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The Geological Society serving science & profession 2017 YEAR OF RISK

Managing Risks across the Mining and Oil & Gas Lifecycle

10-12 July 2017 **Imperial College London**

Abstract Book

Convenors

Glen Burridge (Glen Burridge & Associates)
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CONTENT PAGE

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Managing Risks across the Mining and Oil & Gas Lifecycle

10th – 12th July 2017
Imperial College London

Conference Objectives

The industries of the extractives sector face many risks of a similar nature. As part of the Geological Society of London's "Year of Risk", This conference brings together operators and service providers from both mining and oil & gas to explore our understanding of these risks and methods by which we can better manage them.

Risks, be they: technical, political, environmental, social, regulatory, security, or health & safety, are faced by both Mining and Oil & Gas. This conference will explore the state of the sector focusing on where we need to improve our management of risks across the lifecycle, and what each industry can learn from the other;; include professional development and multi--disciplinary discussions geared to professional geoscientists, risk management practitioners, experts from other technical and sustainability disciplines, owners, and investors;; review how resilient our sectors are really regarding the response to and recovery from failures, and how we proactively plan to ensure these failures do not repeat;; and explore emerging strategic and public policy trends with regards to regulating and insuring risk.

CONFERENCE PROGRAMME

Monday 10 July 2017

08.30	**Registration & tea, coffee** [G41]		
09.00	**Welcome Address**		
Session a: Scene Setting and the Risk of Investing			
09.10	**Setting the scene: Risks faced by the extractives sector value chain** Richard Herrington, Natural History Museum		
09.30	**Investing in oil and gas : a multitude of risks to be understood** Iain Bartholomew, Siccar Point Energy		
09.50	**The risk of investing : Mining** Mick Oliver, NRG Capital Partners		
10.10	***Panel Discussion***		
10.30	**Tea & coffee break**		
Session b: Managing our waste for the long-term		**Session c: Subsurface Risk & Uncertainty**	
11.00	**Introduction:** Dr Franco Oboni, Riskope	11.00	**Introduction:** Marc Bond & Benedikt Steiner
11.10	**Managing our waste** Colleen Crystal, Geo-logic		**KEYNOTE: Risk and Uncertainty** Peter Carragher, Rose & Associates
11.30	**Case Study: Lessons Learned from FERC's Potential Failure Modes Analysis Process** Dean Durkee, Gannett Fleming		**Cognitive Pitfalls in E&P Decision Making** Marc Bond, Rose & Associates
11.50	**Panel Discussion**		
12.30	**Lunch**		
Session b: Managing our waste for the long-term		**Session c: Subsurface Risk & Uncertainty**	
13.30	**Risk Based Decision Making/Risk informed decision making requires a disciplined approach** Franco Oboni Riskope	13.30	**Understanding Technical Risks in the** Benedikt Steiner, Camborne School of M Global
13.45	**Mine Site Restoration – Risks and Opportunities** Richard Howarth, Hargreaves Services	13.50	**The Silver Bullet – That Wasn't Or Ho and Lose a Giant Norwegian Field** John Ancock, INterGeoconsult
14.00	**Evidence-based public perception? Environmental and social perception risks of potentially toxic elements in shale gas wastewater** Izabella Otalega, University of Strathclyde		**Using Risk Assessment Methods to S Making & Project Financing During th Mining** Edmund Sides, Orebody Risks
14.15	**Reducing the environmental impact of hydraulic fracturing through design optimisation of hydraulic fracturing equipment** Aleksander Josifovic, University of Strathclyde		

14.30	**Discussion & Breakout**	14.30	**Tea & coffee break**
15.00	**Tea & coffee break**		
Breakout continued…		**Session c: Subsurface risk**	
		14.50	**Workflows for Managing Risk and Uncertainty in Mature Fields** Mark Bentley, AGR TRACS International
		15.10	**Risk Optimisation (a 'novel' approach for frontier exploration)** Guy Loftas, K2V
15.45	*Present back from breakout*	15.30	**Event-Based Risk Management Applied to Subsurface Risks in Oil & Gas Fields** Craig Smalley, Imperial College London
16.15	**PANEL:** **Samarco Tailings Dam disaster** Harry Floyd, James Fryer, Charles Harcus & Darren Loftas, JLT Specialty	15.50	**Technical Risk in Oil & Gas Exploration Projects: Pitfalls and a Pragmatist's Approach** Nicholas Stronach, Gaffney, Cline & Associates
		16.10	**Panel discussion**
17.15	**Summary**		
17.30	**Drinks Reception**		

Tuesday 11 July2017			
08.30	**Tea & coffee**		
Session d: Geoethics & risks above and beyond		**Session c: Subsurface risk**	
09.00	**Introduction** Louise Porteus	08.30	**Breakout session introduction**
09.10	**Tax Governance & Transparency** Tim Law, Engaged Consulting	08.45	**Breakout session (All)** ***Key Subsurface Challenges and Best Practice Processes***
09.30	**Managing Social Risk** John Castner, Isometrix	10.45	**Tea & coffee break**
09.50	**Understanding and Managing Societal Risk for Shale Gas Extraction (SGE)** Chris Ford, University of Strathclyde	11.00	**Breakout session presentations (All)**
10.10	**Questions** Nic Bilham	12.00	**Improved Actions to Improve Performance (All)**
10.30	**Tea & coffee CHALLENGE**		
10.50	**Breakout session**		
11.50	**Panel-led discussion + summary**		
12.30	**Lunch**		
Session e: Planning for Success			
13.30	**Introduction**		
13.40	**Mining –** Zak Wood, Satarla		
14.00	**Oil & Gas –** Richard Oxlade, AGR		

14.20	**Table + Panel Discussions**	
14.30	**Breakout Sessions**	
	Risk Management in Unconventional Oil and Gas Tom Kelly, RSKW	**Why do we get performance surprises in companies that seem to have good risk management processes?** Craig Smalley, Imperial College London
	Adapting to Extreme Weather Events: Lowering Your Exposure to Risk and Saving Your Business Money Ollie de Boer, Satarla	**Managing Social Risk** Cecila Jofre, Isometix
	How should the environmental and social factors be accounted for in business decisions? Which valuation models should be used? When do we know when estimates are accurate enough? Livia Mello, University of British Colombia	**Some challenges and solutions related to the assessment of mining project risks** Ed Sides, Orebody Risks
	Tea & coffee break	
16.30	**Breakout group feedback**	
17.00	**Summary**	
17.30	**Close of Day**	

Wednesday 12 July2017	
08.30	**Tea & coffee**
09.00	**Welcome Address**
09.05	**Summary of Session A – The risk of investing**
09.10	**Summary of Session B – Managing our waste for the long-term**
09.20	**Summary of Session C – Subsurface risk**
09.30	**Summary of Session D – Geoethics**
09.40	**Summary of Session E – Planning for success**
09.50	**Recap for day and planned outcomes**
Session f – (Human) Resourcing our future	
10.00	**PANEL led by Prof Jan Cilliers.** Guests: Michelle Klinkert; Chris Flavell
11.00	**Tea & coffee break**
Leaders' discussion #1	
11.00	**PANEL discussion**
12.30	**Lunch**
Leaders' discussion #2	
13.30	**PANEL discussion**
14.30	**Summary and round-up**

15.30	**Urban Fieldtrips** • Natural History Museum *backstage tour* • Building Stones around Piccadilly • Geological Society


9.00 – 10.30 Monday 12th July
A) The Risk of Investing
Where and how do we invest our $$$?
Without investment, commodities stay in the ground. Often the information required to inform an investor if a project is the right one for them is difficult to to present in a way that makes sense. This is either because the information is in itself difficult to obtain, or is the wrong information to be asked for.
This workshop brings together investors and geoscientists to align on what knowledge is really required for an investor to assess all relevant risks to a project and make a decision.
Session themes:
- Influences in business decision making, be they technical, non-technical, or market related.
- Explore how investors perceive risk and what they look for in a project, be it mining or oil & gas.
- What information do investors need in order to manage risks identified from their perspective?
- What information is it possible to provide by the technical specialists, and how can it be made more accessible for non-technical experts to interpret?

Setting the Scene: Risks faced by the extractives sector value chain.

Prof Richard Herrington
Head of Earth Sciences, Natural History Museum

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Investing in oil and gas: a multitude of risks to be understood

Iain Bartholomew
Siccar Point Energy

The lifecycle of an oil or gas field is complex with a lifespan often exceeding 50 years from acquiring the exploration acreage to decommissioning the production facilities. For the potential investor, there are multiple risks that need to be considered prior to an investment decision. These risks can be divided into 5 categories:

1. Technical: both geological and technological
2. Safety and environmental: hydrocarbons are highly flammable and have potentially catastrophic environmental impact if released
3. Economic: oil and gas prices fluctuate wildly and are hard to predict; drilling and operational costs also fluctuate wildly and not always 'in sync' with the commodity price changes; fluctuations in exchange rates also often have a big impact on project economics
4. Commercial: infrastructure (pipeline and refinery) and market access; and competing 'greener' technologies
5. Political: stability of governments and fiscal systems, risk of nationalisation, exposure to corruption.

Some of these risks are common across the world; others are highly variable depending on the country of operation. The stage of an oil and/or gas project at which an investor chooses to invest depends on their willingness to take on risk versus the potential return.

The chance of commercial success of a typical hydrocarbon exploration well is between 10% and 50% depending on the maturity of the basin and the amount of data available. If the exploration well is a success the eventual returns could be very material. As a project matures and moves into a development phase it has largely been de-risked on the geological side, but the requirements for capital investment materially increase with large offshore developments often costing in excess of $10 billion. Once a field is on production it is at last generating positive cash: this is often the point where the field is at its maximum value and a new investor should only invest at this stage if they can identify additional upside that they don't have to pay for. As a field comes to the end of its life decommissioning is required which, for an offshore fixed platform, can cost multiple billion $s.

There are many ways that the investor can mitigate against the risks: spreading the risks across a portfolio of opportunities, often in different geological basins and countries; using technological advancements such as modern 3D seismic, deep water sub-sea production systems, and long horizontal drilling techniques; hedging future production and exchange rates; selecting 'stable' countries to work in; acquiring long-life fields.

Most importantly an investor should understand what the risks of a particular opportunity are and any investment should be made with eyes wide open and a full understanding of all the potential outcomes.

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Scene setting and the risk of investing

Mick Oliver
Managing Director, Natural Resources Global Capital Partners

It is possible to lose all your money investing in Mining and Oil & Gas. In fact, if you decide to leverage your position with derivatives, you can lose more than the total invested. That, however, is on the downside and for those optimists amongst us today, there is an upside and that is the reward part of investing. Despite the accusations from some politicians that the City is little more than a casino, it serves the purpose of allocating capital efficiently. Taking the FTSE100 as a proxy for the market, some 7% of your pension is invested in mining and double that linked to Oil & Gas. It is possible to invest across the entire lifecycle of a natural resources project, from exploration through production to closure, using a variety of instruments. Choosing what and how to invest is entirely a function of your risk tolerance. This presentation provides an overview of the investment landscape and specific examples are provided to illustrate the risk/reward balance.

