creates a legal framework to regulate environmental liability derived from damage to the environment.

The LFRA allows for joint and several liability and requires the assessment of the environmental injury, which can include an individual organism, a community of organisms, habitat or ecosystem. It also allows for the restoration of the injury by way of restoration of the ecosystem services and provides for compensation for loss of services and for compensation when “repair” is not possible. However there are considerable technical challenges in determining actual injury, restoration and compensation requirements, as discussed later in this article. Under the LFRA, local inhabitants can sue for damages, as can the appropriate government agencies, and the suit can be filed up to twelve years from the date on which the damage and its effects were caused.

These risks are not restricted to developing countries where improved regulations are being instituted and enforcement actions are taking place. Increasingly stringent regulations are also apparent in more developed jurisdictions.
In Chile, the Environmental Law was amended in 2010 and an Environmental Court system was established in 2012. The amendments enhanced the role of the local community and allowed for larger fines to be imposed. Individuals can bring about an action, as can relevant authorities. Recent changes have seen a significant increase in the activity of NGOs and pressure groups in relation to environmental matters such as threats to health, indigenous rights and biodiversity. These can have a significant impact:

"to date the empowerment of citizen participation in Law 20,417 has altered and eventually undermined the environmental authorities’ ability to maintain a technical and objective assessment of the projects they evaluate, turning it into a political one".4

For example, lawsuits brought against Endesa in Chile shut down the coal fired power plants Bocamina I and II over alleged (but as yet unproven) mortality to fish and invertebrates and health effects on local residents.3

A polluter can file a restoration plan as a means of avoiding an action being brought, however, determining the nature and extent of the restoration is challenging (see later).

Ultimately it is considered likely that environmental liability claims will become more common place and institutionalised in LAC.

Increasing regulation of air, land, and water in the United States

In the United States, the expansion of regulatory authority under existing environmental laws such as the Clean Air Act, the Endangered Species Act, and the Clean Water Act, as well as other regulatory activities, pose a significant risk to mining operations.

The US Environmental Protection Agency’s (EPA) expansion of the Clean Air Act to regulate carbon dioxide as a pollutant and greenhouse gas is resulting in new standards of practice for accounting and reporting of carbon emissions.

Under the Endangered Species Act, designation of additional species as threatened or endangered, and, the broadening of regulatory interpretation of what is a critical habitat for other species already designated as threatened or endangered, means that more and more land area is being regulated and restricted.

The Clean Water Act regulatory update by US EPA, referred to as the Waters of the United States (WOTUS) Rule is resulting in a much more expansive interpretation of what constitutes a “navigable water”, extending the definition to almost any water body, wetland, or wet area.

The expanded authority is arguably an overreach of legislative intent in the original Clean Water Act passed by Congress, and is thus the subject of significant litigation activity, the outcome of which is highly uncertain. For now, the rule has been stayed by a court in which the rule is being litigated. In any case, it is likely that the trend of increasing regulation of water will continue.

In relation to mining in particular, The US Office of Surface Mining Reclamation and Enforcement (OSMRE) has proposed a “Stream Protection Rule” for regulation of coal mining. In part, the rule would:

“revise OSMRE’s regulations to clearly define “material damage to the hydrologic balance outside the permit area,” and require that each permit specify the point at which adverse mining-related impacts on groundwater and surface water would reach that level of damage. The proposed rule would also require mine operators to collect adequate pre-mining data about the site of the proposed mining operation and adjacent areas to establish an adequate baseline for evaluation of the impacts of mining and the effectiveness of reclamation.”

The rule would also further regulate perennial and intermittent streams, and requirements related to federally listed threatened or endangered species and designated critical habitats, and would apply to both surface and underground mines.5 6

These changes to the Clean Air Act, the Endangered Species Act, and the Clean Water Act, and other regulatory actions pose an increasing challenge for miners in all phases of activity including exploration, permitting, planning, construction, operation, reclamation and closure, and post-closure within the United States. Regulatory changes in the United States will tend to drive changes more broadly, as regulators elsewhere may adopt some of these increasingly restrictive regulatory approaches, and as multinational mining companies adopt best practices throughout their operations globally.

In relation to mining in particular, The US Office of Surface Mining Reclamation and Enforcement (OSMRE) has proposed a “Stream Protection Rule” for regulation of coal mining.
What are the key emerging environmental risks?

In general the environmental impacts of mining are well known, for example, in 2007 the International Finance Corporation (IFC) issued Environmental, Health and Safety Guidelines for Mining. The document identified the following potential environmental issues associated with mining: water use and quality; wastes; hazardous materials; land use and biodiversity; air quality; noise and vibrations; energy use; visual impacts. These impacts can occur throughout the mine life-cycle, from the exploration phase, through to site enabling, extraction, milling and processing, smelting, transportation, waste disposal, site reclamation, closure and long term aftercare.

However, in recent years additional risks are emerging which also require careful consideration and management. Risks are associated with the growing regulatory controls put in place to manage these impacts, as well as the potential for climate change to increase the level of risk. Emerging themes include greenhouse gas emissions, air quality and human health impacts, water use, quality, scarcity, thermal pollution and the potential impact of climate change, land take and use of resources, tailings dam management and catastrophic failure, together with the over-arching theme of obtaining and maintaining a social licence to operate in the light of these potential environmental and social effects. Increasing regulatory control and scrutiny of these issues and the concerns from the public create further potential exposure for mining corporations. In the following paragraphs we examine some of the issues.

Risks are associated with the growing regulatory controls put in place to manage these impacts, as well as the potential for climate change to increase the level of risk.
Obtaining and maintaining social license
Social license is a huge area of risk, given the immense capital investments that must be made, and the extended time-frames often necessary before a project ever generates income, let alone breaks even. A case in point (see above) is Newmont’s $5 billion Conga copper and gold project in Peru that has been shelved due to community protests. Newmont recently removed the project from their reserves. Earning community support must be a central focus from the outset of a project, and that community support must be maintained through the project life, to maintain social license. That requires careful and diligent community engagement within an integrated compliance, risk management and sustainability program.

Tailings risks and management
The failure of tailing dams can pose one of the most significant threats to human life, property, and/or natural resources. The history of tailing dam failures and their widespread impacts underscore the hazards posed by dam and levee failures. The recent Samarco failure in Brazil resulted in the release of approximately 32 million m³ of tailings, the destruction of a town, loss of life and destruction of habitat. Samarco is currently in the process of securing a significant settlement agreement with Brazil’s government to cover and repair damages. In addition, a separate lawsuit filed by federal prosecutors is seeking damages for $44 billion. Therefore, achieving a more complete understanding of the risks and possible consequences of failure of tailings dams is paramount.

Requirements for performing risk assessments of dams, including tailings dams and levees, are included in many codes. In Brazil, for example, Law 12-334 for National Dam Safety Policy indicates that dam safety should be considered during planning, design, construction, first filling and the first spillage, operation, decommissioning and future uses (Article 4). It also indicates the owner is legally responsible for dam safety, and is responsible for the development of actions to guarantee it. The same law also requires a Dam Safety Plan (Article 8), which must include an Emergency Action Plan.

Reportedly, a number of incidents involving the failure of tailings dams occurred following heavy rain, leading up to the failure. An article published in 2010 reviewing 100 years of tailings dam failures stated that failures attributed to “unusual rain” had increased from 25% of the failures pre-2000 to 40% post-2000, but also noted that failures due to poor management had increased from 10% to 30% between the two time periods. A paper published in 2016 concluded that although the causes of tailings dam failure are often related to a combination of factors including design, construction and maintenance, the most common cause of failure was related to unusually heavy rain.

Social license is a huge area of risk, given the immense capital investments that must be made, and the extended time-frames often necessary before a project ever generates income, let alone breaks even.
Public concern over fugitive dust emissions from a mine operation located in an area that includes tribal villages and subsistence hunting nearly resulted in a shutdown of that operation over concerns of potential heavy metals exposure. A detailed human health and ecological risk assessment found that exposure and risks to human health were low.

