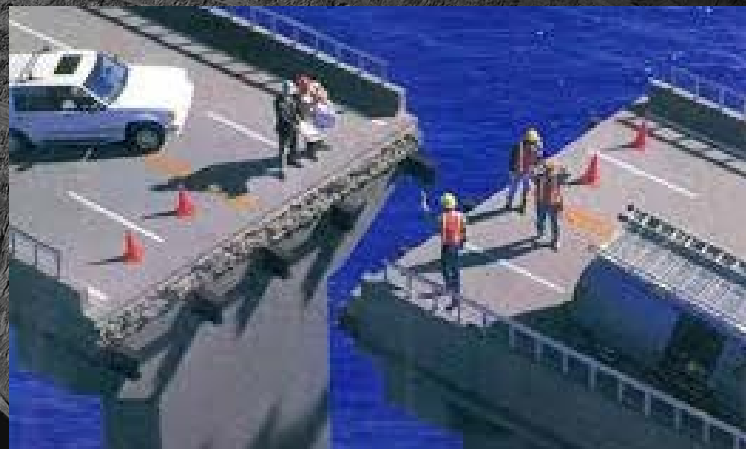


Why do projects go wrong and what systemic risks exist in the current design process?

Are there unknowns we should know?

Presenter: David Pearce, General Director - SRK

Location: Webinar



1. Overview – why do projects go wrong?

2. Discussion by discipline

- Resource estimation & Geology for engineering
- Open Pit slope design
- Groundwater
- Mining risks
- Processing risks
- Tailings risks
- Environment and Social Risks

3. Concluding comments

Sergey Shestak, SRK

Anton Pavlovich, SPMI / Ivan Livinsky, SRK

Roman Bondarenko, SRK

David Pearce, SRK

Mike Hallewell, MPH Minerals

Jamie Spiers, SRK

Ksenia Dyachkova, SRK

There are known knowns; there are things we know that we know.

There are known unknowns; that is to say, there are things that we now know we don't know.

But there are also unknown unknowns – there are things we do not know we don't know.

-Donald Rumsfeld



Project	Actual Capital x \$1 Million	Actual Completion	Cost Overrun	Schedule Overrun	Performance achieved
RGP5	A 4800	3Q2011	0 per cent	-5 per cent	Yes
Degrussa	A 400	Sep-12	4 per cent	0 per cent	Exceeded
Tropicana	A 833	Sep-13	11 per cent	-6 per cent	Exceeded
Kevitsa	US 470	Aug-12	18 per cent	3 per cent	Exceeded
FMG Stg 1	A 2825	May-08	26 per cent	18 per cent	Yes but delayed
E&G	A 2995	1Q 2012	58 per cent	28 per cent	Yes
Karara	A 3051	Jan-13	79 per cent	113 per cent	No after 2 years
Rocklands	A 480	not completed	92 per cent	N/A	Not completed
Kaunisvaara	US 1500	Dec-13	116 per cent	35 per cent	Abandoned
Minas Rio	US 8400	Oct-14	143 per cent	242 per cent	Too early
Sino Iron	US 12000	Dec-13	386 per cent	230 per cent	No after 3 years

W Mackenzie & N Cusworth, 2016

Why did it go wrong?

Project	Category	3 phase study process	Study scope complete	Scope Frozen at Go Ahead	Permitted at Go Ahead
RGP5	Good	✓	✓	✓	✓
Degrussa	Good	✓	✓	✓	✓
Tropicana	Good	✓	✓	✓	✓
Kevitsa	Not Too Bad	✓	✓	✓	✓
FMG Stage 1	Not Too Bad	✓	✓	x	x
E&G	Not So Good	✓	✓	✓	✓
Karara	Ugly	✓	x	x	x
Rocklands	Ugly	x	x	x	x
Kaunisvaara	Ugly	✓	x	x	x
Minas Rio	Ugly	✓	x	x	x
Sino Iron	Ugly	x	x	x	x

W Mackenzie & N Cusworth, 2016





**The
Guardian**

- Norilsk Nickel diesel tank leak due to warming of the permafrost:
 - Potentially \$ 2 billion fine

- Levikhin mine near Kirovgrad, Urals:
 - Long term treatment costs by local authority