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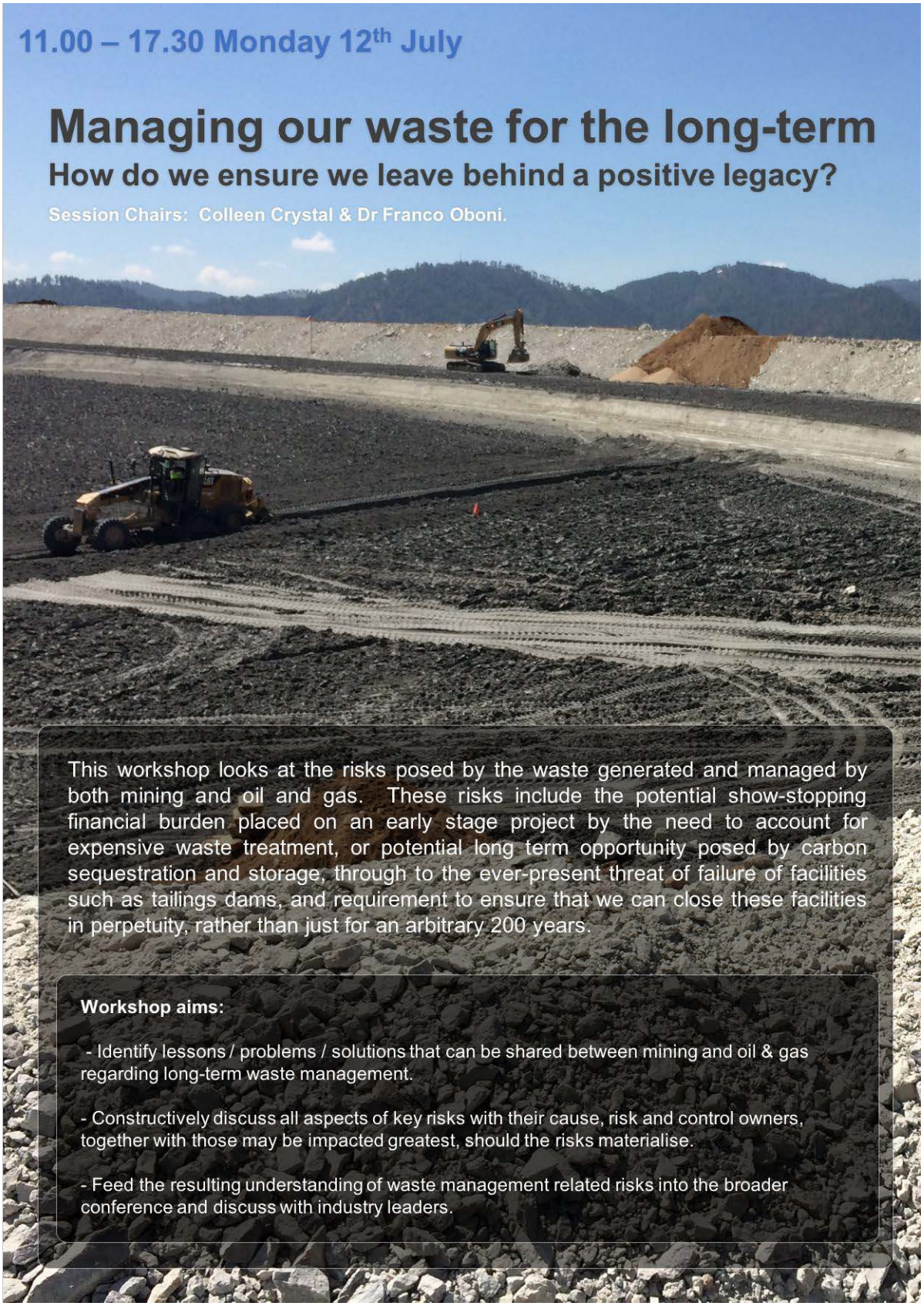
11.00 – 17.30 Monday 12th July
Managing our waste for the long-term
How do we ensure we leave behind a positive legacy?
Session Chairs: Colleen Crystal & Dr Franco Oboni.
This workshop looks at the risks posed by the waste generated and managed by both mining and oil and gas. These risks include the potential show-stopping financial burden placed on an early stage project by the need to account for expensive waste treatment, or potential long term opportunity posed by carbon sequestration and storage, through to the ever-present threat of failure of facilities such as tailings dams, and requirement to ensure that we can close these facilities in perpetuity, rather than just for an arbitrary 200 years.
Workshop aims:
- Identify lessons / problems / solutions that can be shared between mining and oil & gas regarding long-term waste management.
- Constructively discuss all aspects of key risks with their cause, risk and control owners, together with those may be impacted greatest, should the risks materialise.
- Feed the resulting understanding of waste management related risks into the broader conference and discuss with industry leaders.

Managing our Waste

Colleen Crystal
Senior geotechnical engineer, Geo-logic Associates inc.

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Case Study: Lessons Learned from FERC's Potential Failure Modes Analysis Process

Dean B. Durkee, Ph.D., P.E.
Gannett Fleming, Inc.

California Department of Water Resources (DWR) operates a hydroelectric complex in Southern California that falls under the jurisdiction of the Federal Energy Regulatory Commission (FERC). The system is licensed as FERC Project No. 2426 (P-2426) and is comprised of four interrelated facilities under the FERC Part 12D process. The four facilities comprise the West Branch Division, which includes Pyramid Dam and Quail Dam and the East Branch Division, which includes Cedar Springs Dam and Devil Canyon Second Afterbay.

FERC has recommended procedures and criteria to develop Dam Safety Performance Monitoring Programs for hydroelectric projects subject to the Part 12D Inspection process. This process is outlined in FERC's Chapter 14 Engineering Guidelines dated July 1, 2005. The Dam Safety Performance Monitoring Program is based on three key components:

- Developing and maintaining a Supporting Technical Information Document (STID),
- Performing a Potential Failure Mode Analysis (PFMA), and
- Developing a Dam Safety Surveillance and Monitoring Plan (DSSMP)

This expanded abstract presents a summary of PFMAs that were performed on the DWR P-2426 Dams.

The first PFMA workshops for the dams in the P-2426 project were completed in 2005, shortly after FERC adopted the PFMA process. Very few PFMs were developed in the 2005 PFMAs. The PFMA reports were audited in 2010 as part of the 5-year FERC Part 12D inspection requirement. The updated PFMA reports consisted of the 2005 reports with revisions noted in the report including re-categorization of some PFMs.

As part of the 5-year FERC Part 12D inspections in 2015, DWR coordinated three weeks of PFMA Workshops for the P-2426 dams. This is significantly more time than has been previously devoted to review of the PFMAs for the project. The effort utilized the results of the 2005 and 2010 PFMA reports, while evaluating PFMs with consideration to possible future risk assessments, and the benefit of additional time to perform the workshops and provide more detail. The PFMA workshops were performed in December 2014 and February 2015.

The 2015 PFMAs were performed following the current interpretation of the FERC Chapter 14 Guidelines (2005) and provided for a more exhaustive effort to fully develop PFMs. It is anticipated that DWR's investment in the recent PFMA better prepares DWR's P-2426 staff for continued safe operation of the facility.

Summary of Results

Table 1 below summarizes the number of PFMs identified in 2005 and in 2015 for the four DWR P-2426 dams. In 2010 PFMA audits were performed on all four dams and the results generally tracked with the original findings in 2005. The 2015 PFMAs for the P-2426 dams resulted in significantly more identified PFMs than the 2005 workshop and the 2010 audit. Reasons for this difference relate to a number of issues, including FERC's recent efforts to develop Risk Informed Decision Making (RIDM), re-interpretation of failure mode category descriptions, and emphasis by FERC to establish more rigid correlation of the DSSMP with identified PFMs.

Table 1 Summary of the number of PFMs from 2015 PFMA

	Category I		Category II		Category III		Category IV	
	2005	2015	2005	2015	2005	2015	2005	2015
Pyramid Dam	0	2	0	10	1	3	0	2
Quail Dam	0	4	3	16	0	1	0	1
Cedar Springs	0	0	0	11	0	0	0	1
Devil Canyon AB	0	2	0	3	0	0	0	0

Other federal agencies (US Army Corp of Engineers and Reclamation) have advanced the use of risk analysis and risk informed decision making for dam safety over the last ten to fifteen years. More recently FERC has initiated development of guidelines for dam owners to be used in development of risk-informed approaches to dam portfolio management. Since the guidelines are still in development, it is not clear exactly how the PFMA process (Chapter 14) will be incorporated into RIDM. However, from the outset, FERC and DWR agreed that the PFMA for the P-2426 Dams should refocus efforts to fully develop PFMs and develop consensus on the intent and meaning of the PFM Category definitions. Full development of the PFMs, by FERC's guidance meant that each PFM would be described in a sequential nature beginning with loading, initiation through development and ending with description of the uncontrolled release of the reservoir. FERC's intent is that these PFM descriptions can one day be used to construct event trees for risk analysis calculations. With respect to Classification categories, the Core Team for the P-2426 PFMAs revisited the Category definitions several times throughout the workshop to move toward consistency in their interpretation and to ensure that PFMs were not moved too quickly to non-credible (Category IV or Other Considerations).

Lessons learned

The discussion presented in this section relates directly to the FERC process and the experience of DWR. While tailings dams are constructed and operated differently than hydropower projects and are not regulated by FERC, the lessons learned presented below are relevant to tailings dams as the mining industry moves to more widespread use of risk informed decision making. The first and arguably most important step in risk informed decision making is development of credible failure modes. Through recent conversations with FERC, it is now generally understood that Category I and II was never intended to include only failure modes that need remediation, however that was not the interpretation during the 2005 PFMA workshops. FERC has clarified that the intent is to highlight PFMs that need to be front and center in an owner's DSSMP. These may include things in existing dams that should be remediated but the need to fix something is not the only criteria for a credible PFM. For example, if a dam owner designs a new embankment dam and includes filters, drainage features, and other modern components that are consistent with state-of-the-art design for mitigating the potential for seepage related failure modes, because of potential hidden defects, flaws during construction, or other unforeseen circumstances, a piping failure can never be completely ruled out. Therefore, a diligent dam owner would

always include some level of surveillance and monitoring for the initiation of a piping or internal erosion event. This perspective holds true for tailings dams and may be even more important due to the nature by which tailings dams have been constructed and operated historically and the associated inherent uncertainties.

Generally, Category I and Category II are credible failure modes with higher and lower degrees of likelihood and consequences, respectively. The likelihood might be very low but not so low as to completely ignore the possibility, thus the need to monitor. On the other hand Category IV is considered to be of such low likelihood as to be considered not credible, and therefore the need for monitoring or surveillance specific to that failure mode may not be necessary or desired.