To improve its environmental management and the sustainability of its operation, the company developed and implemented an enhanced risk management program with systematic stakeholder involvement. A variety of efforts were included in the dust-related risk management program, including:

- Identifying stakeholders from different groups, including landowners, managers, and operators, local and regional governments including tribal authorities, state and federal agencies, nongovernmental organizations, and technical experts
- Implementing a strong stakeholder communication and engagement program, including regular community visits to share data and gather community input and ideas on dust management issues
- Defining risk management objectives with the involvement of stakeholder representatives through a workshop process, and through comment on a subsequent risk management plan and periodic review
- Objectives addressed a variety of topics including minimizing metals dust emissions; remediating or reclaiming selected areas; verifying the continued safety of subsistence foods and water; environmental monitoring with action levels for adaptive management; protection of worker health; and effective communication and stakeholder engagement
- Preparing a comprehensive set of implementation efforts designed to identify and effect the actions needed to achieve the risk management objectives
- Integrating the risk management objectives with the company’s ISO 14001 Environmental Management System database to track task assignments, roles, and responsibilities, and to ensure timely completion of risk management tasks
- Establishing a reporting process for continued engagement with the stakeholders, including local communities
- Conducting periodic review of effectiveness of the efforts, to facilitate continuous improvement on the risk management program, and thereby improve the sustainability of the operation as a whole.

The Company benefited from more proactive management of the dust issues to reduce impacts over the long term, and established an improved trust level with stakeholders, particularly local tribal communities, thereby minimizing the risk of future litigation and achieving a more sustainable operation.
Whether it is the result of anthropogenically-caused climate change or not, an increasing number of high intensity rainfall events are being recorded and it is possible that these events will become more frequent, resulting in the need for more rigorous design and management of tailings dams, in order to mitigate the risks associated with unusually intense rainfall.

A recent report on the Mount Polley tailings dam failure in British Columbia (B.C.) suggest that mining companies should consider the use of “dry stacking” technology, whereby the storage of both water and tailings is avoided, elimination of surface water takes place and the tailings are adequately drained. Following the publication of this report, the B.C. Ministry of Energy and Mines is now undertaking a Mining Code review with policy and regulatory changes anticipated. This may have far reaching consequences for both legacy and operational sites.

Ultimately, risk assessment studies and emergency action plans for tailings dams require a multidisciplinary approach in which engineers, geologists, hydrologists and environmental scientists collaborate to provide a complete and thorough evaluation of feasibility, design, construction, performance, rehabilitation studies and root cause failure analysis. This will mitigate against risk of failure and satisfy the regulatory authorities that an holistic approach to risk management is being pursued.

Managing/minimising environmental damages liability

Companies need to take positive steps to understand, manage, and minimise the risk of potential environmental (i.e., natural resource) damages claims including buying appropriate risk transfer products. Although there are some major differences between environmental damages regimes of the various countries (e.g., liability is retroactive only in the USA), there are two fundamental technical concepts upon which the extent of liability is defined – baseline and causation – and these concepts afford companies opportunities for limiting liability. Both concepts can protect companies from damage claims where all or a portion of the damages may be attributable to environmental conditions not associated with a covered event. In addition, all environmental damages regulations require a responsible party to restore damaged resources to their baseline condition, and understanding the methods for determining the scale of that restoration is critical to managing liability.

The baseline condition of a resource is that condition that would be expected had a specific environmental incident not occurred. The baseline condition should take into account natural variability as well as any other environmental stressor (such as pollution from other sources and habitat loss) that might be affecting the status of a given resource. The series of photographs on the opposite page shows a boulder in the unaffected intertidal zone of Prince William Sound Alaska in the years following the Exxon Valdez oil spill.
Natural interannual variation in the degree of algae cover is dramatically evident. It is important to understand and account for natural variation when estimating the extent of environmental damages from an incident.

Causation is a fundamental aspect of law that requires a claimant to be able to establish that an event "X" resulted in an observation "Y". Causation is inextricably linked to baseline, but may also involve careful consideration of ecological and toxicological factors. Causation may be relatively easy to understand in cases where an event results in a direct and acute environmental impact such as a fish kill; however, in most cases, there are subtle adverse effects that may be attributable to environmental degradation as a whole or might simply be correlated with an event but have no causal linkage. Take for example a claim for damages to citrus trees from oil burn pits and flaring in Yemen (see photographs opposite). A careful assessment of causation revealed that excessive groundwater withdrawal had resulted in degradation of soil quality of the region and toxicity to orchards.

It is thus important for insureds to collect the right kind of information associated with their area of operations so that baseline conditions are well defined. This might involve a narrative history of resource use and development as well as collection of environmental (biological and chemical data) to understand the conditions of resources should an incident occur at their facility. In the event of an incident that results in a claim for environmental damages it is also important for insureds, and insurers to engage with qualified experts who can confidently and convincingly determine the nature and extent of damages that were caused by the incident and how quickly recovery will occur.

Since the cost of restoration is an important component of total liability for environmental damages, appropriate scaling of restoration actions is critical.

Restoration scaling requires determining actual liability (based on proper analysis of baseline and causation) as well as applying the most appropriate ecological and economic tools and metrics. For example, in the event of a sudden and quickly reversible fish kill, the appropriate metric for scaling restoration may be numbers of fish. By contrast, restoration related to long-term pollution of a salt marsh and coastal habitat may require application of more holistic approaches that consider entire habitats or ecosystems.

Conclusion

The landscape of environmental risk in the mining sector is evolving and complex and although it varies across the globe, the underlying theme appears to be increasing regulation, enforcement of stricter standards and greater emphasis on obtaining and maintaining a social licence to operate. These developments, together with the increase in public awareness and the empowerment of individuals to act, means that the risk profile of the mining industry remains high and the bar continues to be raised. Mining companies must act to understand the breadth and depth of these potential risks and liabilities and seek to manage these using all means at their disposal, including a holistic and integrated approach to risk management and the consideration of appropriate insurance coverage.

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Part three
Mining industry risk transfer issues
The UK 2015 Insurance Act – why it matters

It has been reported that 1 in 4 London market insurers will have to rely on investment returns to make a profit in 2016 (PwC December 2015). The market is soft across various classes of business and this includes the mining sector, which also faces a number of key challenges from increasing costs associated with sourcing and extracting various commodities.

Business costs in such circumstances are always under the microscope - particularly expenses such as insurance premiums.

With the needs of mining companies and their insurers potentially in conflict, policy coverage specialists are no doubt being inundated with potential amendments to policy wordings relating to mining insurance contracts now that the Insurance Act 2015 has been introduced in August 2016 (“the 2015 Act”).

A new landscape for insurance contract law
Despite 60 years of criticism, the Marine Insurance Act 1906 (“MIA”) has not been formally repealed but the 2015 Act sets out a new landscape for insurance contract law. Fundamental changes will be made in respect of the negotiation of the contract of insurance and a greater onus now falls upon insurers to ask key questions of the Assured and its business before the policy incepts or renews.

The 2015 Act affects the way in which business is underwritten and placed. It also changes insurers’ remedies for non-disclosure and misrepresentation, breach of warranty and fraudulent claims. The 2015 Act has particular ramifications for key aspects of insurance law, including critical policy provisions such as Warranty and Due Diligence Clauses.

The Assured and its broker are required to make a fair presentation of the risk. This represents a fundamental shift from the doctrine of “utmost good faith” (enshrined in Section 17 of the MIA). That is not a new concept - in fact there is an element of going “back to the future”.

Nearly 250 years ago Lord Mansfield (Carter v Boehm (1766) 3 Burr 1905 at 1909) stated:

“Insurance is a contract based upon speculation. The special facts upon which the contingent chance is to be computed, lie most commonly in the knowledge of the insured only; the underwriter trusts to his representation and proceeds upon the confidence that he does not keep back any circumstance in his knowledge, to mislead the underwriter into a belief that the circumstance does not exist, and to induce him to estimate the risqué as if it did not exist”

What does this mean in practice, against the backdrop of statements of practice, FCA rules, FOS discretions and industry guidance?