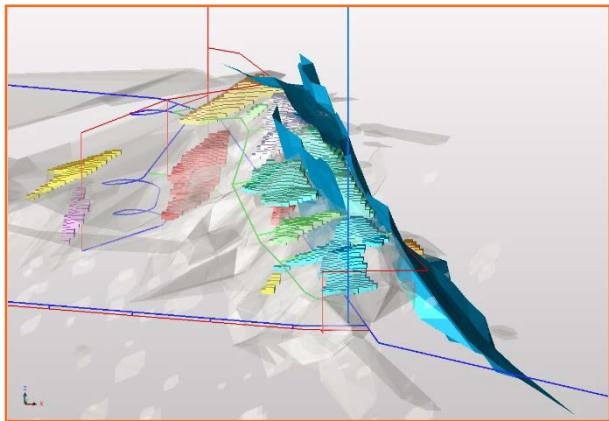
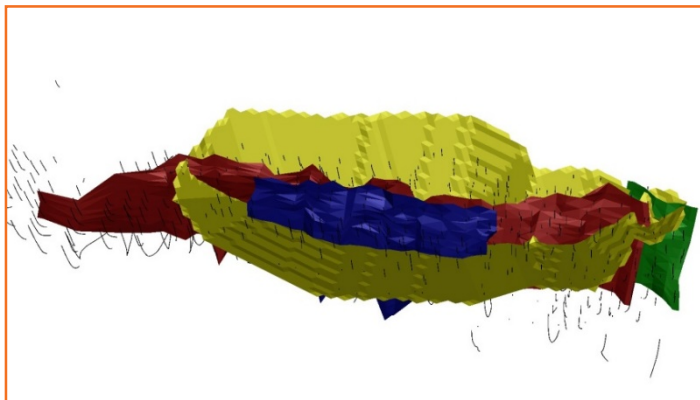
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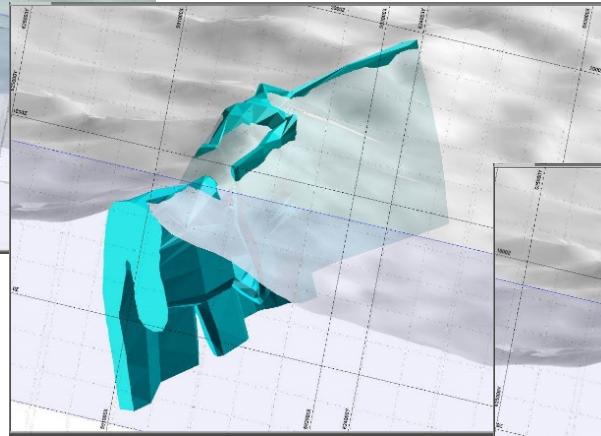
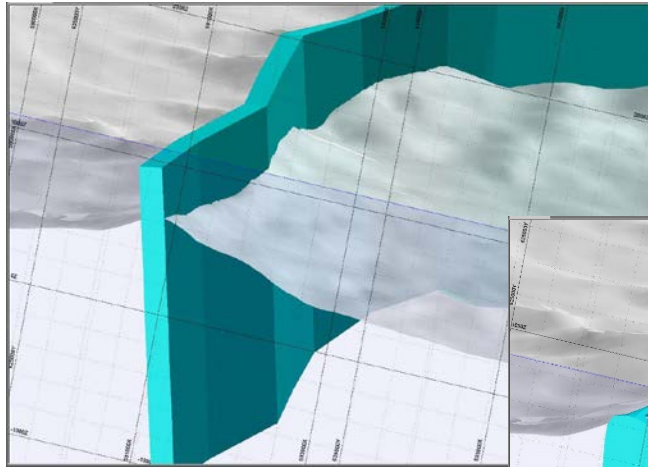
-Donald Rumsfeld