Although not required by FERC, DWR repeated an in-depth evaluation of its four P-2426 dams during the 2015 PFMA workshops. For the 2015 PFMA workshop a number of presentations by DWR staff and subject matter experts led to productive, but lengthy discussions. While these discussions benefited the process by re-familiarizing participants to the dams, they did not focus exclusively on PFM development. Further, the PFMA process and scope, PFM categorization, and level of detail necessary to meet FERC expectations required repeated clarification. Specifically, DWR realized that FERC expected PFMs leading to uncontrolled releases, not just dam failure, to be included in the process and that failure to do so could potentially lead to an inadequate and non-compliant submittal. The PFMA reports on record clearly focused on dam failure rather than uncontrolled releases. Because of these expectations, DWR planned a full three weeks for the P-2426 PFMAs. Ultimately, only ten working days were needed to complete the PFMA workshop. The facilitation team delivered new, comprehensive PFMA reports for all four dams for use by DWR's Board of Consultants in their Part 12D Safety Inspection effort.

The 2015 PFMA workshops for Project 2426 represented a large percentage of the State Water Project Dam Safety Program's 2014 fiscal year budget. However, from an owner's perspective, the investment provided great value on several fronts. The workshop brought together current and former DWR staff, subject matter experts, and regulators with varying experience and roles in the stewardship of the dams. The facilitation team captured the group's collective knowledge, experience, and judgement in the PFMA reports and these reports will undoubtedly enhance the understanding of the dams by future generations of DWR staff, consultants, and regulators. The workshops benefited the Board of Consultants and DWR engineers by bringing to light subject matter and issues that were buried in the vast quantity of documentation or communicated for the first time by Operations personnel during the workshop. The Category I PFMs identified and documented in the reports provide DWR dam safety engineers with strong justification to pursue and prioritize applicable risk reduction measures in advance of other competing projects. Lastly, DWR dam safety engineers believe the PFMA effort and reports provide an excellent resource and basis for any future RIDM efforts if needed.

Moving forward, a number of lessons learned suggest improvements are needed within the PFMA process. In particular from an owner's perspective it is important that the process provide for a cost effective effort for maintaining safe dams while not sacrificing the value of thorough treatment of the subject matter. Issues relevant to cost and the process that developed during the P-2426 PFMAs are described below.

- The cost and duration of the PFMA workshop is driven by the number and collective knowledge of the PFMA participants. Because most participants had not familiarized themselves to the level needed prior to the workshop, an inordinate amount of time was needed to familiarize attendees with each dam's design, construction, and historical performance.

- Voting members should be limited to core members only. Allowing too many voting participants makes achieving general consensus on a PFM category difficult and time consuming.
- Early clarification and statement of expectations by FERC in advance of a PFMA workshop should streamline the schedule, remove confusion, and limit debate. However, the duration of a workshop will still be difficult to predict as it depends on numerous factors, such as the number of participants and their preparation, PFM brainstorming effort, the dam's complexity, the recorder's speed, and the Facilitator's ability to keep the participants focused and on-task.
- Because of the complexity of the P-2426 facilities, having co-Facilitators and using multiple note-takers greatly enhanced the ability to capture critical information, expedite the process, and develop a comprehensive document. However, the increased cost of these benefits must be weighed against the value of the final product, and may not be warranted for other less complex projects.
- The development of the risk reduction measures is a brainstorming exercise during which the concepts are minimally vetted and discussed amongst the participants. However, the risk reduction measures can be applied indiscriminately within the Part 12 recommendations, potentially increasing the cost of Part 12 compliance without fully understanding their feasibility or actual risk reduction benefit or cost. Dam owners and Part 12 Independent Consultants should thoroughly vet risk reduction measures to ensure they effectively and efficiently address their respective PFMs. It is possible that the implementation of RIDM, while adding another required step to an already expensive and time consuming process, could allow for the proper vetting of the risk reduction measures.

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Risk Based Decision Making/Risk informed decision making requires a disciplined approach

Dr Franco Oboni
Oboni Riskope Associates Inc

Twenty years ago the Balangero Asbestos Mine Dumps Environmental Rehabilitation competitive bid was won by an engineering group supported by what was then called Risk Based Decision Making (RBDM). Thus it was demonstrated that including risk assessment through the design of a project, from inception to delivery and including risk driven maintenance concepts brought value and a leading edge to the proponents.

Recently NASA and the US Nuclear Regulatory Commission have brought forward a process called Risk Informed Decision Making (RIDM). Both RBDM and RIDM use probabilistic risk assessment (PRA) as a tool within the process to allow for rational evaluation and enhance communication.

During the presentation we will use caricatures of typical decision-making stakeholders to pinpoint difficulties in opening the debate to multiple stakeholders and to show how a disciplined approach can help the RBDM process.

We will show the step by step RBDM procedure used for Balangero and highlight the subtle differences with RIDM meanwhile “narrating” the behaviour of various stakeholders. The differences are necessary to make the process accessible and economically sustainable for any civilian project, including, of course mining ones.

20 years post remediation lesson learned at Balangero Asbestos Mine Dumps will be described, including remote monitoring made possible by drones and data treatment.

RBDM/RIDM have been deployed in many civilian and mining projects.

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Mine Site Restoration – Risks and Opportunities

Richard Howarth
Hargreaves Services

Hargreaves Services plc delivers a range of projects and services in the infrastructure, property and energy sectors. Historically, Hargreaves had a substantive involvement in coal particularly mining, sourcing and handling. As a result, Hargreaves owns a range of former surface and deep coal mines particularly in northern England and across the central belt of Scotland. However, as trends in energy generation have changed many of these assets have ceased to be economic to operate. Therefore, these assets now likely require restoration. Unfortunately, due in part to the reduction in coal burn, shortages in restoration materials and inadequate restoration bonds, particularly for sites recently acquired by Hargreaves from others, restoration proposals designed at the start of the mine's life in many instances can now not be achieved. Thus, to restore many of these assets to beneficial use can involve significant risks. These risks include the management of existing financial and operational liabilities for the continued ownership of the site, managing stakeholder expectations and developing and delivering appropriate restoration solutions for the site. In many cases negotiation with the Local Planning Authorities is often required to review, renegotiate and revalidate the restoration proposals. These revised proposals can include the provision of new infrastructure and development that will in part pay for the restoration of the site as a whole and represent opportunities for the local and regional area in terms of employment, housing or amenity. Hargreaves approach to managing these risks will be discussed using two examples that are currently being restored by Hargreaves: The former deep mine at Maltby, nr. Rotherham and the former opencast site at Broken Cross in Lanarkshire.

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Evidence-based public perception? Environmental and social perception risks of potentially toxic elements in shale gas wastewater.

Izabella Otalega
University of Strathclyde

Public perception of the risks of shale gas extraction remains a key control on development of European resources. Environmental risks associated with production of shale gas, especially those related to water resource contamination with flowback and produced waters, are the focus of much attention. The large quantities of wastewater produced throughout the lifetime of a well (~10^7 L) can contain toxic metals and other regulated potentially toxic elements (PTEs), most likely mobilised from the target formation by the hydraulic fracturing fluids. High levels of PTE may pose a hazard to the environment, for example, through accidental releases or spills of wastewater.

We have collated publicly available data on the inorganic composition of shale gas wastewater, focusing on PTEs, and compare the reported levels to different water quality criteria. The publicly available information pertaining to *exact* concentrations of PTEs was limited to a handful of grey literature reports. The frequency of detection for individual PTEs is mixed, and they typically show a wide range of concentrations, with varied compliance rates across different water quality regulations and guidelines. The insubstantial publicly available data and limited associated metadata impedes comprehensive evaluation of potential impacts created by shale gas wastewater mismanagement. Even though the data show relatively low levels of PTEs, this uncertainty may have negative implications for social perception, hinder evidence-based policy making, and confound the assessment of on-site risks.

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Evidence-based public perception? Environmental and social perception risks of potentially toxic elements in shale gas wastewater

Aleksandar Josifovic
University of Strathclyde

The current approach to hydraulic fracturing requires large amounts of industrial hardware to be transported, installed and operated in temporary locations. A significant proportion of this equipment is comprised of the fleet of pumps required to provide the high pressures and flows necessary for well stimulation. Studies have shown that over 90% of the emissions of CO_2 and other pollutants that occur during a hydraulic fracturing operation are associated with these pumps. Pollution and transport concerns are of paramount importance for the emerging hydraulic fracturing industry in Europe, and so it is timely to consider these factors when assessing the design of high pressure pumps for the European resources.

An overview of the industrial plant is followed by an analysis of the design space of the pump that could result in improved efficiency, and the optimal means of operating a fleet of pumps to stimulate a well. We find that changes to the pump design can increase the pump efficiency by up to 4.6% and reduce the mass of the pump by up to 30%. We present a whole system model that uses a use a case study well stimulation to quantify the associated reductions in environmental impacts (e.g. emissions of GHG and other pollutants, embedded carbon) and social impacts (e.g. volume of traffic, damage to roads) as well as the economic gains of lower fuel consumption. This work illustrates how shale gas developments can be designed to reduce their environmental and social impact.

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Samarco Tailing Dam Disaster

Harry Floyd, James Fryer, Charlie Harcus & Darren Loftas
JLT Specialty

The Samarco Tailings Dam disaster in 2015 was one of the worst environmental mining disasters to occur in decades with the event resulting in significant environmental, humanitarian and property damage. The incident served as a catalyst for mining companies to review their exposure to tailings dam failure, to conduct engineering reviews, and to implement procedural and operational changes. The disaster also highlighted the importance of the robustness of insurance policy wordings for such events and the need for appropriate claims protocols and crisis management strategies to be in place.

The deployment of a multiple disciplinary risk management approach which includes environmental engineering, legal contract reviews with host governments and applicable joint venture partners and contractors, policy stress-testing and refinement, and claims protocol evaluation are all vital parts of a best practice risk management approach. Insurance can be seen as one part of the jigsaw as an enabler for mining companies to allow them to alleviate funds from the balance sheet and ensure that they have cover in place in case of a claim.

JLT will conduct a panel discussion hosted by Harry Floyd (Partner, JLT Mining) with industry experts including a property underwriter, risk engineer and a claims specialist* to discuss the broad value of insurance for mining companies with a specific focus on Tailings Dams exposures and the risk management and risk transfer options available in the insurance market.