First, these changes will apply only to business insurance (consumer insurance having already been clarified by the Consumer Insurance (Disclosure and Representations) Act 2012).

Fair Presentation
The most important aspect of the 2015 Act is the requirement of a fair presentation of the risk.

The Law Commissioners criticised the perceived practice of overly complicated presentations and “data dumping” by Assureds and their agents. Accordingly, disclosure must be “in a manner which would be reasonably clear and accessible to a prudent underwriter” (Section 3(3) (b) of the 2015 Act).

Multi-nationals seeking coverage in the London Insurance Market have been accused of “data dumping” and providing a mass of information that may not be particularly relevant to Insurers in determining whether to accept the risk. The Assured must carry out a reasonable search for information; with what is “reasonable” depending on the size, nature and complexity of the business.

The 2015 Act places a duty on the Assured’s senior management (including the board of directors and others such as Risk Managers, amongst others, who have actual knowledge of the Assured’s business) to make a fair presentation of the risk.

The Assured is deemed to know what “should reasonably have been revealed by a reasonable search”.

52 willistowerswatson.com
Positive duty of inquiry for the insurer
Unlike the MIA where the Insurer was not required to ask questions or indicate what it wished to know, the 2015 Act also creates a positive duty of inquiry for the insurer. Also, an Assured is not required to disclose information that an insurer already knows (Section 5 (1)); or information that it ought to know (Section 5 (2)); or information that it is presumed to know (Section 5 (3)). As is the case now, an Insurer will also be presumed to know things which are common knowledge.

Examples of “material circumstances” for the purposes of a “fair presentation” are set out in the 2015 Act for guidance. They include “special or unusual circumstances” relating to the risk; any particular concerns that led the Assured to seek insurance in the first place; or anything which those concerned with the class of insurance and field of activity would generally regard as being required to be dealt with in a “fair presentation”. Insurers and brokers have been tasked with developing protocols setting out their agreed procedures.

The fundamental change is that Insurers are required to raise queries if they are put “on notice” of information that requires further clarification. No defence of non-disclosure will be available to Insurers who do not raise enquiries in those circumstances.

Also, the effect of the MIA had “evolved” in the Courts where if an insurer had been put fairly on enquiry about the existence of other material facts, which an enquiry would have revealed then if the insurer does not pursue those enquiries he will have been held to have waived the disclosure of those material fact(s). The test is objective while the insurer need not be “….a detective on one hand nor lacking in common sense on the other” notwithstanding that mere possibilities would not put the insurer on enquiry (per L.J. Rix – WISE (Underwriting Agency) Ltd v Grupo Nacional Provincial SA [2004] 2 All ER 613 at [64]).

Remedies
The 2015 Act also changes the remedies that are available to parties to the policy.

The test for reliance on the “nuclear” remedies of non-disclosure or misrepresentation has changed significantly. Furthermore, the ability of either party to avoid the policy for a breach of good faith is abolished.

It is now possible to avoid a policy only where the misrepresentation or non-disclosure was deliberate or reckless, which, depending on the facts of the case may prove to be an extremely difficult test for an insurer to overcome. In all other cases the following proportionate remedies will apply, depending on what the Insurer would have done if a fair presentation had been made:

1. If the Insurer would not have entered the contract at all, it can avoid the contract but return the premium
2. If the Insurer would have entered the contract on different terms, the contract is treated as if those different terms were applicable
3. If the Insurer would have charged a higher premium then the amount paid on a claim may be reduced proportionately

The test of what the Insurer would have done had it known the true facts remains entirely subjective, while the burden of proof for avoidance is also unchanged. It remains to be seen whether the Courts will be more willing to conclude that the Insurer has met this burden with proportionate remedies being on the menu as opposed to the one option presently available.

The level of egregious behaviours – in terms of what constitutes an unfair presentation – will no doubt be developed by case law. The increased options available to Insurers should assist commercial relationships as opposed to having only the sole present “nuclear” option.

Warranties
The MIA provided that a warranty had to be strictly complied with, whether it was material to the risk or not (Section 33 (3)). If not complied with, the insurer is discharged from liability from the date of the breach.

The effect of the breach is actually automatic rather than being dependent upon the insured's acceptance or election of the breach (per Lord Goff - Bank of Nova Scotia v Hellenic Mutual War Risks Association (Bermuda) Ltd (The Good Luck); HL 1992.

The 2015 Act mirrors the present position in consumer contracts of insurance by doing away with basis of the contract clauses. Long lists of answers to questions in a Proposal Form being “converted” into individual warranties have therefore become a thing of the past.

Instead, all warranties have become “suspensive conditions” so that an Insurer will be liable for losses that take place after a breach of warranty has been remedied, assuming this is possible. For example, if an oil tanker steams in to a warranted excluded area she may be without cover for the period of that element of the adventure and she is only “back on cover” when she is navigating non-excluded waters.

Alternatively, and considering the matter from a non-marine perspective, if the Assured breaches a warranty that an alarm system will be inspected every six months that breach will be “remedied” if the system is inspected after seven months, with coverage being deemed to have been suspended for one month in such circumstances. If a claim arises during that one month period then Insurers can potentially rely upon the breach of warranty.
The Act makes it clear that breaches of warranty that are irrelevant to the loss that occurs will no longer discharge insurers from liability. If the Assured can show that failure to comply with any term in the contract (including warranties) could not have increased the risk of the loss which actually occurred in the circumstances in which it occurred, insurers will no longer be able to rely on the breach to exclude liability.

In order to limit the scope for dispute, it would be advisable for the parties to clearly set out their requirements and the consequences for non-compliance. Warranties are still “live” but clear wording is required for them to bite. The usage of detailed protocols has been encouraged and should include specific reference to warranties.

**Fraudulent claims**

An Insurer is not of course liable to pay a fraudulent claim. Under the 2015 Act an Insurer has the option of terminating the contract from the date of the fraudulent act – not the discovery of it – or if it does not treat the contract as having been terminated refuse all liability to the insured in respect of a relevant event after the time of the fraudulent act without any return of premium.

The Law Commissioners believed that Insurers would welcome this option as it would allow greater commercial flexibility. The Insurer can then refuse to pay any claims from that point onwards (but will remain liable for legitimate losses before the fraud) whereas previously under the MIA an Insurer may be able to cancel the policy from inception regardless of when the fraudulent act occurred enabling them to recover any sums already paid prior to the act.

**Contracting out**

The changes are intended to be a “default regime” for business (non-consumer) insurance. The Law Commissioners anticipated that “in sophisticated markets, including the marine insurance market, we expect contracting out will be more widespread”. A business opportunity has been presented to Insurers and brokers who wish to provide and negotiate a bespoke product.

That said, if Insurers seek to proceed arbitrarily during the placing negotiations they will be required to identify every change which they do not intend to apply and the opt-out for that change separately in the policy. The changes need to be transparent.

Where Insurers intend to include a more disadvantageous term than in the default position, they must take sufficient steps to draw that to the Assured’s attention before the policy incepts and the disadvantageous term must be “clear and unambiguous as to its effect”. Particular attention in that regard should be given to small businesses (especially when purchasing via online platforms). However it is not possible to contract out of basis of contract clauses (see Warranties above).

**The Enterprise Bill**

This bill proposes an amendment to the 2015 Act that, if passed, could be law in 2017. Basically, insurers are now faced with an implied obligation to pay claims within a reasonable time.

How long is that? I do not know, as with all claims the facts will differ from case to case. Where the insurer is in breach the remedy is damages which will be awarded in addition to and distinct from any right to enforce payment of the sums due under the policy and any right to interest on those sums.

Again, the amount will be case specific and will vary. This implied term can be “contracted out” provided the transparency requirements are complied with and the insurer does not deliberately nor recklessly fail to pay the claim.

A limitation period is deemed to be of one year from the date when the insurer actually makes payment (if it does) or the last payment if in tranches or if earlier 6 years from the date on which the cause of action for the breach of the implied term occurred.

