Failure is not an option: tailings dam investigations with geophysics and the Mount Polley review

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TÜV NORD GROUP

Overview

- **Review of the Mount Polley case**
- **General case for geophysics and project timelines**
- **Perceptions of geophysics in the engineering world – reasons not to use geophysics?**
- **Best Applicable Practices (BAP)**
  - Professional Geophysicist's role
  - Communication
  - Thoroughness
- **Best Available Technology (BAT)**
  - Matching the technology to the objective

Mount Polley spill blamed on design of embankment

Independent investigation finds foundation of earthen dam failed because of unstable underlying layers

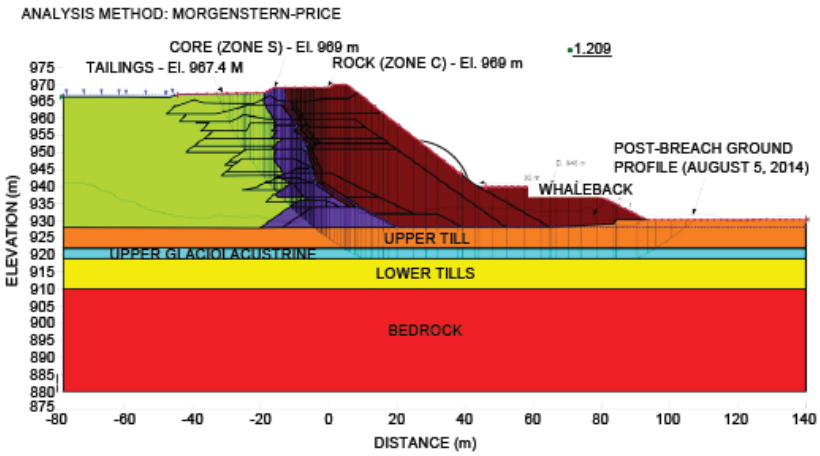
CBC News · Posted: Jan 30, 2015 5:56 AM PT | Last Updated: Jan 31, 2015 1:50 PM PT

An earthen dam containing the Mount Polley mine tailings pond gave way early on the morning of Aug. 4, 2014 discharging 25 million cubic metres of contaminated water and mining waste into creeks and rivers near the town of Likely, B.C. (Ministry of the Environment)

The root cause of the breach was the undrained failure of the Upper GLU under the imposed load of the Perimeter Embankment on August 4, 2014. (p.104)

The design did not take into account the complexity of the subglacial and pre-glacial geological environment associated with the Perimeter Embankment foundation. (P.105)

2015, Report on Mount Polley Tailings Storage Facility Breach, Independent Expert Engineering Investigation and Review Panel, Government of British Columbia



2015, Report on Mount Polley Tailings Storage Facility Breach, Independent Expert Engineering Investigation and Review Panel, Government of British Columbia

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In the view of the Panel, the fundamental need is to improve the geological, geomorphological , hydrogeological and possibly seismotectonic understanding of sites proposed for tailings dams in B.C.

2015, Report on Mount Polley Tailings Storage Facility Breach, Independent Expert Engineering Investigation and Review Panel, Government of British Columbia

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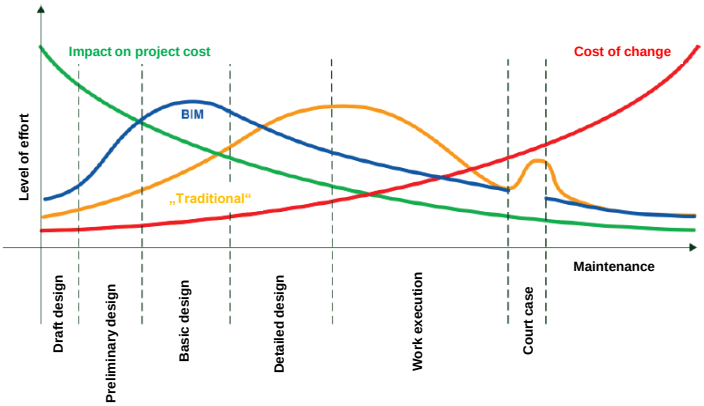
Project timelines: BIM & design management
„Building Information Modelling“