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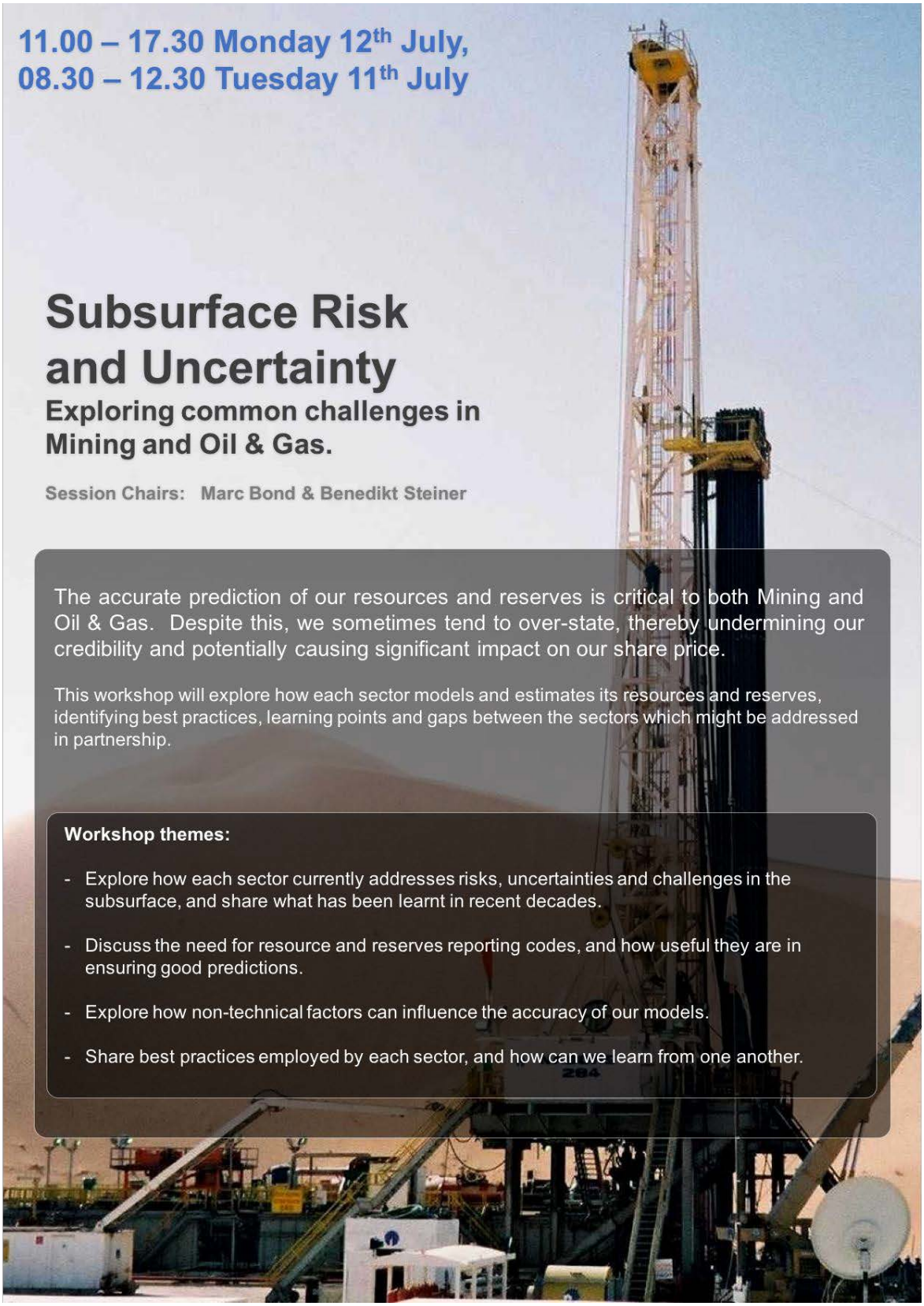
11.00 – 17.30 Monday 12th July,
08.30 – 12.30 Tuesday 11th July
Subsurface Risk and Uncertainty
Exploring common challenges in Mining and Oil & Gas.
Session Chairs: Marc Bond & Benedikt Steiner
The accurate prediction of our resources and reserves is critical to both Mining and Oil & Gas. Despite this, we sometimes tend to over-state, thereby undermining our credibility and potentially causing significant impact on our share price.
This workshop will explore how each sector models and estimates its resources and reserves, identifying best practices, learning points and gaps between the sectors which might be addressed in partnership.
Workshop themes:
- Explore how each sector currently addresses risks, uncertainties and challenges in the subsurface, and share what has been learnt in recent decades.
- Discuss the need for resource and reserves reporting codes, and how useful they are in ensuring good predictions.
- Explore how non-technical factors can influence the accuracy of our models.
- Share best practices employed by each sector, and how can we learn from one another.

Risk and Uncertainty

Peter D. Carragher
Rose & Associates

Executives and their teams of geoscientists and engineers are continuously challenged to make major decisions based on limited data sets. These decisions always involve both Risk and Uncertainty.

Risk is the chance that a resource project will lose money. Resource projects can lose money by failing to discover any resources at all – the “dry hole” in oil and gas exploration, or by failing to discover enough resource to be either economic or commercial.

Uncertainty is the description of the range of resources, given a discovery is greater than a technically defined minimum value. The uncertainty in the range of resources is carried forward into the range of possible value for the project, given discovery.

Resource companies typically take advantage of the portfolio effect to manage risk and uncertainty. In exploration ventures, companies typically enter into joint ventures in order to lessen the burden of failure in a particular exploration well, and to increase the number of wells they can participate in within their budgets.

In unconventional resource projects, companies take advantage of aggregation methodology to manage both uncertainty and risk. The critical forecast is whether the average well in a program will be economic. The risk of losing money occurs when the average well in an appraisal program fails to meet economic criteria and the capital invested is written off.

NOTES

Cognitive pitfalls in E&P Decision Making

Marc Bond
Rose & Associates

The human brain is a wondrous but flawed instrument. The capacity of one's brain to problem solve is immense. However, research has shown that, possibly because of evolutionary adaptation, it is an imperfect engine. This adaptation has led to instinctive, experience based and emotional based techniques for problem solving and decision-making.

These heuristic methods are used to speed up the process of finding a satisfactory solution with little effort, and are often called "rule of thumb", "educated guess", "intuition", or "common sense". The majority of times these methods serve us well and lead to a satisfactory outcome. However, they also lead to irrational behaviours, misguided interpretations and poor decisions, otherwise known as cognitive biases. These biases allow for simple conclusions but often introduce systematic errors. Due to the complicated nature of modern life, many situations require more thorough analysis and critical thinking rather than the simplest and fastest route to a decision.

The E&P business is full of highly creative and intelligent people, leading to some outstanding successes. Decisions are often made in situations of high complexity and uncertainty, and unfortunately cognitive biases have occasionally led to costly decisions and results related to mistakes in reasoning that erode value. Some common themes that relate directly to the hydrocarbon industry include: poor performance in adequately expressing the volumetric range, production underperformance, project delays, and cost overruns. Although some of this can be credited to technical failings, motivational biases or circumstances beyond our control, often they can be attributed to cognitive biases.

There is an evolving list of cognitive biases that have been identified over several decades of research on human judgement and decision-making. Of the hundred odd listed biases, there are some that are directly related to the inefficiencies observed in our industry. Unfortunately there is no magic antidote that will inoculate us from these biases. We all find ourselves at the mercy of these distortions, including the "experts". We can, however, reduce their impact. The objective of this presentation is to increase the awareness of cognitive biases and their impact on judgements and decision making.

NOTES

Understanding Technical Risks in the Mining Industry

Benedikt Steiner
Camborne School of Mines & XPLORE GLOBAL Ltd

Historically risk management in the mining industry focused on the health, safety, environment and community sectors of mining operations. Incidents, such as Samarco or Lassing, had a lasting and damaging effect on the public perception and ability of mining companies to sustainably run mining operations.

Equally important, however, is the management of technical risks. The Bre-X scandal in the 1990s showed that fraud and technical misconceptions are a serious concern in mineral exploration and mining. The resulting introduction of resource reporting codes was one way to minimise the potential impact of technical errors to mining companies and their investors. Technical risks and erroneous results are particularly common in early exploration stages when a limited amount of data is available to inform decision making. However, major errors can also be introduced during resource evaluation and feasibility studies and therefore require technical experts, so-called ‘Qualified Persons’, to oversee and approve reports and announcements to the investor market.

The aim of this presentation is to increase the awareness of the plethora of technical risks present in the mining and mineral exploration sector and to improve our understanding of how these risks can be efficiently dealt with.

NOTES

The Silver Bullet – That Wasn't - Or How to 'Over-Risk' and Lose a Giant Norwegian Field

R.John. Ancock
InterGEOconsult

This study presents events of 1977-8, and even though embarrassing, I feel the story should be documented.

The Exploration Team identified a structural trap with an extensive DHI, a 'flat seismic event'. This crosscut the stratigraphy but extended beyond the identified structural closure. The seismic 2D data was on an approximately 2km grid. The depth conversion was problematic and the interpretation was on unmigrated sections!

The prospect was high-graded after the conventional peer review and risking of source, seal and trap parameters using 'Monte-Carlo' risk analysis. It was considered the most interesting prospect and referred to the Headquarters for review.

They used a 'Top Secret' (Silver Bullet) procedure for statistical evaluation of prospect risk, that showed the prospect size, utilising the DHI, to be much too large to be 'believable'. A seismic processing team at the Research Company was tasked with investigating the multiple/flat event to confirm the down grading. Their report gave a qualified opinion that it 'may be a multiple or a complex interference effect with an anomalous sequence boundary'.

The block was awarded to a multi-national consortium who drilled the discovery well.

Subsequent publication of the 'Top Secret' procedure showed a fatal flaw in the development of the 'Silver Bullet'.

The lessons are:

- too much secrecy can hurt consistent evaluation
- team work in ALL facets of the evaluation is the best approach
- secret silver bullets - can miss-fire
- more could be done by the authorities to extract miss-steps and develop a better approach to risk analysis.

NOTES

Using risk assessment methods to support decision making and project financing during the development of mining projects

E.J.Sides
Orebody Risks Limited

The CRIRSCO family of Mineral Resource and Mineral Reserve reporting codes provide guidance on expected standards of public reporting by mineral companies. A key element of these codes is the requirement to sub-divide Mineral Resources into different confidence categories, namely Inferred (low confidence), Indicated and Measured (high confidence).

For a particular project, the proportions of a Mineral Resource in each specific category depends on an assessment (by the responsible Competent Person) of the underlying uncertainties and risks related to specific technical considerations such as data quality, geological continuity, grade continuity, extraction and processing methods, etc.

This paper illustrates how the checklist of assessment criteria given in Table 1 of the CRIRSCO template (as incorporated into the JORC, PERC and SAMREC codes amongst others) can be used to provide the basis for a formal risk assessment throughout the life cycle of an individual mineral project. For any particular project stage, the key elements of the proposed approach include:

- Preparation of a register of risk issues
- Assessment of likelihood, consequence and information availability for each risk issue
- Ranking of issues in terms of overall risk rating
- Planning of risk management strategies to be applied in the next project stage

Using this approach throughout the life cycle of a project enables individual key risk issues to be identified and managed in a timely manner.

NOTES

Workflows for Managing Risk and Uncertainty Workflows in Mature Fields

Mark Bentley
AGR TRACS International Ltd

Standard modelling workflows often let us down when it comes to supporting decisions in mature fields. The models tend to become large and unwieldy, the integration of production data is time-consuming and the incremental nature of the data accumulation means models tend to become 'patched'. Models are commonly passed hand-to-hand between practitioners to the point that ownership is lost. The update and maintenance of the 'field model' becomes a job in itself, often separate from the process of managing the mature field. The modelling process thus reaches a technical limit, and loses its value.

We argue that successful modelling and simulation in mature fields requires a different generic workflow, building on concepts of front-end loading and design, with much of the work and the thinking done before significant modelling work is undertaken. This goes significantly beyond the idea of holding a project framing session. We use the analogue of the Forth Rail Bridge as a reference, the cantilevers representing short periods of team-based working and the nodes between the cantilevers representing meeting points when the disciplines come together to compare findings and plan for the next work segment.