The bill is currently in the House of Commons having been amended by the Lords last year.

**A final word**

The Act has in parts codified modern case law (as did the MIA in its day). However, the introduction of proportionate remedies in cases on non-disclosure and warranties are startling and the effects on the insurance market will be far-reaching.

The clock is ticking – insurers, brokers and Assureds would be well advised to get up to speed with the new framework and be prepared for the “new normal”.

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Environmental risk transfer for miners

**Changes in environmental risk landscape**

For mining companies operating across the globe there is a myriad of legislation affecting operations. Much of this legislation includes Environmental Law that imposes strict liability for clean-up and third party damage arising from all operational phases. There are over 16,000 different environmental laws around the world, creating huge potential for change of law exposures occurring during long term contracts.¹

Increasing public awareness of environmental issues has massively increased the scrutiny operators are under.

Recent catastrophic environmental issues in Brazil have also very publically pushed the impact of pollution incidents to the top of all boardroom agendas. Indeed, in Hungary there was a very well publicised “red mud” contamination issue in recent years.

**Case Study: European Union**

In the European Union the EU Liability Directive has created a number of additional exposures for operators that are commonly excluded from other insurances:

The Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remediying of environmental damage (ELD) establishes a framework based on the “Polluter Pays” principle to prevent and remedy environmental damage. The Polluter Pays-principle is set out in the Treaty on the Functioning of the European Union (Article 191(2) TFEU). As the ELD deals with the “pure ecological damage”, it is based on the powers and duties of public authorities (“administrative approach”) as distinct from a civil liability system for “traditional damage” (damage to property, economic loss, personal injury).

The Directive defines “environmental damage” as damage to protected species and natural habitats, damage to water and damage to soil:

- Operators carrying out dangerous activities listed in Annex III of the Directive fall under strict liability (there is no need to prove fault).
- Operators carrying out other occupational activities than those listed in Annex III are liable for fault-based damage to protected species or natural habitats.
- The establishment of a causal link between the activity and the damage is always required. Affected natural or legal persons and environmental NGOs have the right to request the competent authority to take remedial action if they deem it necessary.

The ELD was amended three times through:

- Directive 2006/21/EC on the management of waste from extractive industries
- Directive 2009/31/EC on the geological storage of carbon dioxide and amending several directives
- Directive 2013/30/EU on the safety of offshore oil and gas operations and amending Directive 2004/35/EC

The amendments broadened the scope of strict liability by adding the “management of extractive waste” and the “operation of storage sites pursuant to Directive 2009/31/EC” to the list of dangerous occupational activities in Annex III of the ELD. The Offshore Safety Directive, containing an amendment to the ELD (extension of the scope of damage to marine waters), was adopted in June 2013.

**Result: reduced certainty**

The ELD has reduced certainty for operators in the mining sector by creating a significant exposure over and above the pure clean-up cost. What must be remembered is the potential for compensatory remediation and “alternative habitat creation” can be directly linked to a corporate’s size and market capitalisation – rather than the cost of cleaning up the original pollution incident.

In simple terms a “clean up bill” of, say, £100,000 over a 2 month period could result in a Natural Resource Damage remediation requirement 20 times greater in terms of both cost and time.

Further introductions of Pure Financial Loss clauses to contracts have increased contractual exposures for many contractors operating on a global basis. This means that many contractors are effectively indemnifying the principal for environmental risks that are often uninsured (gradual pollution/1st party clean up and liability arising from pre-existing conditions)
**Balance sheet consequences – the perfect storm**
The volatile price of commodities on the global markets is obviously affecting operators and contractors across the mining sector. But how is the downward pressure of prices affecting what is happening on the ground (and indeed beneath the ground) around the world?

In conversation with many of our clients it is evident that the negative movement has reduced balance sheet reserves and cash at hand because fewer contracts are being let for exploration, production and processing. This economic downturn is apparent across the globe.

But isn't everyone in the same position? Well yes, to a degree, there is a general downturn across the globe. But what is interesting is that falling prices have had multiple effects, namely:

1. The price drop has caused many projects to be mothballed.
2. Abandoning old infrastructure or extending the operational phase of existing infrastructure increases the potential for loss of containment.
3. Reduced revenue streams at a time when management costs relating to tailings facilities and environmental compliance costs are increasing.

So, in effect we have a perfect storm of latent liability being increased by more stringent regulation across the EU whilst less cash goes on the balance sheet or into captives.

**Available risk transfer solutions**
The London insurance market (in conjunction with Willis Towers Watson) has recently designed some novel and unique risk transfer policies that address many of the issues mentioned previously. This market is at the forefront of designing bespoke polices for the natural resources industry across the globe in the following areas:

- Contractors Pollution Liability policies, for mining operations across the globe
- Pure Financial Loss policies, to cover Third Party Financial losses following a pollution Incident
- Environmental Impairment Policies, that sit alongside General Liability policies and “fill the gaps” left by the common exclusions of gradual defect and pre-existing conditions
- Insurance for Contractual Warranty and Indemnity provisions, something that is commonly excluded by other standard policies

One of the major limitations to the provision of large scale insurance for the mining industry is capacity, while the market could easily put together £250 million of capacity for a project, the size of the numbers involved in potential EIL claims simply dwarf this sizeable figure.

So where does the market provide benefit? The benefit is for all those claims and issues that are currently either uninsured or are being funded out of profit (declining) and loss accounts in the future. For prospecting and contracting companies EIL Insurance can be an essential part of the risk management process to transfer contractual risk and protect.

For any company with captive and/or balance sheet reserves the insurance community can, and does, provide meaningful insurance and reinsurance of these complicated (and potentially long tail) liabilities.

**Conclusion**
Insurance is only part of the risk management toolkit for all companies involved in the mining industry. Advanced engineering, operating at the outer extremes of the globe and increasingly strict regulation dictates that the management of environmental risk is part of daily operations. Integration of specialist insurance products into the conventional risk transfer suite can only add to insulate business during these uncertain times.

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The mining industry: Alternative Risk Transfer solutions revisited

The challenge to the mining industry

Insurers and risk management professionals have been talking about so-called ‘Alternative Risk Transfer’ (ART) since the 1990s. Over the years this vaguely-defined term has variously been applied to a wide range of risk management products. During this period some of the more outlandish approaches have been abandoned and their more ‘creative’ interpretations of risk and accounting confined to history. However, ART lives on and we examine in this article how risks facing the mining sector may now benefit from the solutions that extend beyond the ‘plain vanilla’.

What, if anything, has changed?

In recent years the volume of capital in the traditional reinsurance market has remained somewhat stable, whereas the volume of alternative capital continues to grow and may now represent as much as 15% of the global total. This influx of new capital has resulted from uncertainty in some asset classes and the low interest rate environment, which has created an appetite amongst sophisticated investors to look into alternative investments. The increase in new capital is significant in itself, but it is also instrumental in creating leverage in the offerings of traditional insurers and reinsurers. Insurers in both Europe and the US have responded with investments in ART focussed teams and a willingness to offer more flexible and bespoke solutions to the risk issues of corporate buyers.

New capital is not the only driver of change in this market. The far greater availability and sophistication of data creates opportunities for innovative (re)insurers to price and underwrite new types of risk business.

Mining industry challenges

In parallel to these changes in the risk capital environment, the mining sector market is similarly going through a period of transition so mining companies need to make commensurate changes if they are to survive. Not only is the nature of both supply of and demand in extractive industries changing, but also the environment in which those two drivers exist – not least the focus on environmental impact, resilience from climate change and energy efficiency.
Today the mining sector is confronting challenges from a variety of diverse influences, including global economic stagnation and an ongoing weakness in the commodities market.

At the same time, risk managers in the sector are increasingly confronting emerging risks that are traditionally difficult to insure. These include non-damage business interruption, environmental, climate, reputational and cyber risks, the impacts of which can amount to many billions of dollars of cost.