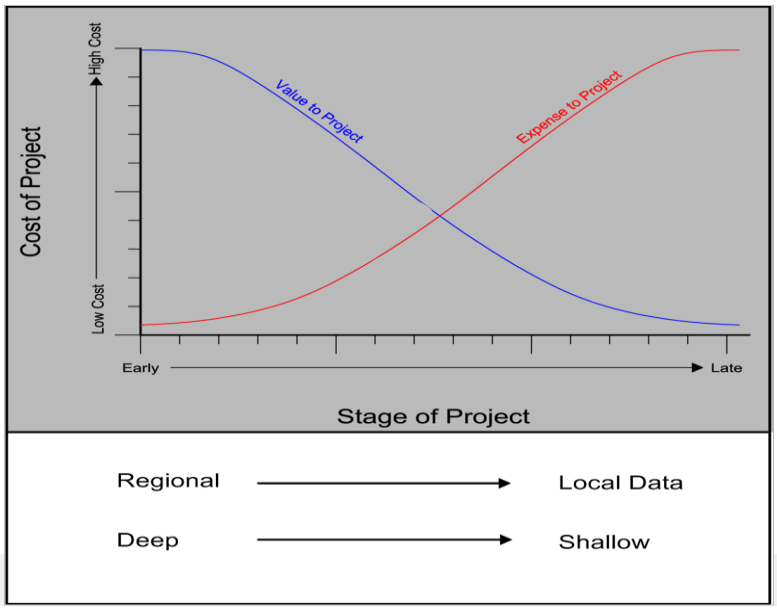
Interests of our customers:

- Reliability of budgets
- Reliability of time schedules
- Improved efficiency
- Improved risk management
- Sustainability



Adapted from, Civil + Structural Engineer magazine, Zweig Group, Fayetteville, AR 72703.

Geophysics and project timelines



Perceptions of geophysics in the engineering world – reasons not to use geophysics?

Professional Geophysicist

Reasons for Failure of Geophysical Investigations:

1. Bad planning
2. Incorrect choice of technique or specifications
3. Insufficiently experienced personnel

From; Weight, W.D., and Sonderegger, J.L., 2001. Manual of Applied Hydrogeology. McGraw-Hill, New York.

communication

thoroughness

Decision Matrix – USACE, Geophysical Exploration for Engineering and Environmental Investigations

Table 2-1
Decision Matrix of Surficial Geophysical Methods for Specific Investigations

	Lithology	Top of Bedrock	Rippability	Detection of Water Surface	Fault Detection	Suspected Voids or Cavity Detection	In Situ Elastic Moduli (Velocities)	Material Boundaries, Dip, ...	Linear Subsurface Water Conduits	Landfill Boundaries	Large Ferrous Bodies-Tanks	Conductive Bodies, Ores, Plumes, ...
Seismic Refraction	S	W	W	S	S		W	S				
Seismic Reflection	S	S	S		S	S		W				
SP									W			S
DC Resistivity	S	S		S	S	S		S		W	S	S
Electro-Magnetics					S			S	W	S	S	W
Ground Penetrating Radar		S		S	S	S		S	S	S	S	
Gravity					S	S		S				
Magnetics					S					W	W	

W - works well in most materials and natural configurations.
S - works under special circumstances of favorable materials or configurations.
Blank - not recommended.

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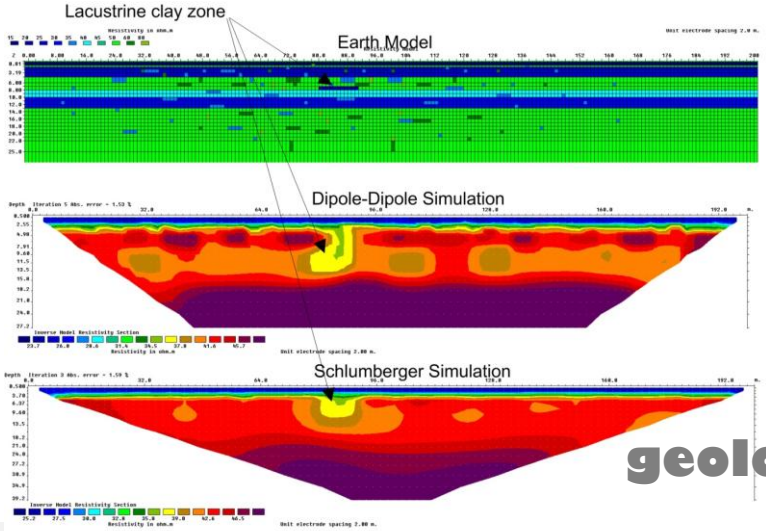
BAP: Choice of specifications Mount Polley