The generic content of each node and cantilever is predictable:

- *Node* - problem definition ('frame')
- *Cantilever*- data review
- *Node* - definition of uncertainties – the long list
- *Cantilever* - analysis of significant uncertainties – root cause analysis
- *Node* – review result and short list
- *Cantilever* - initial static/dynamic models to test commercial sensitivity
- *Node* - decision on modelling – worth it or not?
- *Cantilever* – the larger modelling exercise, or not
-

Work in the early cantilevers is short – measured in days or weeks. The early modelling choices are not known at the outset – the problem has to be defined, deconstructed and worked - and hence the study plan is *not* constructed at the kick-off (the 'framing'), as too little is known at this point. The outcome may be that detailed full-field models are not required to support the decision at hand; potentially modelling is not required at all.

An example is given from a mature field in France in which standard modelling workflows proved incapable of delivering useful technical support for decision-making. Work commenced and it quickly became apparent that the static-dynamic iteration of a full-field model at the resolution needed to capture production behavior was time consuming - too time-consuming to support the decision on infill drilling which the asset team was required to make. The technical limit of the default modelling process was reached. The initial, traditional modelling plan was therefore abandoned in favour of a multi-scale approach with

static-dynamic iteration on small sectors combined with coarser full-field material balance and volumetric work. There was no ‘field model’ but many models, each addressing part of the problem. The decision-point was reached in time for the corporate planning cycle (just), was supported by the models and the wells have subsequently been drilled successfully. A traditional, detailed, history-matched full-field model was not required and was never built. The technical limit was overcome.

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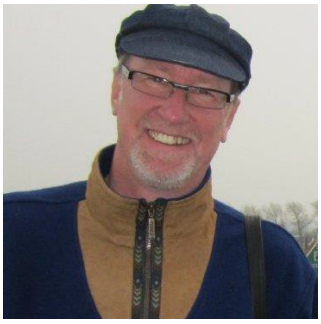

Risk Optimisation (a 'novel' approach for frontier exploration)

Guy WF Loftus
K2V Ltd

Talk to process engineers about risk and they will probably describe it as a form of optimisation because to an engineer, failure is not an option. In frontier exploration, however, we live with the reality that despite all of our hopes for success, there may actually be nothing there. Consequently, risk is viewed as value-destructive, something that needs to be mitigated against but that doesn't mean that risk itself cannot be managed. In fact, the optimisation of risk is, in itself, a significant value-adding opportunity.

Exploration for minerals or hydrocarbons is fundamentally an evidence-based science. Whether geoscientist or geo-commercial by background, when we are presented with an opportunity to invest our money in, we pull together everything that we know from the available evidence, often allowing prior experience or knowledge to set our cognitive bias, which tends to guide our thinking all the way to discovery or failure. Only then do we find out if our perceptions were really rooted in reality.

To aid us along the way, we construct a framework as a coat-hanger for what we know, which helps us identify gaps ("what we know we don't know"). Unfortunately, our framework is incomplete because "we don't know what we don't know", resulting in us potentially understating risk or, just as importantly, understating the opportunity. To fill those gaps, and to allow us to better assess and thereby mitigate risk, we seek to broaden our evidence base by deepening our knowledge, thereby optimising the convergence of our perceptions with reality.

NOTES

Event-based risk management applied to subsurface risks in oil and gas fields

P. Craig Smalley
Imperial College London

The event-based risk management (EBRM) approach, commonly used for safety and operational risks in the oil industry, can also be applied to risks whose consequences are solely related to business performance. Here we focus on subsurface risks: risks with subsurface root causes, or risks that would normally be described, assessed or managed by a subsurface team in an oil and gas project or producing field. EBRM enables subsurface uncertainties to be described in a manner that facilitates specific actions to improve business performance. In EBRM, uncertainties are viewed as potential causes of risk events that could in turn lead to consequences that affect the attainment of business objectives. This "causes–event–consequences" framework aids the design of prevention measures to inhibit the causes turning into the event and mitigation measures to reduce the potential consequences should the risk event occur. This risk description framework also facilitates construction of a risk taxonomy based on risk consequences, events and causes, that can be used to compare risk data between fields, projects and companies. We described a large database of risks in this manner, placed them in a taxonomy, and analyzed the proportion of risks in each taxonomic group. This revealed clear trends in the frequencies of risk types depending on field/project characteristics and field maturity, demonstrating that this approach provides a common basis for sharing risk information. The intelligent use of such risk analogue data is potentially a major step forward, helping with the identification of relevant risks, the anticipation of future risks, and facilitating the creation of successful risk management actions to improve business outcomes.

NOTES

Technical risk in oil and gas exploration prospects: pitfalls and a pragmatist's approach

N.J. Stronach
Gaffney, Cline & Associates

Risks attached to the implementation of oil and gas exploration and production projects are technical, commercial, political and financial. All are crucial, but the technical arena poses particular problems in achieving a consistent and comprehensive risk analysis of investment options, characterised by varying geology, different critical factors and disparate, often incomplete datasets.

There is an established literature on theory and method of risking of Prospective Resources, and a group of software vendors who have systematised approaches, with standard templates, look-up tables and a statistically rigorous approach to calculating probabilities. However, universal applicability of methods is yet to have been achieved.

Based on a substantial number of audits of Prospective Resources, it appears that despite scientific advance, sound methodologies may be subordinate to the application of wisdom and experience in unstructured, uncalibrated risk analysis systems.

A pragmatic approach is proposed, illustrated by selected examples, comprising:

- A comprehensive categorisation of risk factors
- Definition of independent risk questions to be addressed in the assignment of probabilities
- Due regard to the application of individual data entities and their uncertainties, making use of statistically defined parameterisation where possible
- Incorporation of dependencies
- Gathering of results into a simple, robust framework for ease of comparison and communication
- Structured review and learning.

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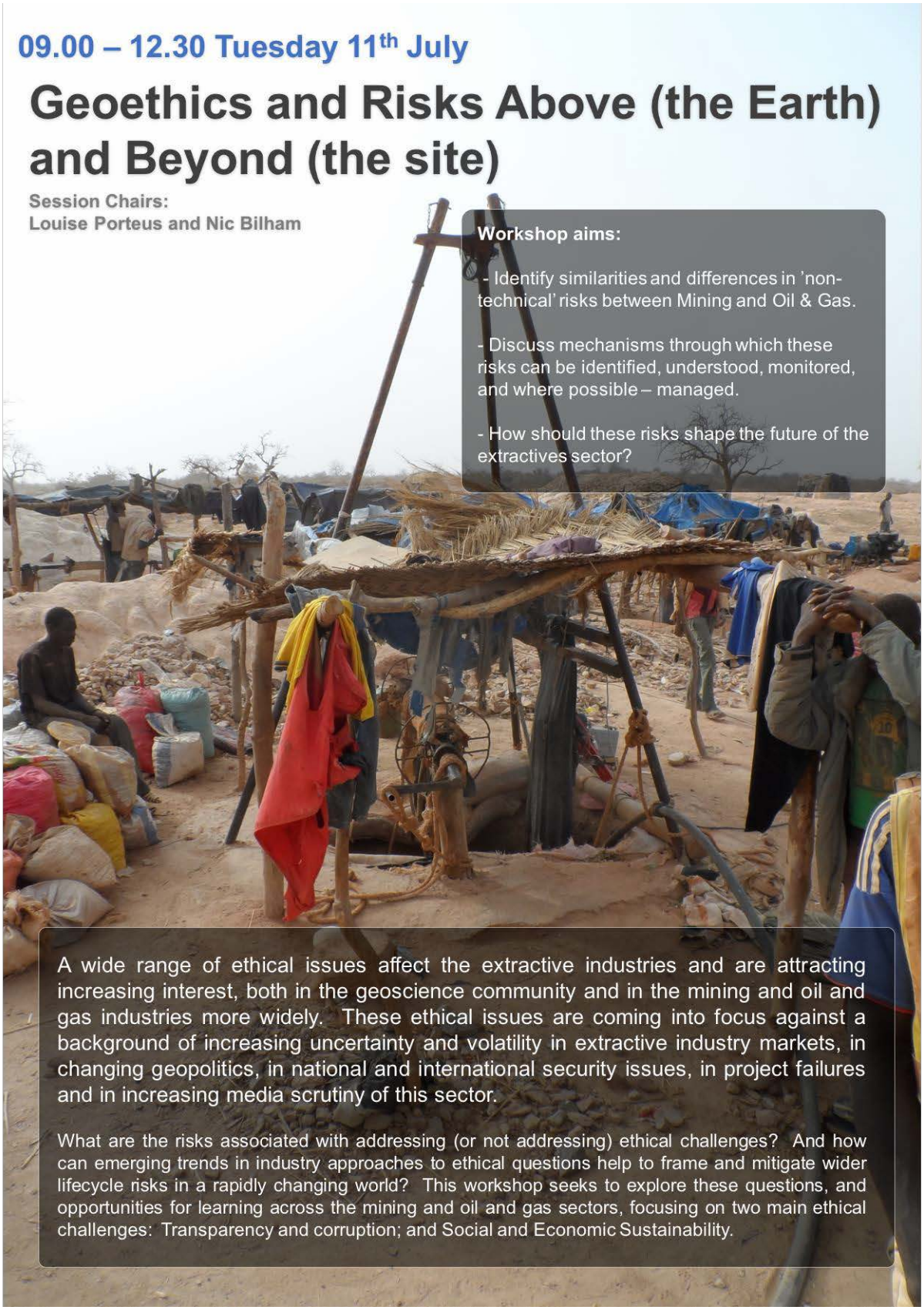
09.00 – 12.30 Tuesday 11th July
Geoethics and Risks Above (the Earth) and Beyond (the site)
Session Chairs:
Louise Porteus and Nic Bilham
Workshop aims:
- Identify similarities and differences in 'non-technical' risks between Mining and Oil & Gas.
- Discuss mechanisms through which these risks can be identified, understood, monitored, and where possible – managed.
- How should these risks shape the future of the extractives sector?
A wide range of ethical issues affect the extractive industries and are attracting increasing interest, both in the geoscience community and in the mining and oil and gas industries more widely. These ethical issues are coming into focus against a background of increasing uncertainty and volatility in extractive industry markets, in changing geopolitics, in national and international security issues, in project failures and in increasing media scrutiny of this sector.
What are the risks associated with addressing (or not addressing) ethical challenges? And how can emerging trends in industry approaches to ethical questions help to frame and mitigate wider lifecycle risks in a rapidly changing world? This workshop seeks to explore these questions, and opportunities for learning across the mining and oil and gas sectors, focusing on two main ethical challenges: Transparency and corruption; and Social and Economic Sustainability.

Tax governance and transparency

Tim Law
Engaged Consulting

Tax governance and transparency have never been more important issues for businesses than they are now. Mining companies face higher levels of scrutiny and expectation from their tax stakeholders, and so have been at the forefront of tax transparency for a decade or more. There is an inextricable link between the taxes a company pays, the way that is communicated to governments and stakeholders, and the ability of a mining company to retain its licence to operate.

The tax governance and transparency agenda is very fast moving. There are numerous initiatives at UK, EU and OECD levels, not to mention the impact of uncertainty in the US. Businesses adopt a range of approaches to tax transparency, driven by factors such as their size, geographic exposure, appetite for risk and availability of resources. However, tax governance cannot be ignored. Boards expect the approach taken by their business to have been properly considered, and to be based upon an appropriate understanding of the tax landscape.