**Today’s ART solutions**

Today’s ART market is flexible and far-reaching, providing many ‘types’ of solution according to the buyer’s specific risk management objectives and financial circumstances.

**ART solutions can offer risk management alternatives to the mining sector**

Undoubtedly ‘traditional’ insurance coverages provide the bedrock of the coverage needed by the mining sector. This is a tried and tested approach. However, it is recognised that there are certain ‘no go’ risks for which insurance is not available – either at all or at economically feasible cost – for which ART may provide a feasible alternative.

Many mining businesses already have their own captive insurer which, whilst being far from ‘alternative’ does enable an interaction with alternative capital providers and the structuring of self-funding and multi-year solutions that are not otherwise available.

**Integration of the traditional and the innovative**

Key to the growth in the deployment of ART solutions is the ability to integrate traditional re/insurance products and capital market techniques with forms of self-funding, flexible multi-year, multi-line and multi-trigger products.

The ability to draw upon this broad palette is enhanced by the availability of deep pools of data which were previously unavailable or effectively so within reasonable time and cost constraints. For example, open-source satellite-derived imagery enables the pricing and settlement of contracts in real time which would, only a short while ago, have been inconceivable.

**New sources of risk bearing-capital**

Another key driver enhancing the practical availability of ART products in today’s market is the influx of new sources of risk-bearing capital, that are available – even aggressively so – to address the risk of the mining sector.

The early 1990s witnessed the introduction of so-called Catastrophe (“Cat”) Bonds, more generically referred to as Insurance-Linked Securities.

These highly tailored instruments enabled buyers to access bespoke capital ‘directly’ from investors who were able to evaluate natural catastrophe risks such as windstorm or earthquake. At that time, the sophistication of modelling of such risk had, for the first time, reached a point to enable non-expert risk takers to participate in an objective and price-transparent fashion. The providers of the models were – and still are – specialist third parties accessing the most up-to-date perils data and science to evaluate the expected loss to the contract. On the other side of the deal, such products enabled investors for the first time to participate directly in insurance ‘event’ risk – without either the need to register as an authorised re/insurer or to invest in the general stock of such companies that were.

Since that time, the base of capital that has become available has grown exponentially in absolute size and broadened in origin. At the outset of the ILS market, investors were confined to a small number of far-sighted institutions (typically pension and specialist funds) with the aptitude and appetite to dip their toe in the water of a new asset class. Investments were individually modest, all deals rated and little, if any, reference was made to the process of indemnity. In other words, contracts were typically settled against an index or a modelled version of the risk. The structure of such cat bonds was deliberately set so that pay-outs were indeed at the catastrophe end of occurrence probability – somewhere in the region of 1 in 75-100 years or greater. This remote probability of expected loss enabled the securities to be issued with an investment grade rating or better, this being an essential prerequisite of the investor community at that stage.

### Moving into traditional territory as appetite broadens

During the last couple of decades, investors of alternative capital in the re/insurance market have certainly found their stride and made in-roads into the space occupied by traditional insurers and reinsurers. In particular, their appetite has broadened in terms of the type of underlying risk they are prepared to invest in and the forms in which these contracts are drawn. Notably there is some willingness to accept traditional indemnity style (or ultimate net loss) contracts whose pay-outs are the same as traditional insurance or reinsurance contracts.

### What makes a great index?

However parametric, or index-based, contracts remain a more suitable basis for the efficient participation of alternative risk investors, particularly in respect of the risks of corporate (as opposed to insurance company) buyers. The design of the index itself is open to infinite possibilities so long as there is data available upon which to structure and price the contract and upon which to settle claims. This flexibility allows buyers to develop bespoke coverage to reflect their own specific circumstances.
There are a few prerequisites for good index design and for their underlying data:

- The data must be independent; it needs to be measured and recorded by a third party that is trusted by both buyer and seller
- There can be no subjectivity or lack of transparency in the way in which the data points are measured or compiled
- The data should not be subject to historic (or indeed future) discontinuities that cannot reasonably be accounted for
- The index data must continue to be reported in the same way (and generally by the same agency) during the foreseeable duration of the contract

**Correlation to actual underlying losses essential**

In general terms, an index based contract is only a good alternative to traditional indemnity style contracts if the index itself provides a good proxy for the actual underlying losses. In general terms this requires that a strong correlation in statistics terms can be shown between the historic performance of the index and the losses sustained by the buyer.

There are two main reasons why this may not be the case:

- If the measurements for the index data are taken at a time or place which does not accord well with the activity and location of the risk(s) in question
- A simple single parameter index (say wind speed or rainfall) may not be sufficient to capture all the components of risk that impacts the insured assets or the revenues/costs of the buyer.

It is, of course, possible to design highly complex multi-parameter indices so that these fit the actual loss profile more accurately, but, although an overly complex index design may have scientific merit or mathematical credibility, it may not be sufficiently easy to explain to a buyer or seller.

**Consideration of the basis risk**

This so-called basis risk must be considered in the design of any index-based contract. It must, wherever possible, be estimated and discussed between buyer and seller to ensure absolute transparency. However, this potential for mismatch between actual loss and contract pay-out is certainly not confined to parametric structures. Conventional contracts of insurance and reinsurance also contain terms and conditions (exclusions, warranties, excesses, waiting periods and the like) which can severely constrain the payment obligations of the insurer. Some would argue that these conditions of non-payment are far more penal and prone to subjective interpretation than the very simple operation of an index.

**Speed and simplicity of contract settlement**

Although basis risk is a potential disadvantage of contracts which respond to an index as opposed to the actual losses sustained by the buyer, the use of a parametric index confers certain functional and economic advantages over the more conventional indemnity-style contract - in particular, the speed and simplicity of contract settlement (pay-out or otherwise) after the event or at the end of the contract period. So long as the underlying index data are available without delay (and it is typically the case that index data are published in real time), then there is no reason why the settlement amount cannot be agreed immediately and payment made within a number of days. Two weeks would be a typical timeframe in which to reach such an agreement.

This speed and simplicity of payment, especially after a severe event, can easily compensate for any differences that might be observed between an index-based contract and the conventional indemnity process which can, in the most complex cases, take months or even years to finalise.

**An illustration from Australia**

It is the case that alternative, including and especially index-based, contracts provide the potential for contractual risk transfer where simply none would otherwise be available from conventional insurance providers.

Take, for example, the recent case of a major new mining project in Australia. At the stage of completing its project finance, the lenders to the project became aware that completion time could be significantly delayed and overall expense greatly increased in the event of severe land-falling tropical cyclones occurring at or near the project location – the site was located in a cyclone exposed area.

**No need for physical damage loss – massive cyclone exposure still remained**

The problem was not that damage (and consequent business interruption) might be a causal factor, as this was properly covered by the project's normal insurances; the issue, in this case, was that such damage might not occur and hence the traditional coverage would not pay a claim. Should a tropical cyclone be forecast to approach the project site, health and safety obligations meant that the many thousands of employees would have to be evacuated to a place of safety irrespective of any damage that may, or may not, occur. Such was the remoteness of the project location that the time and logistics of such an evacuation could cause substantial additional expenses – as well as a costly delay in the resumption of normal activities.
Parametric structure ideal for pre-funded specific contingency facility

As no insurance was available to cover the expenses associated with a forecast event that might or might not occur, the project lenders determined that a specific contingency facility – additional to the existing borrowing requirements of the project – should be pre-funded. In this case a parametric structure provided exactly what was needed: to the satisfaction of the lenders and at far less cost than the cash-reserve alternative. Furthermore the product was structured as a multi-year contract to track the intended timeframe of the construction and commissioning phase of the project.

The proof of the pudding

The solution that was ultimately implemented was elegantly simple and highly effective, as judged by its performance following a triggering event in its first year. It followed the format of a so-called ‘Cat-in-a-Box’ product; in this case, a circle not a box. Working with the project’s senior management, the boundaries of a zone (the circle) were defined. A pay-out formula was devised whereby any tropical cyclone entering the coordinates of the circle automatically entitled the buyer to a fixed pay-out for every hour that the storm remained within the circle at tropical cyclone strength. As storm tracks and intensity are recorded and formally reported by the local meteorological bureau, a credible and rapid basis of settling the contract was possible.