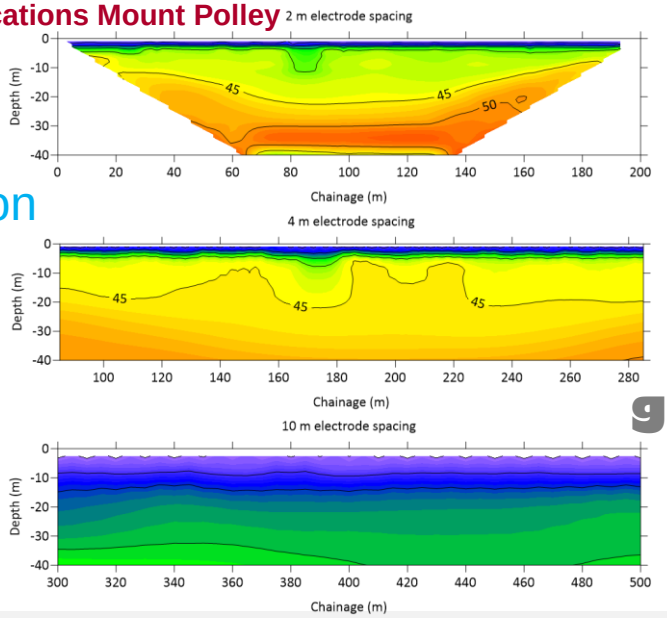
communication



geological

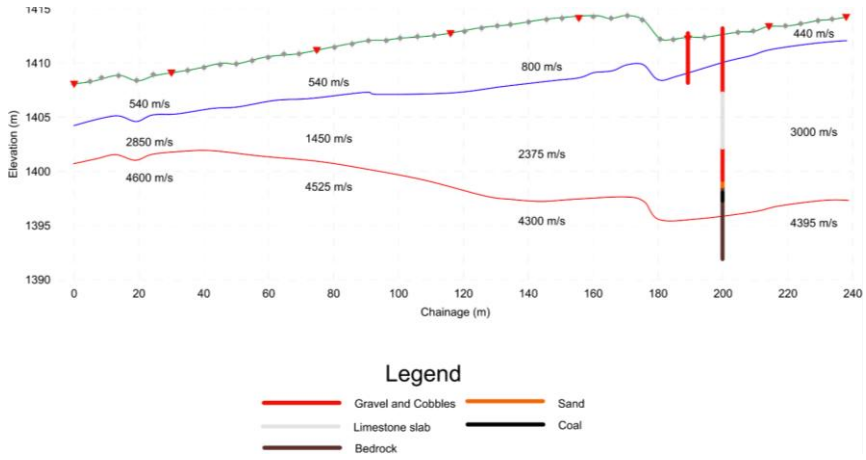
Choice of specifications Mount Polley

communication

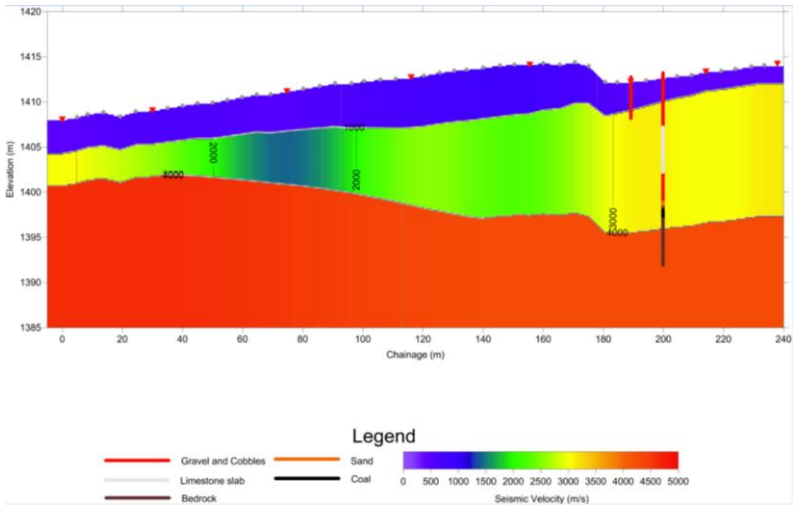


geological

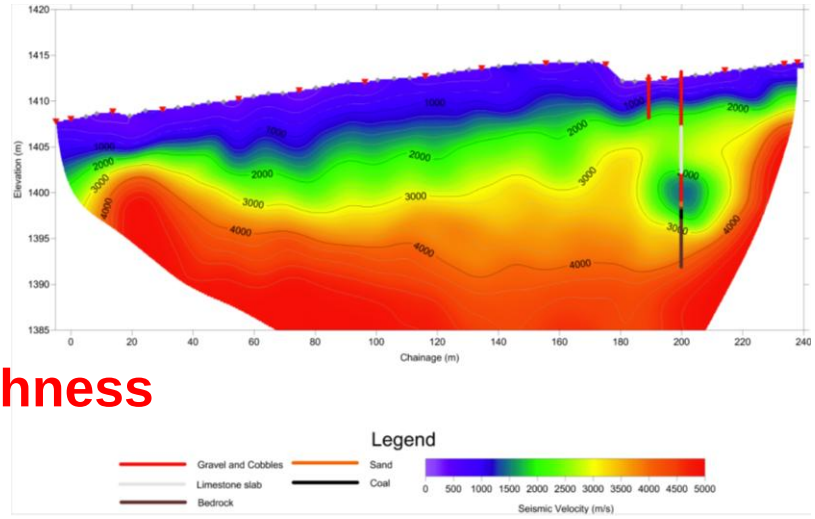
Choice of specifications