The key is to understand the issues that are really important to your business and where to devote your resources.

The other key tax issue faced by mining companies is certainly and stability. Government tax policy changes, and in an environment where mining companies are making investment decisions over decades, a change in the mining taxation regime can have a significant impact on the economic viability of the project.

In order to understand what a stable tax regime might look like, it is important to understand what drives mining tax policy from a government perspective.

NOTES

Managing Social Risk

A.N. John Castner
Isometrix

The term Social Licence to Operate has been in existence for less than twenty years. Yet risk around the management of social issues in the extractive industries is today regarded as one of the highest priority risks.

Social risk management is now seen as an integral part of integrated reporting. We will examine the reasons behind this shift towards the focus on a triple bottom line of profit, people and planet, examining the cost of not getting it right, and the difficulties associated with effective social management.

Growing populations and the exploitation of more easily accessible reserves has resulted in mining activity affecting a greater number of people than in the past. This, aligned with the rapid spread of knowledge through the internet and social media, means that communities are far more aware of their rights and resettlement programmes have to be managed with a great deal of care and caution.

Standards introduced by bodies such as the IFC and an increase in government legislation have heightened the need for land access and resettlement projects to be carried out in a professional and transparent manner.

The very fact that the term Social Licence to Operate enjoys the currency it does is indicative of the seismic shift social management has experienced over the past two decades. Companies in the extractive industries ignore it at their peril.

NOTES

Understanding and Managing Societal Risk for Shale Gas Extraction (SGE)

C.D. Ford
University of Strathclyde

Societal risk for SGE needs to consider two levels ; the formal licensing, regulatory statutory approval, and the informal wider societal approval or acceptance. As recent UK experience shows there is an important interplay between these. Whilst the first is an established process the second is altogether more intangible and problematic.

Discourse Analysis has shown that the 'anti-fracking' coalition enjoyed greater success in the UK, questioning the 'social license to operate'. This paper presents recent research investigating the issues and dynamics at play in the key crunch point where societal influence interacts with discretionary regulatory decisions, to highlight the potential manageability and challenges of gaining social acceptance.

The research was conducted by : analysis of the plans, supporting environmental statements, public representations and Planning officers' reports for all recent SGE related development proposals; observing decision making meetings and public inquiries, which included hearing members of the public, officers' reports and Councillors' debate to identify the key influences on decisions; and interviews with affected members of the public and members of campaign groups were carried out to understand 'the public' perceptions.

The study found two distinct types of objectors: affected local residents, whose concerns are similar to those raised against renewable development, and non- affected objectors using SGE as a vehicle to challenge national policy relating to climate change. Deep public concern has led to intense scrutiny by Planning Authorities which has significantly delayed although not stopped early SGE proposals.

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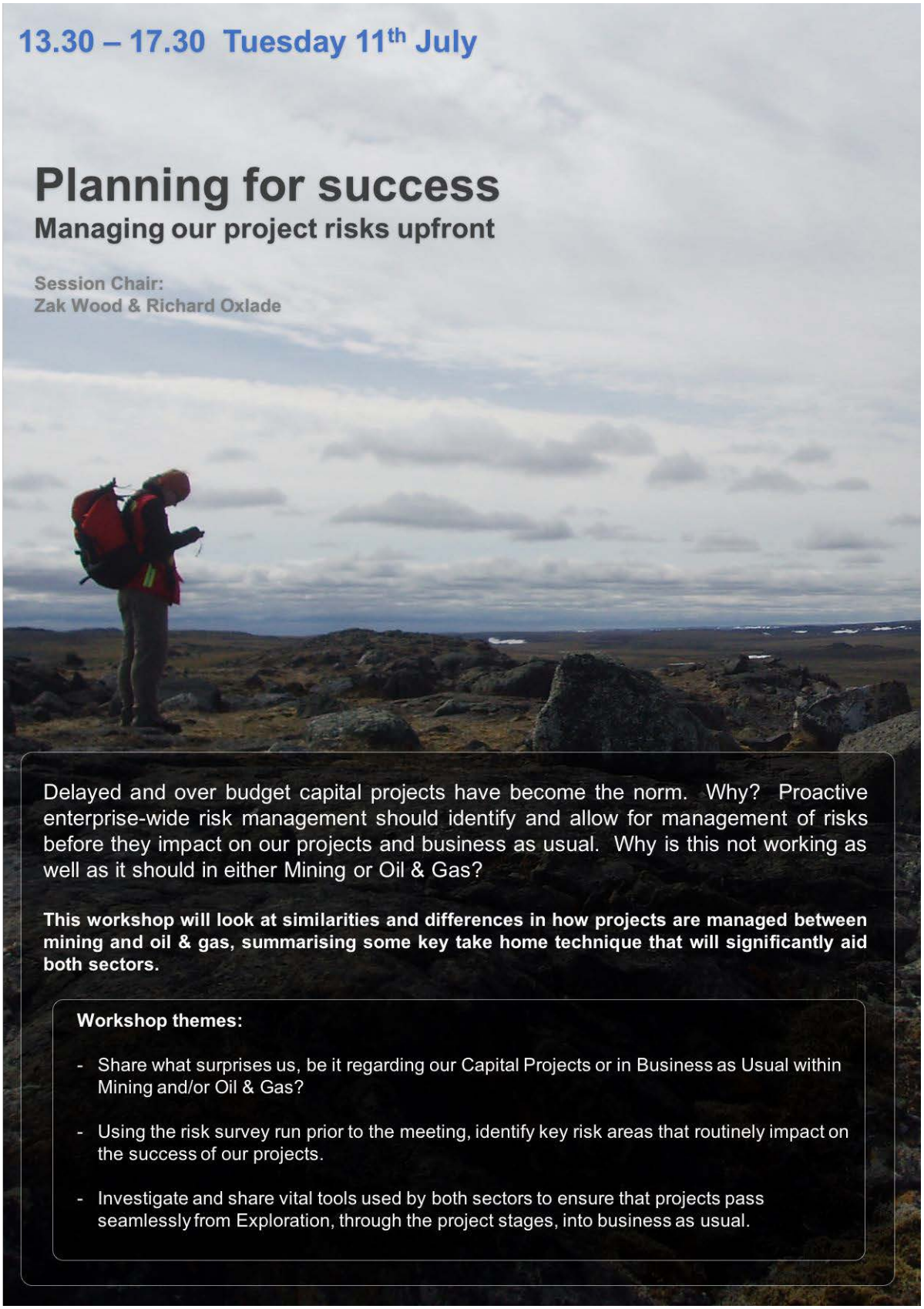

13.30 – 17.30 Tuesday 11th July
Planning for success
Managing our project risks upfront
Session Chair:
Zak Wood & Richard Oxlade
Delayed and over budget capital projects have become the norm. Why? Proactive enterprise-wide risk management should identify and allow for management of risks before they impact on our projects and business as usual. Why is this not working as well as it should in either Mining or Oil & Gas?
This workshop will look at similarities and differences in how projects are managed between mining and oil & gas, summarising some key take home technique that will significantly aid both sectors.
Workshop themes:
- Share what surprises us, be it regarding our Capital Projects or in Business as Usual within Mining and/or Oil & Gas?
- Using the risk survey run prior to the meeting, identify key risk areas that routinely impact on the success of our projects.
- Investigate and share vital tools used by both sectors to ensure that projects pass seamlessly from Exploration, through the project stages, into business as usual.

Planning for success - Mining

Zak Wood
Satarla risk management

NOTES

Planning for success – Oil & Gas

Richard Oxlade
AGR

We usually associate risks in the oil gas industry with geology. Whether it be the exploration risk associated with drilling a new prospect, or the operational risks (e.g. kicks or blowouts) associated with drilling over pressured formations in oil and gas wells.

If we work in business planning, or have been bitten by project delays and cost escalation we will be well aware that risks in the oil and gas industry extend well beyond the subsurface. For example a recent report by the UK Oil and Gas Authority (OGA) found that 58 recent North Sea capital projects either started up between 2011 and 2016 or are currently under execution had suffered an average delay of approximately 12 months and an average cost growth of 20-35%. The total capital cost of these projects was £39bllion. The lessons learned covered organisation, project management, front –end loading, execution and behaviours. Oil and gas industry professionals will recognise the same issues in most parts of the world.

The OGA report excluded smaller capital projects. But the same pattern is evident in "business as usual operations" e.g. infill drilling, workovers etc. Surprises appear to arise in all functional areas – this is not just about the subsurface.

These risks will be discussed to some extent during the Planning for Success workshop. However, the session will mainly explore wider issues with the intent of learning from the mining industry and risk management professionals. And to communicate and discuss some of the bigger picture thinking in the oil and gas industry.

Why do we need to go wider than geology and project management? Interestingly a recent article in the Oil & Gas Financial Journal (Rudloff & Schultz) reported on an annual global risk survey of directors and senior executives. Oil and gas industry leaders included the following in their top 5 risks:

- Heightened regulatory changes & scrutiny
- Economic conditions in markets we currently serve may restrict growth opportunities
- Organisations may not be sufficiently prepared to manage cyber threats that could disrupt operations or damage brands
- Resistance to change may restrict organisations from adjusting business models and operations
- Succession challenges and the ability to attract & retain top talent

Another 3 risk were close – shifts in social, environmental and other customer preferences and expectations; the organisation not being sufficiently prepared for an unexpected crisis that can rapidly turn into an enterprise-wide risk event; rapid speed of disruptive innovations and technology which outpace the organisation's ability to compete or change.

It's interesting that geology doesn't even appear. In summary risk in the oil and gas industry is a very broad topic with plenty of cope for learning from other industries and how they manage them. It should lead to some interesting discussions and shared learnings.

NOTES

Risk Management in Unconventional Oil and Gas

T. Kelly
RSKW

As the unconventional petroleum industry continues to develop, the potential environmental, social, regulatory and health issues have become more apparent. The rapid growth of the shale gas industry in North America has unearthed challenges that can occur at varying stages of development: during well stimulation; in relation to well integrity; and the handling, storage and disposal of materials on the surface. As part of an EU Horizon 2020 project, SHEER (SHale Exploration and Exploitation induced Risks), the environmental impacts of hydraulic fracturing are being assessed at a site in northern Poland. The project covers three main areas of risk: air quality, induced seismicity and groundwater contamination which tie into a detailed study on the approach to risk management and best practice. An assessment of risk from a cost-benefit approach reveals the necessary forward planning to reduce economic liabilities in the long-term. Using case studies and the current study in Poland the process of risk management in line with ISO 31000:2009 has been critically assessed. The presentation will consider environmental risks with a particular focus on groundwater. Using case studies and examples of regulatory practice, the process of risk management is applied to unconventional oil and gas to create a template for best practice that helps to manage and mitigate risk and, ultimately, reduce financial liability.

NOTES

Adapting to Extreme Weather Events:
Lowering Your Exposure to Risk and Saving Your Business Money

Ollie de Boer
Satarla Associate

The purpose of this topic is to demonstrate how applying proactive risk management can lower a MOG (Mining / Oil & Gas) companies' exposure to EWEs (Extreme Weather Events). The bow tie tool will be used to outline the causes and consequences of EWEs; leading into examples of how EWEs impact MOG companies; future EWE projections; associated costs; adaptive and mitigative responses; and examples of MOG companies' responses.