Similar index-based solutions may be structured for diverse and otherwise intractable risk management challenges more or less anywhere in the world. In other natural resources environments, this could include, for example, the cost of evacuating off-shore platforms in the event of real or forecast windstorm activity, the cost uncertainty associated with the construction and maintenance of offshore facilities in high wind or wave conditions or the variability of power output from renewable energy plants that rely on the availability of wind, water and solar. Index based solutions are not a replacement for traditional insurance, but can often provide solutions for risks where traditional insurance is either not available, non-responsive or only available at economically unfeasible cost.

Conclusion: ART and the sophisticated buyer

While index-based solutions are one form of ART, the term encompasses a much broader range of solutions. These can be employed to provide more efficient structuring for traditionally insurable risks, to access deeper pools of risk capital or to provide capacity for otherwise uninsurable exposures - such as supply chain vulnerability, cyber, pandemic, brand and reputational risk.

ART solutions merge the best of capital market techniques with traditional insurance, risk sharing and risk retention structures, all underpinned by sophisticated analytics, to enable companies to select the most efficient form of risk financing for their specific risk profile, risk exposures, risk appetite and cost of capital. Captive Solutions, Portfolio Solutions and Structured Solutions all form part of the ART palette of options that companies can consider to more efficiently manage risk.

ART is increasingly mainstream amongst the more ‘risk management savvy’ corporates and there is evidence of a positive correlation between a company’s general sophistication and the adoption of ART solutions as part of their management of risk.

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Danger up ahead? A review of the global insurance market for the mining industry

All quiet on the mining front?
At first sight it is evident that the purchase of conventional risk transfer products is currently not the most challenging aspect of a mining industry risk manager’s job. Indeed, our recently published Natural Resources Risk Index showed that there are a number of issues weighing on the minds of top mining industry executives right now, such as currency fluctuations, access to capital, increased regulation and environmental obligations which don’t all have risk transfer solutions.

Focus on cost reduction...
Furthermore, mining companies are focused more than ever on cost reduction and optimizing operations to withstand the current challenging operating environment. While mining executives and risk managers focus on the areas of their business that don’t intersect the insurance market, risk intermediaries must identify those that do and to help risk managers anticipate any changing dynamics in the insurance industry that could have material impacts on their budgets and insurance buying strategies.

...fortunately, the market’s still soft!
In this article we discuss our view of the mining insurance market for the second half of 2016 and beyond. On the whole, capacity remains abundant for the mining sector; competitive pressures continue to keep prices low and the required policy limits continue to be readily achievable for all but the least attractive programmes.

Mining companies therefore have many options in today’s market for evaluating alternative structures, alternative markets and indeed alternative brokers, all in an effort to drive total premium spend downwards. You would be forgiven for thinking that they will continue to reap the benefits of the current market situation for several years to come.

But...
But as an old song has it, “there may be trouble ahead”. In this article, we review not only why the market continues to be an attractive one from a buyer standpoint but also some of the hidden dangers that lurk beneath the surface of today’s market – dangers that could one day have a profound effect on market conditions.
Part one – the good news

No change in the macro (re)insurance picture
Let us start by taking a high level view of today’s global (re)insurance markets. Since the global financial crisis of 2007-2008, capital has been flooding into the (re)insurance markets, with investors viewing the sector as a safe haven for their capital. This in turn has led to cheap and plentiful reinsurance being available for the mining portfolio, which in turn has enabled the direct mining market to offer most miners not only an acceptable level of capacity but at increasingly attractive terms.

New entrants make up for any market withdrawals
Have there been any recent developments to halt this trend? Well, none that have materialised as yet. With the overall Property portfolio still generating positive underwriting returns, and the Liability portfolio showing lower losses than originally reserved in many cases, investors continue to seem confident that (re)insurance can generate the returns they need to make the deployment of their capital worthwhile. And so year on year, we are finding that any capacity withdrawals are more than made up for either by new entrants or by existing mining insurers armed with additional capacity. To date, though return on capital is trending downwards for (re)insurers and some are taking a more cautious approach to the renewal of less attractive business, we have seen no real evidence that overall capacity won’t continue to increase, at least for the short term; with interest rates continuing to remain at record low levels, it is difficult to see where investors would turn to in order to generate more favourable returns.

To illustrate, on average global reinsurers in the first half-year of 2015 reported an annualized return on equity of 10.7%, which although down from 12.2% in the same period last year, still represents a healthy return.¹

However, a note of caution should perhaps be sounded. These figures do not properly reflect the underlying profitability, because insured catastrophe losses have been lower than anticipated and the claims ratio has been reduced by positive reserve releases from redundant reserves for prior years’ claims. Indeed, some underwriters have stated that their return on equity/capital is now only about 9% through Q2 2016 and if it gets below 7%, they fear they will no longer be able to retain or attract new capital.

Abundant capacity
Notwithstanding the above, capacity levels for mining operations still remain abundant. From a Property perspective, the largest programme limits required for surface mining & processing – approximately $1 billion – can be placed without much difficulty, and we estimate that overall global capacity for underground coal mining operations is now in excess of $200 million. These figures reduce significantly for some regional markets, and indeed the involvement of London is essential if these figures are to be achievable.

From a Liability perspective, although maximum realistic capacity is as much as $1.6 billion, economically this again reduces down to about $1 billion, and we are not aware of many programmes that require a higher limit than this at this point in time.

Reasonable loss record
The overall loss record for the mining industry remains moderate, with the exception of two significant regions, Latin America and Australia. In Latin America, 2015 saw the tragedy of the Samarco tailings dam disaster, while in Australia there have been three notable losses involving a fire, a failure of a sea wall and a collapse of a pressure tank. However, apart from these losses, our statistics show very little meaningful loss activity in key regions such as North America and South Africa – a factor that continues to allow the sector to generally remain profitable. However, in South Africa, a platinum mining company did suffer an underground fire in January 2016; unconfirmed market speculation indicates that the estimate is in the region of $50 million to $75 million, a significant claim in South African terms.² In the United States, there was one large property loss in 2015 of approximately $150 million, but this has not been enough to generate any impact on market conditions.³

While mining executives and risk managers focus on the areas of their business that don’t intersect the insurance market, risk intermediaries must identify those that do and to help risk managers anticipate any changing dynamics in the insurance industry that could have material impacts on their budgets and insurance buying strategies.
Regional market competition continues

Given the abundance of capacity, it is not surprising that we continue to see competitive pressures continuing to exert themselves in virtually every region in the world.

In South Africa, rate reductions of 5 to 10% can generally be achieved for mining companies with an embedded risk management programme and acceptable claims record. Stable rating for the less risk-managed clients and those with adverse claims experience is the norm. Meanwhile, the local market for mining risks remains buoyant. Emerald continues to be a mining market leader, benefiting from the Santam rating of S & P “AAA” ZAF (National Scale), the highest of any local insurer. Their capacity is in the region of $30 million underground and $100 million on the surface for South African accounts. Emerald continues to diversify geographically and is gradually expanding into the Middle East, although with moderate capacity of a maximum of $20 million. Furthermore privately-owned Hollard Insurance achieved a gross premium income of approximately $1 billion in 2015 and has expanded in recent years into four other African countries as well as India, China and Australia.

In North America, the two historical supporters of the mining industry, Zurich and AIG, continue to dominate the large account mining portfolio, closely followed by Berkshire Hathaway and Factory Mutual (FM). Chubb, Rockwood Casualty and Houston International are also actively targeting new mining business in the U.S.

On the Property side competition is cautiously intensifying, with both Berkshire and FM poised to compete more vigorously for those programmes where the leading two insurers are scaling back, while further competition is available from the likes of Munich Re (who have shown particular interest in developing their North American portfolio), Swiss Re and Gerling.