Choice of specifications

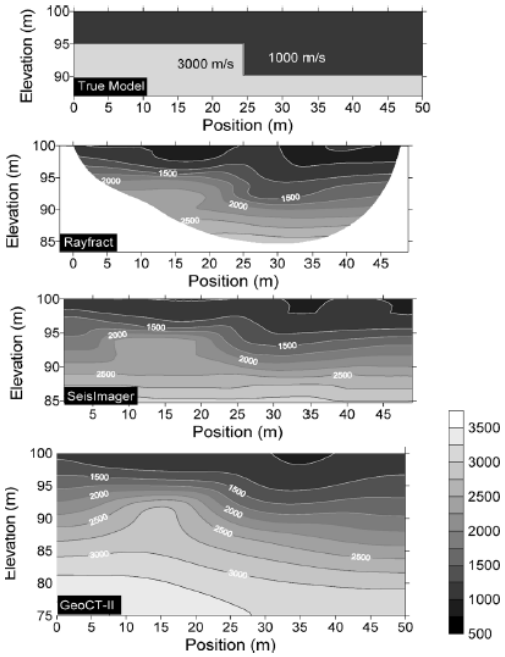


Choice of specifications



thoroughness

Limitations: Refraction Tomography



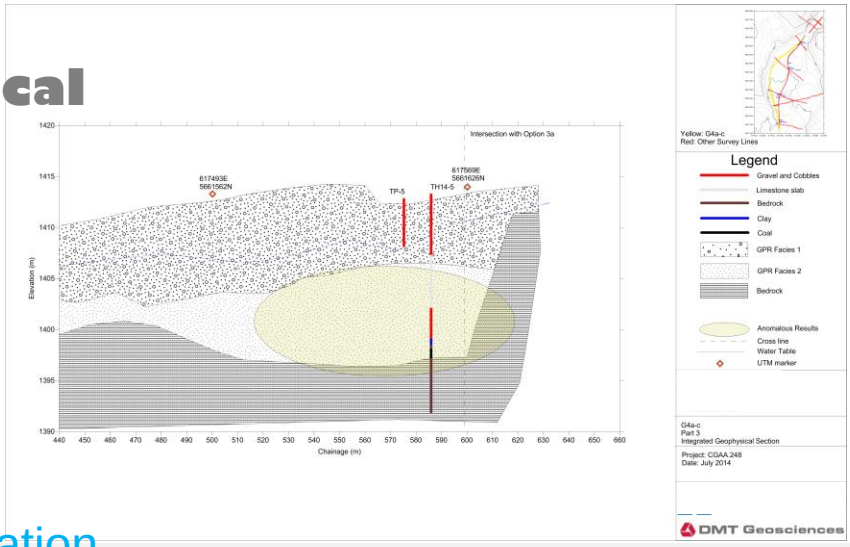
An Evaluation of Methods and Available Software for Seismic Refraction Tomography Analysis