The objectives of this session are:
1. Improve the long-term viability of MOG organisations; and
2. Increase awareness in the sector regarding the inevitable escalation of EWEs.

In the past 50 years, it is very likely (greater than 90% probability) that anthropogenic climate change, caused by GHG (Green-House Gas) emissions from fossil fuels has accelerated the natural 'greenhouse effect'. This has led to rising global temperatures and sea levels, ocean acidification, glacier and permafrost melt and increasing climatic uncertainty. These climatic shifts manifest as more frequent and severe EWEs: temperature spikes and shifts; heavier precipitation; droughts; storm surges; and wildfires. Therefore, MOG organisations are exposed to greater uncertainty, which they are not necessarily prepared for.

As energy producers and natural resource consumers, MOG organisations have a major role to play in preventing EWEs from escalating. However, this poses a major risk (threat and opportunity) to their business models as they transition to renewable energy creation. Regardless, the consequences of EWEs are inevitable, given current and projected use of fossil fuels, offset against natural carbon storage systems. Therefore, MOG companies need to understand where their business and supply chain are vulnerable, and create adaptation plans; these solutions will require assistance from risk management experts, civil engineers and attribution scientists.

NOTES

How should the environmental and social factors be accounted for in business decisions?

Livia Mello
University of British Colombia

How should the environmental and social factors be accounted for in business decisions? Which valuation models should be used? When do we know when estimates are accurate enough? These were some of the questions from 80 upper-management professionals present at GLOBE 2016, North America's largest sustainable business leadership summit (2016). The extent to which organizations can integrate technical and non-technical variables in decision-making processes is crucial for project performance and prevention of impacts. However, the private sector is not equipped for internalizing non-technical, less tangible, aspects in their project assessments.

According to Grant A. Malensek at the Current Trends in Mining Finance Conference 2015, "Social License to Operate (SLO) costs are undervalued and usually not included in project valuations. Project valuations must include all relevant factors, not just geological and technical (Malensek G., 2015)." This is supported by Environmental Resources Management (ERM) study that showed that only 30% of 69 mining projects (US$ 500 M and over) were delivered on schedule from 2008-2012 and 81% of the factors that led to delays were mostly from lack of social acceptance, environmental and permit issues (Molyneux, 2013).

The main three panel objectives are: 1) identify key technical and non-technical variables that should be included in preliminary project assessments 2) Determine the current gap in knowledge/tools in both criteria identification and valuation 3) Provide recommendations for practice. The analysis could be done in groups based on a case study or overarching questions, which will be selected by the facilitator and conference committee.

NOTES

Why do we get performance surprises in companies that seem to have good risk management processes?

P. Craig Smalley
Imperial College London

Most large oil and gas companies have a corporate risk management process, with supporting documentation, people, processes and tools. Nevertheless, there is extensive evidence in the literature of negative project or field performance surprises, such as lower or later production and increased cost, some of which can be traced back to subsurface root causes. Such surprises are a manifestation of subsurface risk events that actually occurred - but why were these not identified and managed effectively to avoid the negative impacts? This presentation imagines the life cycle of a subsurface risk: its conception in a subsurface team, its reporting into the organization's risk management process, its path through the risk management process, its communication to project/field decision makers, and the way risk management measures are communicated and finally implemented. Depending on the organizational construct, there are various places in the risk life cycle that risks can be lost from the system or get "stuck" so that they end up being under-managed, leading to potential performance surprises. These sticking points are discussed, along with suggestions for improvement. The use of lookback analysis on project outcomes, examining risks that were successfully managed and those that were not, is proposed as a powerful tool for performance improvement.

NOTES

Managing Social Risk

A.N. Cecilia Jofré
Metrix Software Solutions

The world's understanding of business value has changed, expanding from traditional financial assets to include multiple capitals. In a resource-deprived world, companies must have a long-term strategy that maintains value creation in a sustainable manner, particularly around critical social and environmental aspects.

Integrated Reporting is fostering a culture of integrated thinking within organizations and both are driving the execution of strategies and frameworks that promote sustainability. In South Africa, the King IV Code has had a major impact on the approach of mining houses to governance and risk, encouraging transparency and meaningful reporting for all stakeholders. As our understanding of what it means to create value shifts, organizations are discovering new ways to develop integrated management systems that create meaningful reports on multiple capitals to thrive in an uncertain future.

The urgency driving this change – conditions such as social inequalities, climate change, scarce resources, poverty and so on – and the growing need to create resilient businesses are redefining the GRC landscape.

Timely visibility of information is crucial in managing the pursuit of opportunity in the context of risk appetite, and tolerance. Visibility highlights trends and shows interconnectedness of value in an organization, which may have previously been overlooked. It supports optimal decision making, allowing companies to respond to challenges better.

NOTES

Some challenges and solutions related to the assessment of mining project risks

E.J.Sides
Orebody Risks Limited

Experience gained in applying basic risk assessment methods in the context of mining studies are discussed. The following approach has been used on several different studies and technical reviews:

- Preparation of a register of risk issues
- Assessment of likelihood and consequence for each risk issue
- Ranking of issues in terms of overall risk rating
- Planning of risk management strategies to be applied in the next project stage

Applying this approach in the context of multi-disciplinary project teams has highlighted several challenges including the following:

- Lack of a common project definition
- Lack of a common basis for ranking risk issues
- Differences in approach in the different disciplines involved

Approaches which have assisted in overcoming some of these challenges include:

- Preparation of a shared project design criteria document at an early stage in project development
- Maintenance of an evolving project design basis register throughout the life of a project
- Adoption of selected engineering terminology and approaches for geological evaluation and Mineral Resource estimation
- Agreement on risk categorisation criteria which can be applied across the full range of disciplines involved.

Examples from selected mining projects are used to illustrate some of these challenges and solutions.

NOTES


10.00 – 11.00 Wednesday 12th July
(Human) resourcing our future
Educating and retaining the skills we need within Mining and Oil & Gas
Panel Chair: Prof Jan Cilliers
A lack of skilled resources features in many risk reports. A down-turn in commodity prices exacerbates this risk due to two key factors:
a) The pressure to lower operating costs is alleviated through reducing headcount, leading to skilled individuals leaving the sector.
b) Institutes of learning see less demand for certain skills (and corresponding funding for those courses) and therefore stop running courses.
This session will look at the how educational establishments (such as Universities) and Mining and Oil & Gas companies can work together to ensure a more sustainable approach to producing and retaining highly skilled individuals critical to both sectors.
Workshop themes:
- The current skills gap – statistics for key skillsets in mining and oil & gas, and what is driving this skills gap?
- Identify what the key skills are that will be required for the extractives companies of the future (e.g. will they be more technology based?)
- Investigate and share methods through which we can make our skills base more sustainable across both sectors.

PANEL SESSION: (Human) Resourcing our Future

The Risk of Running out of Capable Human Capital: Resourcing the Mining Industry

Neville Plint[#] and Jan Cilliers[*]
[#] Director, SMI, University of Queensland, Brisbane, Australia
[*] Professor of Mineral Processing, Royal School of Mines, Imperial College London

The minerals industry requires specific technical expertise in mining- and mineral process engineering and geoscience to maintain and operate its current business and to develop future projects. A steady supply of new graduates is essential to replace not only retirements but also those who left the industry during the recent downturn. The supply of trained graduates is however not instantaneous, and there is a four-year lag from entry into university to graduation. Further, the behaviour of the industry during a downturn affects whether candidates enter degree programmes in the first place and the industry thereafter. It is essential that this lag in human resource supply and a likely shortage of skilled talent is taken into account when considering risks to the business of mining. The shortage of capable people, has in the past has resulted in unsustainable salary expectations and is likely to pose financial and execution risk to new projects.

This paper will review some recent statistics of students in training from around the world to predict the skilled talent available in the next five years. It will also show trends in recruitment to the mining industry of these graduates in the recent past. It will be made clear that the industry faces a significant shortage of graduates from western universities in the next few years. While graduate numbers from universities in China and India remain significant, these have many opportunities in their home countries and are often affected by immigration restrictions.

It can be argued that advances in automation and robotics will reduce the need for so many mining- and minerals engineers. Two aspects will be discussed; the pace at which this advance can and is happening, and whether this will not simply create a shortage of talent of a different kind. It is clear that whatever the direction taken, significant action is required to not only sustain the training courses that provide future ready talent to the mining industry, but also ensuring that graduates from these courses enter and stay in the industry. The future prosperity of the industry is dependent on delivering sustainable stakeholder returns through the cycle.

NOTES

LEADERS' DISCUSSION #1 – NOTES

LEADERS' DISCUSSION #2 – NOTES

Sarah Gordon – Lead Convenor

When Sarah first heard about Glen's idea for this conference, the opportunity to help pull together individuals from the worlds that she routinely works in (both risk and geosciences) was too good to miss.

Having completed her undergraduate in Earth Sciences at the University of Glasgow, Sarah then went on to work as a Geologist for Anglo American, completing her PhD at Imperial College along the way. She was lucky enough to live and work in Canada, Brazil, Southern Africa, and Europe, in a variety of functions from exploration through to sustainability, risk management and assurance. This grounding allowed her to explore different risk management techniques and uses, applying them to real situations.

Together with two other risk managers, Sarah founded Satarla in 2014. Now with 30 Associates based around the world, Satarla provides risk management consultancy, training and research to organisations from sectors such as healthcare, agriculture, charities, finance, together with petrochemicals and the extractives industries.

Sarah currently sits on the Council for the Geological Society and chairs the External Relations Committee. She is also an accredited trainer for the Institute of Risk Management, and an honorary lecturer at Imperial College London.

Georgina Worrall – Lead Convenor

Georgina has been Conference Manager at the Geological Society since March 2006, previously having worked at the Royal Society of Medicine.

Georgina is the Secretariat for the Society's Science Committee, who are responsible for the Society's scientific programme of events.

Georgina is a co-founder of the City of London Geoscience Forum whose aim is to share knowledge between geoscientists and professionals working within the finance and insurance sectors.

Georgina is particularly keen on bringing together professionals from outside geoscience to disseminate knowledge, so was very keen to be involved in this conference.

Glen Burridge – Co-Convenor

When GSL put out a request for ideas for the Year of Risk, Glen jumped at the chance. Informed by his own experiences in aviation, a conference sharing ideas between Earth Scientists and different professions and sectors on how they approach and handle risk was an event he'd been wanting to put on for years.

Originally trained as a geophysicist, he now works as management consultant on technical and organisational topics in Upstream Oil & Gas and is based between London and Australia. He has 20 years of experience of the industry working in a broad range of roles from frontier explorationist to development geoscientist to shaping subsurface assurance workflows for operators, through to designing training programmes and evaluation criteria for technical software toolkits. He's worked on projects in the UK, France, Norway, South America, North Africa, the Arabian Peninsula, India and Australia.