Global environmental concerns and strengthening of the U.S. federal regulatory requirements are focusing attention on financial assurance for mine operators. Both the U.S. Environmental Protection Agency and the Office of Surface Mining Reclamation and Enforcement are considering topics ranging from climate change to selenium discharge into waterways. The viability of self-bonding also joins the conversation. All indicators point to a change in historical surety requirements.

Similar to other insurance lines, surety has experienced favourable loss activity in North America, resulting in a competitive landscape where creative solutions have been tailored across provinces and states. Amid a healthy appetite among the surety underwriters for reclamation and remediation obligations, financially distressed operators are finding surety capacity supported by some collateral while healthier operators are finding financial assurance products underpinned by the surety underwriters. These evolving hybrid products compete with alternatives to bonds providing clients with options as they look to solve their growing financial assurance needs.
In Australia, competitive conditions continue with the majority of capacity for most programmes sourced locally. Complex programmes continue to be led by traditional mining markets who remain dedicated to the sector such as Swiss Re. Mid-tier to large programmes can be led by local leaders such as Vero (although they do not participate on coal risks). Meanwhile markets such as Allianz, Zurich, QBE, AIG, Munich Re and Starr are all also significant supporters of Australian risks.

As a new entrant Berkshire Hathaway has certainly shown an appetite for Australian mining risks; they have established an experienced local team with meaningful capacity offerings although with a disciplined approach to underwriting. In addition, FM seem interested in expanding their gold mine portfolio, and they have expanded their target range to include smaller, mid-sized accounts that demonstrate a healthy risk profile.

The mining portfolio in Australia, especially when there is either a pronounced Natural Catastrophe exposure or significant underground limits are required, remains a fairly niche market and requires the participation of key mining markets. In addition:

- Traditional mining markets are offering rate reductions to retain market share due to competition from non-traditional mining markets
- Premium reductions (in addition to rate reductions) are also being achieved due to general reductions in Business Interruption values
- Requests for detailed information, in particular on exposures such as tailings dams, is increasingly becoming a feature of negotiations to maintain existing coverage

Furthermore, the soft market has seen a simplification of programme structures put together by brokers, with more programmes placed on a quota share basis, which has also coincided with a willingness from risk managers not to over complicate claims settlements when faced with greater numbers of programme layers and carriers.

In Latin America, unlike other regions, the majority of the non-fronting underwriting capacity available is accessed from global (re)insurers such as AIG, Swiss Re, Ace/Chubb and Munich Re that form part of the overall global capacity, so here it is less of a case of local markets competing against the major carriers and more a case of the major Miami-based carriers competing with themselves.

Finally in London, we can report that all the Lloyd's syndicates currently writing mining business continue to do so, providing capacity anywhere in the world to augment existing local market offerings. Indeed, in areas such as Australia where the recent loss record has been less favourable than in other parts of the world, it is perhaps the availability of significant capacity from Lloyd's that has kept competitive pressures intense and has not allowed the local market to effect any kind of a market turnaround.

In general terms therefore, we can effectively report a similar story across the various mining markets across the world. Yes, there have been some losses, one extremely significant. But with the global (re)insurance market so buoyant, competition remains robust across the globe, with the result that, for all but the most unattractive and loss-making programmes, the softening process continues. Insurers continue to compete with each other to meet their capital providers’ demands for sufficient premium income to enable the deployment of their capital worthwhile, and at the same time the overall portfolio remains profitable.
Part two – there may be trouble ahead...

Why, then, are we suggesting that there may danger up ahead for the mining industry from an insurance buying perspective? Despite today’s benign insurance market conditions, we do believe that there are some developments in recent months that should give buyers some cause for further thought.

Perhaps there is no better place to start than with the issue of tailings dams (which are covered extensively elsewhere in this Review but which are addressed here from an insurer perspective). These are now coming under much more increased scrutiny than in the past following the Samarco disaster last year in Brazil, the Obed Mountain release in Alberta, the Mount Polley loss in British Columbia and the Gold King release in the U.S., among others. A significant number of carriers on both the Property side and the Liability side are now scaling back their support for tailings dams, and those that continue to provide cover are now scrutinising their clients’ previous reports, history and stewardship.

Social and reputational risk
Following these events there can be no doubt that tailings dam operations now carry significant social and reputational risks, and some insurers have evidently decided that they no longer wish to be associated with providing cover for an activity that has attracted so much negative publicity in recent months. This is probably more specific to Latin America rather than anywhere else; for the first quarter of 2016 this was headline news, certainly in Brazil but in other parts of the region as well. Some global mining carriers such as Allianz and Chubb are now electing not to give tailings cover because they are concerned as to the associated reputational risk that comes with it.

Older dams causing more apprehension
Furthermore, while new dams that conform to 2016 standards have been welcomed by the market, there is now a lot more carrier apprehension about covering those dams that are now 20-30 years old, as it is felt that many of them may not now stand up to 2016 requirements – at the time that they were built, the applicable regulations were generally much less onerous. In many cases it is likely that these dams have already exceeded their original capacities and have been gradually modified to accommodate the fact that they have filled up much quicker than was originally anticipated. This is a big concern for insurers, in that they clearly need to know how that change in activity is being monitored.

More information required
Insurers therefore are now insisting on being provided with much more underwriting information on tailings dams and are more likely to be in a position to provide coverage if they are furnished with information as to how these dams are actually being managed. One particular area of concern is when a mine is being operated under a Joint Venture (JV) agreement; insurers (especially liability insurers) are going to need to know whether the client has operational control or whether this will be the responsibility of the other partner in the JV. A significant number of carriers are therefore now looking at their aggregation issues more closely.

Application of sub-limits
Although it is true that some modern dams are being provided with full coverage for tailings dams without the application of a sub-limit, increased focus is now being applied on older dams, leaving buyers with the potential headache of an inadequate risk transfer solution from the traditional insurance market.

Alternative risk transfer strategies
What other risk transfer alternatives are available to tailings dam owners? In theory, buyers can consider two alternatives:

1. Purchase of increased limits for Environmental Impairment Liability (EIL) insurance – this provides wider coverage than the standard Third Party Liability policy but typically this is only provided in the primary risk arena, when the exposure is considerably in excess of this part of the risk spectrum, as the Samarco loss demonstrates.

2. Purchase of an Alternative Risk Transfer solution featuring a parametric trigger – this kind of product is now becoming more feasible for mining companies (see our article on this subject elsewhere in this Review). Given the potentially significant overall loss exposure to recent tailings dam failures, it is clear that mining companies are increasingly exposed to catastrophic losses in excess of the policy limits currently provided by the conventional insurance market.

However, given the current pressure on mining company risk management budgets, the most likely scenario is that these tailings dam exposures are likely to remain uninsured or underinsured. Current liability programme limits tend to range between $400 million and $1 billion for the largest miners, with mid-sized miners in the US buying as low as $50 million in some cases; we understand that most mining companies are not in a position to increase these limits as they are under severe pressure to reduce costs.
So, should another significant loss occur, such a catastrophe could be extremely difficult in the event that no realistic risk transfer solution is available – particularly if the mining company concerned is not well capitalised.

**Concentration of underwriting leadership**

Inadequate risk transfer solutions for tailings dam operations is only one issue that should be of concern to the mining industry. In many parts of the world, particularly North America, the mining insurance leadership panel is still a very restricted one, despite abundant overall capacity levels.

**Zurich and AIG – the only games in town in North America?**

Unlike other natural resources industries, most mining lines of business - Property Damage, Business Interruption, Third Party Liability, D&O, Worker’s Compensation, Surety and so on – only attract a relatively small number of key players (although for Property and Surety lines, the competition is more pronounced). But in some lines in North America, particularly in the Primary Liability and Worker’s Compensation sectors, there are only two major carriers that write the class at the moment, namely AIG and Zurich (with Rockwood Casualty and Houston International showing some selective interest in the mid-sized account space).

In the long term that represents a pretty tenuous situation for the North American mining industry. Indeed, there has been so much change in the underwriting strategies of both AIG and Zurich recently that their continued participation in these classes can no longer be taken for granted. In Canada, the situation is equally tight; because of the requirement to have a license to write business in Canada, again only a handful of insurers are in a position to lead these classes of business.