Jacob R. Sheehan[1], William E. Doll[1] and Wayne A. Mandell[2]
[1]Oak Ridge National Laboratory, Oak Ridge, TN 37831
[2]United States Army Environmental Center, Aberdeen, MD 21010

JEEG, March 2005, Volume 10, Issue 1, pp. 21–34

The best use of geophysics is to position the drill

geological



communication

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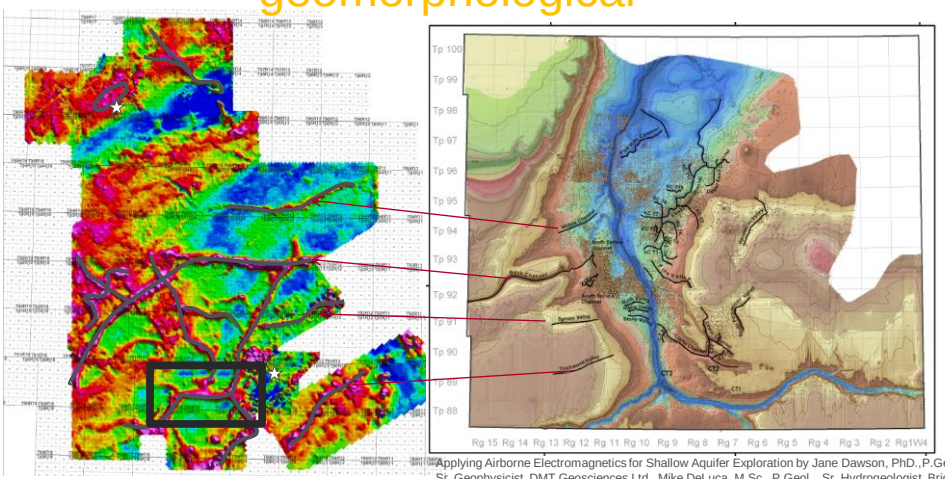
Channel aquifer understanding

hydrogeological

Brion 2008 – 2011

Adriashek 2000 – 2007

geomorphological

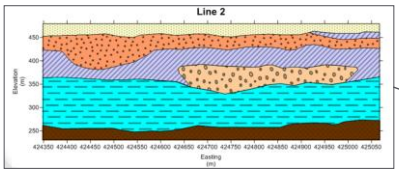


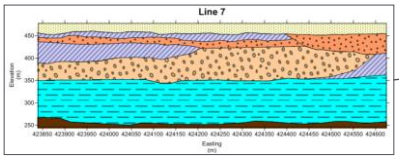
☆ Brion Central Plant Locations

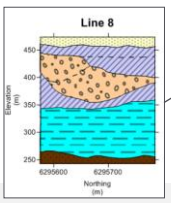
Applying Airborne Electromagnetics for Shallow Aquifer Exploration by Jane Dawson, PhD.,P.Geo. Sr. Geophysicist, DMT Geosciences Ltd., Mike DeLuca, M.Sc., P.Geol., Sr. Hydrogeologist, Brion Energy Corporation, CSEG 2015.

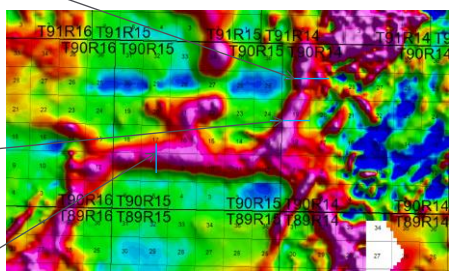
Earth. Insight. Values.

Mackay channel – hydrogeological features









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hydrogeological

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Thoroughness, the complete picture, with limitations

Geophysical investigation for containment structure design, Athabasca Oil Sands, 2015

Objectives

- Prime objective to find 1st clay horizon
- Identify different soil types in the near surface when calibrated to borehole

- Differentiate Quaternary sediments
- Identify clay layers and anomalous areas in the upper 15-20 m

- Differentiate Quaternary sediments to about 50 m
- Identifying clay layers and anomalous areas

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Earth. Insight. Values.