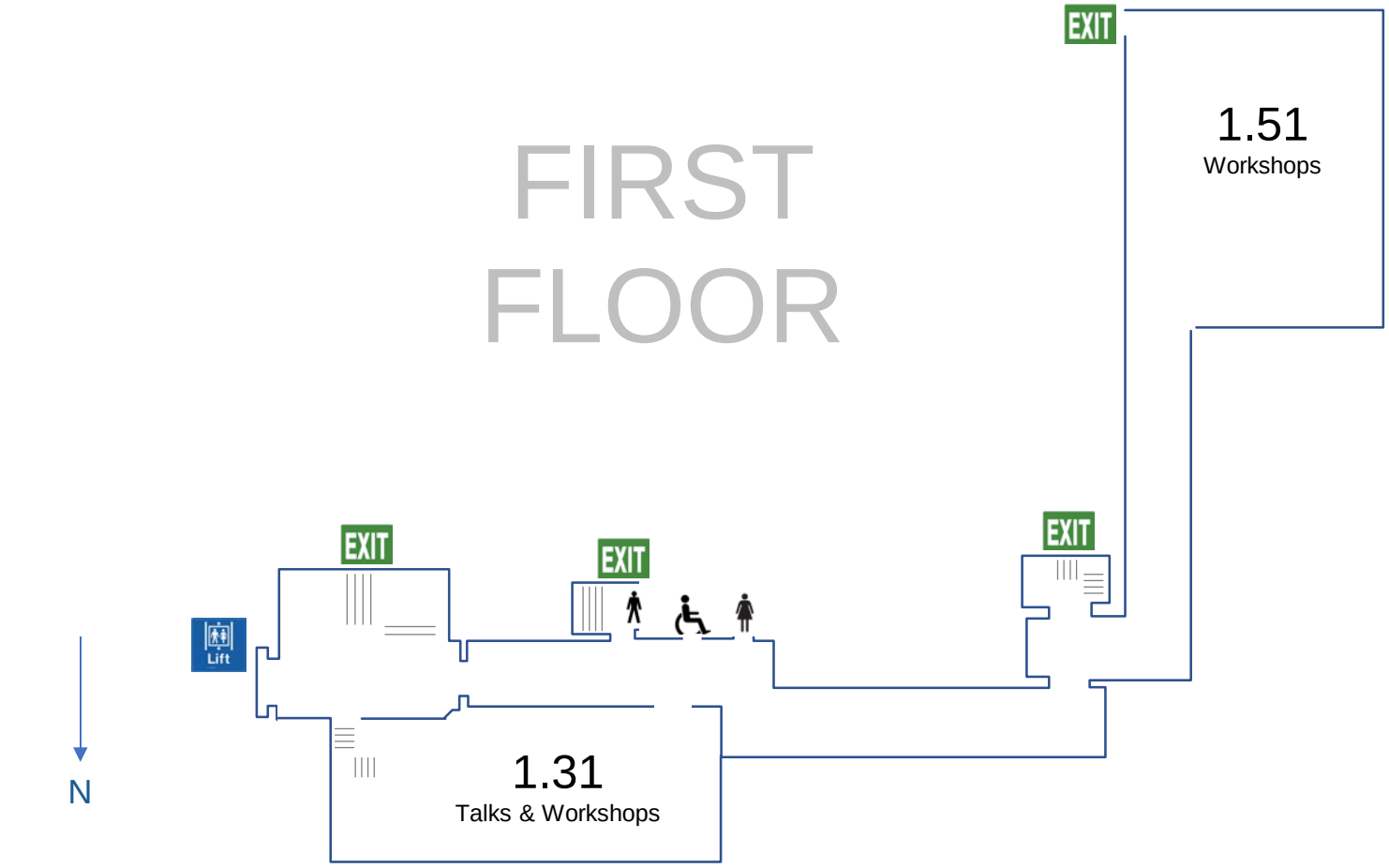
His particular interests are in effective knowledge capture for technical assurance, the role of cultural risk, improving well planning workflows and raising the profile of geomechanics as a discipline.

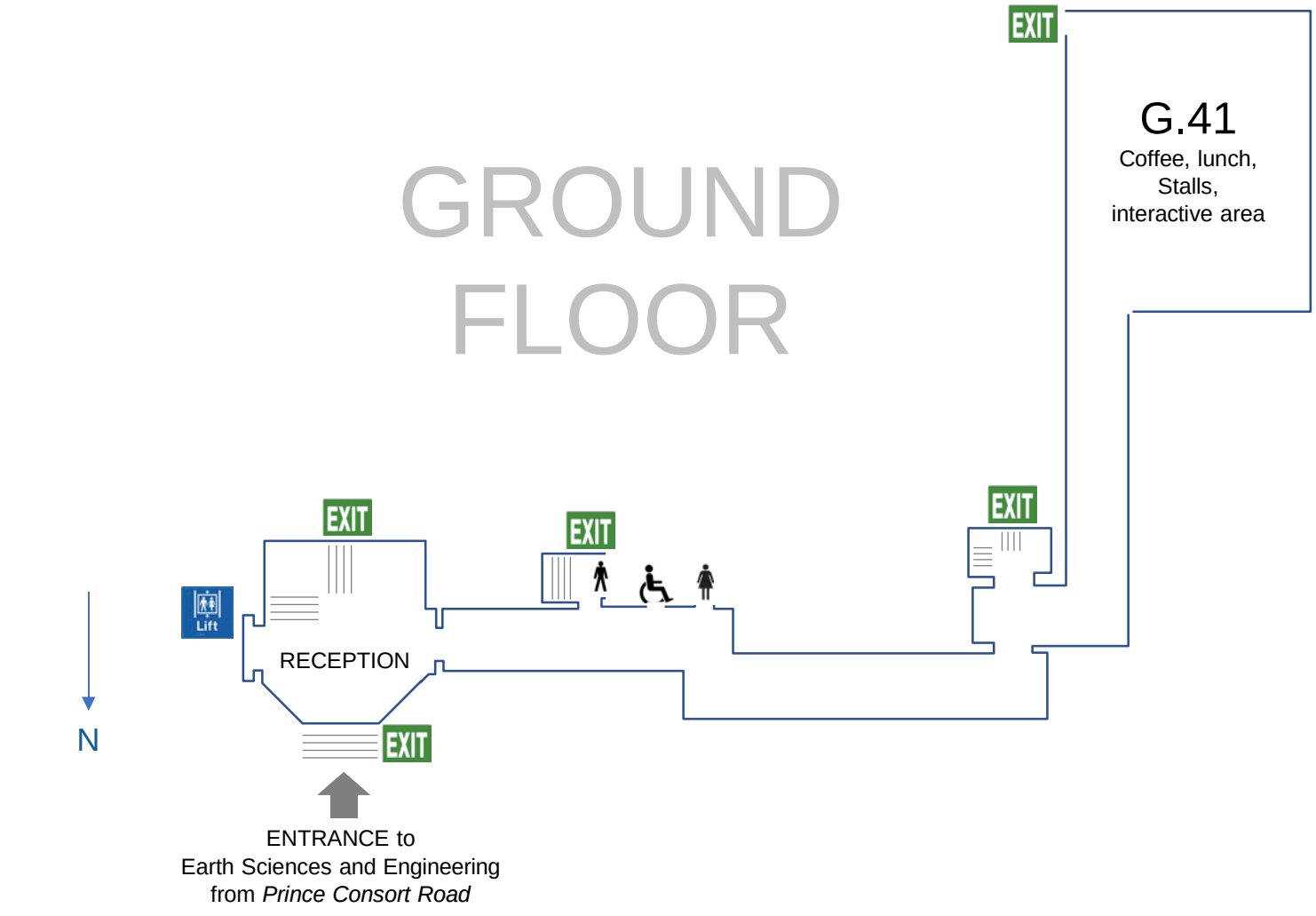
He is passionate about bringing a holistic view of risk involving the Earth Sciences to the fore, one that includes all its constituent elements across technical, commercial and human spheres and hopes that this conference provides a wonderful opportunity for Earth Scientists and our very welcome guests to reach towards that goal while sharing lessons from their own fascinating experiences.

Glen is Program Chair and co-founder of the Society of Petroleum Engineers (SPE) Geomechanics Technical Section, Steering Committee member of the SPE/EAGE *Integrated Geomechanics* conference in Abu Dhabi in 2018, co-convenor of the GSL's *Managing Risk across the Mining and Oil & Gas Lifecycle* conference and has been an invited keynote speaker and contributor at a number of international management and subsurface technical conferences. He is also a contributor on cultural and risk topics to SPE Publications, the Intercultural Training Channel and Airsoc.com.

Imperial College London

EARTH SCIENCE AND ENGINEERING





Kirsty Simpson – Co-convenor

Kirsty met Sarah after a lecture at the Geological Society and as they were discussing the conference Sarah and Glen were pulling together she had to offer to help having spent the last few years evaluating exploration risks in the oil industry.

Kirsty studied Geology at Durham University before heading off to the Centre for Palynology at Sheffield University to study for an MSc. A few years later, after getting slightly sidetracked into chemistry teaching and an MSc in Petroleum Geoscience at Imperial College, she went to work for BG Group. Progressing through the graduate program she took a role in the New Ventures Team which was where she learned all about risk and through working with Marc Bond (trying to get his approval for her risked opportunities) she became interested in the human biases affecting the assessment of risk, thus the opportunity to be involved in this conference was too great to pass up.

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The Conversation Continues..... in Perth 2018.

Managing Risks in Mining & Oil & Gas across the Asset Lifecycle

In 2018, we're intending to bring the mining and petroleum worlds together again to talk about risk, this time in Perth, Australia.

For further details and expressions of interest:

- Leading sessions
- Presenting
- Workshops
- Training
- Sponsorship

Please contact:
Sarah Gordon sarah@satarla.com (Mining) / Glen Burridge gburridge@ndbteam.com (Petroleum)

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Geological Society 2017 Conferences

Date	Title	Location
10-12 July	Managing Risks across the Mining and Oil and Gas Life Cycle	Imperial College, London
13-14 July	Sharing an Uncertain World: Lessons in Managing Risk	Burlington House
7-8 September	Building Resilience	Burlington House
14-15 September	The evolution of flooding and flood risk: past, present and future	Burlington House
25-27 September	Fermor Meeting 2017: Factory Earth	Burlington House
3-5 October	William Smith Meeting 2017: Plate Tectonics at 50	Burlington House
16 October	6th UK Deep Geothermal Symposium	Burlington House
26-27 October	Ground related Risk to Transportation Infrastructure	Burlington House
31 October – 2 November	PG: Fold and Thrust Belts: Structural style, evolution and exploration	Burlington House
6-7 November	Janet Watson 2017 Meeting: The Future of Contaminated Land Risk Assessment: stakeholder perspectives	Burlington House
08 November	GSL Nottingham Career and Industry Day	British Geological Survey, Keyworth
15-17 November	PG: Handling Fault Seals, Baffles, Barriers and Conduits	Burlington House
22 November	GSL Edinburgh Career and Industry Day	Our Dynamic Earth, Edinburgh
23 November	Bryan Lovell 2017 Meeting: Title TBC	Burlington House
27-28 November	PG: Cross-border Exploration between UK and Norway	Burlington House

https://www.geolsoc.org.uk/Events/Society