**Imposition of sub-limits**

To illustrate, AIG has recently exited the Pollution Legal Liability market. We understand that they were writing too many unsustainable types of programmes with fairly broad coverage, and now that they have exited there are precious few insurers that are interested in taking up their previous positions. It’s true that Ironshore, Aspen, XL Catlin, Liberty and Chubb are interested, but to date they are imposing more restrictions and sub-limits than AIG would have offered. For example, where AIG was offering a $25 million programme with no sub-limits, now we might see carriers coming in and wanting to sub-limit tailings dams impoundments to $10 million. This is relatively new and we are just getting into the renewal cycle of the old AIG programmes that have to be replaced. It’s a bit too soon to know where this is going to land, but early on it seems that this will be the position of quite a few insurers.

**Possible gap in coverage on the horizon**

So what would happen if one of these major carriers quit the primary liability arena completely? Given the reduced premium income on offer from this portfolio, it’s quite possible that this may happen at some stage in the future.
At the moment, this would leave mining companies with potentially the prospect of running the first $5 million of their primary liability risk, a prospect which would fill most mining companies with alarm. Of course, the laws of supply and demand would eventually ensure that cover would be provided by a different set of insurers entering this space, but very possibly at terms which may bear little relation to what has been provided in the past – we have seen this in past years when capacity was limited. Of course, the one thing that most risk managers try to avoid is a scenario where they are forced to increase their premium spend to a point above the budget allowed for the year by their senior management. Furthermore, some of the other carriers that are currently competing for mining business have a track record of adopting somewhat opportunistic underwriting strategies – they may be able to provide attractive terms and strong capital at the moment, but should this capacity suddenly withdraw, then miners might well be equally challenged by such an eventuality.

**Excess Liability portfolio under scrutiny**

Meanwhile away from the primary arena some major excess markets have recently rescinded and reduced their participations, based on some of these big international losses, including Samarco; now it will be a case of looking to the excess liability carriers to try to drop down on some of these sub-limits. The coverage will be slightly more restrictive than what miners might obtain in the primary environment; brokers will want to do what they can to dovetail it into a slightly more restricted excess cover or build up a bigger excess tower, including the environmental liability market.

**Premium depletion may increase chances of eventual market withdrawal**

We have seen that the mining insurance market remains dominated by a handful of global carriers, particularly in the primary arena. The possibility of a market withdrawal from this portfolio is also exacerbated by the depletion in the mining industry premium income pool for these classes of business, which at some stage is bound to provoke carriers into considering whether to continue with this portfolio or to walk away.

**Looking to the mid-market**

Carriers that have historically only written large mining programmes are now loosening their underwriting guidelines and looking more to mid-market business in an effort to recapture some of the lost premium income. At current rates, there may not be sufficient premium income to withstand multiple losses and if new accounts don’t materialize, it will put additional pressure on them to withdraw from the class.

There are two basic reasons for the decline in premium income for this class. On the one hand, as we have seen capacity is plentiful, the sector remains generally profitable, rates are going down as a result and insurers now have to fight increasingly fiercely for the choicest programmes to maintain their premium income targets. This of course only serves to deplete the premium income pool still further.

**Emphasis on cutting costs**

However, it is not just market pressures that are reducing the premium income pool – the mining industry itself is under pressure to cut costs, and one easy way to do that is to cap or even reduce budgets for insurance purchases. We have therefore seen some mining companies scaling back their insurance purchases, for example, buying Fixed Costs rather than full Gross Profit Business Interruption.

**Merger and acquisition activity limit BI purchase**

Moreover, specific areas of the industry are facing their own challenges. For example, there has been a considerable amount of merger and acquisition activity in the US coal industry sector recently; only a few years ago US coal companies were buying up assets wherever they could find them, whereas in 2016 they are generally finding it hard to service their debts from these acquisitions because the price of coal is so low. As a result, we have seen a lot of companies who historically have been significant contributors to the overall premium income pool being broken up; the cream assets that used to belong to these organisations have been sold off, often at very cheap prices. The end result of this process is that these companies do not need to buy the sort of Business Interruption limits that they used to do in the past. In the US alone, coal production has dropped from nearly 900 million tons in 2015 to an estimated 625 million tons for 2016 according to EIA – a 30% reduction as a result of market pressure and mine closures.

So if we take these two sets of pressures together, it is clear that the premium income pool for this industry has reached a critically low level and is likely to remain low for the next few years. And without sufficient income to feed capacity, the possibility of insurer withdrawals, although currently remote, starts to become a more realistic proposition.

**Surety: concentration of counter party risk**

While surety loss results have been favourable, this product line reacts similarly to other catastrophic lines in that meaningful loss results cause significant, severe reactions. An additional layer of complexity for surety is the concentration of counter-party risk as viewed by senior executives of financial institutions including insurance. If political pressure is applied, it is possible that markets may elect to retire from certain classes such as mine reclamation. This void could cause stress upon the mining sector.
Conclusion: Choose your partners carefully!

Both the mining and insurance industries are going through periods of rapid change. In this fast moving environment, it is essential that the mining industry keeps abreast of the situation in the insurance market and is prepared for every eventuality. We have seen that although the insurance market remains both stable and competitive on the surface, miners should remain vigilant. In some areas, the extent of the reductions that can be obtained is moderating and should level off in 2017 (although they will remain low for many years).

Insurers looking closely at reserves

Moreover, we understand that most insurers are looking closely at their reserves and releasing large amounts of these reserves where either losses have not materialized as expected or where they were over-reserved in the first place. This provides temporary relief to the balance sheet, but they are now unable to rely upon these techniques going forward as reserves are lowered as much as possible. So we see insurers taking action to try to improve their financials, but the low insurance rates and low (sometimes negative) interest rates are continuing to hurt their ability to generate returns.

As a result, some insurers are really cutting to the bone. If there were an upturn in catastrophe losses, we might very well see some serious financial strains.

No clear answer to larger mining exposures

Meanwhile, there is no question that the current range of risk transfer solutions available at the moment could do much to mitigate the effects of another disaster on the scale of Samarco at a price that would be affordable to the industry. And in the meantime, it would only take the withdrawal of a handful of mega-carriers from certain lines of business to create a supply side vacuum, at least in the short term.

Need for long term relationships

During the June/July renewal season here in London we oversaw a series of major mining programme renewals. During this time, great attention was paid by clients and insurers alike on the need to continue to develop long term relationships and a commitment to sharing as much information and good practice as possible.

While some well-informed clients have had to make cost savings like so many others in the mining industry, they have continued work in partnership with their leading insurers, particularly in the face of some of the recent losses. Interestingly they are finding that their insurer partners are also speaking their language – major insurers understand how they feel because they have recently lost staff as well.

Is going for the cheapest price always the best strategy?

There will always be buyers who are driven by short term pricing considerations above all else. However, some of these companies should perhaps consider how they will ensure that they get the best co-operation from the market in the event they incur a large loss. Those buyers who are looking for a long term strategic relationship with their key carriers are likely to benefit most in such a situation. Furthermore, the one thing that the mining industry does not need is a dramatic spike in the price of insurance. This is certainly a possibility should the market be pushed to the point where prices get so low that a significant number of insurers elect to withdraw.

Quality underwriting submissions are paramount

In the meantime, we believe buyers should be focussing increasingly on the quality of their underwriting submissions. Armed with a quality submission, underwriters can then demonstrate to their management that should they decide to give a premium reduction it can be technically justified.

To sum up, predicting the future direction of the mining insurance markets is no easy task. Even as this Review went to press, we understand that some reinsurers are beginning to pull back from the least attractive reinsurance treaties and we know of a handful of direct mining insurers in some regions who also are beginning to walk away from certain programmes.

Nothing therefore can be taken for granted by the buyer in the years ahead, and it will be up to brokers to prove their worth in steering the mining industry through a potentially challenging time in the market.

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