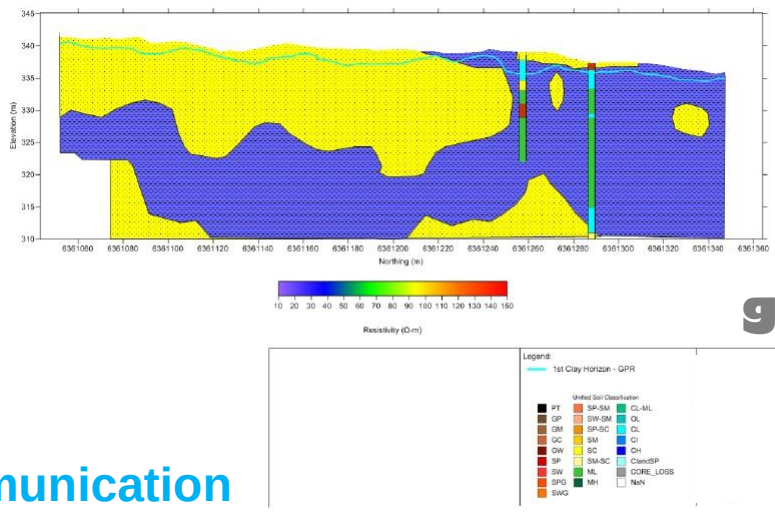
Thoroughness, the complete picture, with limitations

After a complete review of existing BH and airborne geophysics, complementary geophysical investigations were designed and conducted by DMT Geosciences Ltd. between in June, 2015

Methods

- **Ground Penetrating Radar (GPR)**
  - Prime objective to find 1st clay horizon
  - Identify different soil types in the near surface when calibrated to borehole
- **OhmMapper Capacitively-Coupled Resistivity**
  - Differentiate Quaternary sediments
  - Identify clay layers and anomalous areas in the upper 15-20 m
- **Time-Domain Electromagnetics (TEM)**
  - Differentiate Quaternary sediments
  - Identifying clay layers and anomalous areas
  - Has a greater depth of exploration than the OhmMapper, over 50 m in this case
  - Better suited to areas with thick sandy till at surface

Limitations – tendency to Lump rather than split, grouping together of many thin layers



geological

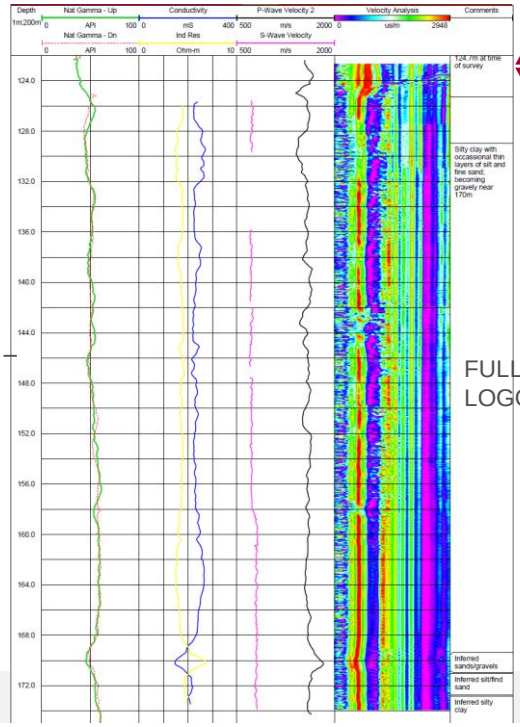
North

communication

BAT: Technology - natural period of the soil column

Natural period of the soil column is a function of the shear velocity and thickness of the soil layer used in seismic design of structures.

seismotectonic



FULL WAVEFORM SONIC LOGGING

Conclusions

Perception	Facing limitations and misconceptions
1. Bad planning	1. Thoroughly investigate the geological problem and objectives
2. Incorrect choice of technique or specifications	2. Deliver engineering compatible products
3. Insufficiently experienced personnel	3. Provide PROFESSIONAL advice in all stages of a project

Conclusions

“Thus, the path to zero leads to best practices, then continues on to best technology”

2015, Report on Mount Polley Tailings Storage Facility Breach, Independent Expert Engineering Investigation and Review Panel, Government of British Columbia

to improve the geological, geomorphological , hydrogeological and possibly seismotectonic understanding add geophysics and:

communication

thoroughness

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Thank You

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