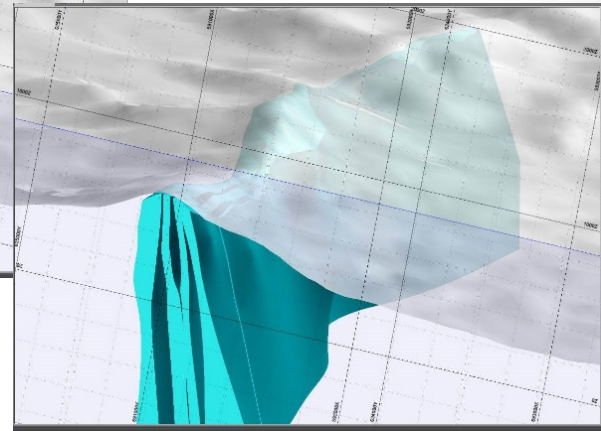


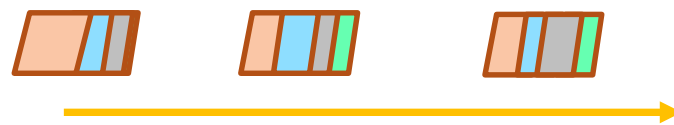
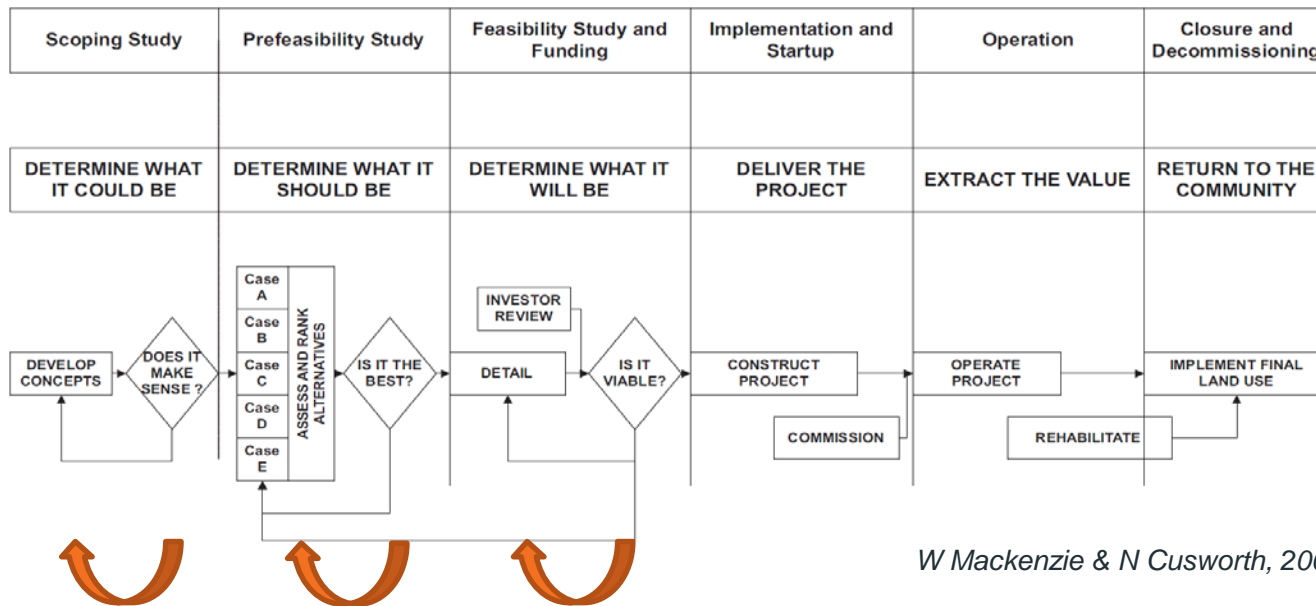
We actually analyse only ~0.0001% of the deposit

Inferred



Indicated





Additional, focused data collected after each stage

Scope item	Scoping Study	Prefeasibility Study	Feasibility Study	Operation
Resource Confidence & Geologic Controls	Inferred	Indicated & Inferred	Measured & Indicated (Inferred is upside)	Confirmed by grade control and production
Pit slopes	Assumed	Based on interpretation	Based on oriented core	Based on face mapping
Ore Sampling and Test Work	Identify Conceptual Flowsheet using Composite samples	Optimise Flowsheet parameters & Start Variability Testing	Minimise metallurgical risks, pilot plant for complex projects. Further focused and detailed variability testing.	Confirmed by production
Operating costs	Analogue	Database & 1 st principles	Quotations & 1 st principles	Confirmed by production
Capital costs	Database	Database; Analogues	Quotations	Too Late!

... and the amount of effort will depend on the specific areas of sensitivity for each project.

Amount of effort	Less			More
Geological Continuity	Good			Poor
Mining method	Open Pit – bulk	Open Pit – selective	Underground bulk mining	Underground narrow vein
Ground conditions	Good			Weak
Water management	None			Plenty
Processing flowsheet	Simple; good recoveries			Complex
Climatic issues	Benign			Challenging
Environmental & Social issues	Minor			Significant
Infrastructure	Good or not material			Remote
Impact of failure	Minor			Catastrophic
Project Economics	Low opex, High IRR			Marginal

Russian documentation	International documentation	Comments
Preliminary assessment of mineral deposits at early exploration stages (TES, TED, TEO, TEP)	Conceptual study/ Scoping Study	Study of the deposit aimed at identifying key issues and the potential for deposit development. Determination of the efficient development options, feasibility and economic viability of the deposit mining.
TEO Konditsii.	Pre-feasibility study	Studies aimed at working out the uniform technical-economic parameters (Options) for the deposit exploitation which determine the optimum and cost-effective methods of project development.
Detailed project and project documentation		
Project of Construction Organization (POS)	Feasibility study	Development of a project design under the one preferred option of deposit development.
	EPCM	Construction of the mine.
OVOS	ESIA	OVOS requires a less detailed study as compared to ESIA

... but key differences exist

- International resource-reserve estimates are flexible – they can be changed at any time
 - Often a challenge to reduce On-Balance reserves
 - Modelling methods often prescribed
- International studies focus on investment and funding criteria (economic optimisation & risk management); Russian studies on technical solutions and compliance with regulations
 - NB Russian regulations are actually more flexible than many designers admit
- International studies focus more on environmental and social impact, as well as designing for closure
 - Russian studies focus more on compliance and calculating land-use taxation
 - International studies on collecting information needed to identify risks and design the operation to manage them to minimise impacts

... and most important is the experience of the study team

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3. Concluding comments

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