Tailings Risk Management

Mine Design Operations and Closure

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Mount Polley Tailings Failure August 4, 2014


Mount Polley
Mine
Polley
Lake
retention
basin
Quesnel
Lake
Hazeltine Creek
N
1 km

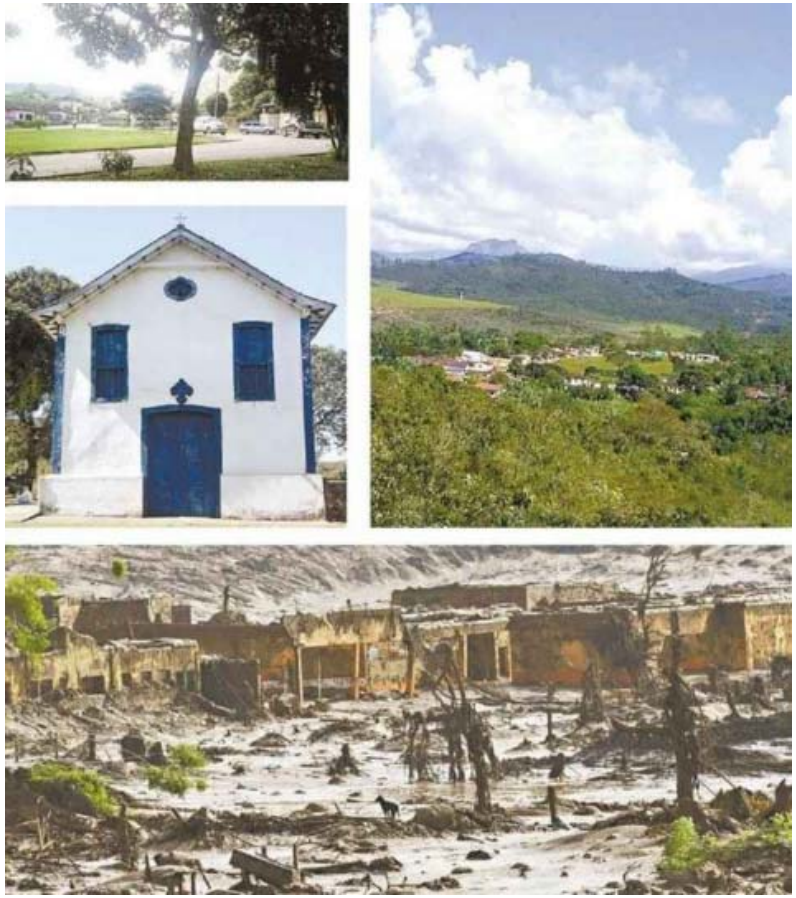

Mount Polley
Mine
Polley
Lake
Quesnel
Lake
Hazeltine Creek
N
1 km

Mount Polley Tailings Storage Facility Breach on August 4, 2014

Samarco Tailings Failure, November 5, 2015, Minas Gerais State, Brazil

- 19 Fatalities
- Large release (about 30 Mm^3 of tailings)

Bento Rodriguez, Minas Gerais




500 km along the Rio
Doce to the Atlantic Ocean

July 20, 2015

November 9, 2015

Post-Failure Contrasts Between Mount Polley and Samarco

- Focus of actions:
  - Mount Polley: BC Government concern was with confidence in the mining industry and the regulatory controls
  - Samarco: Prosecutors' concern seems to be finding and prosecuting the guilty

Post-Failure Contrasts Between Mount Polley and Samarco (2)

- Investigations:
  - Mount Polley:
    - Independent Expert Panel appointed by BC Government and two First Nations Bands
    - Chief Mine Inspectors Office
    - Conservation Officer Service
  - Samarco:
    - Police under guidance of Prosecutor's office
    - Expert Panel appointed by BHP Billiton, Vale and Samarco; activity managed by a law firm in New York (Cleary Gottlieb Steen & Hamilton, LLP)
    - Law on banning upstream construction in Brazil under consideration, moratorium on upstream construction in Minas Gerais

Outline

- Definitions
- Tailings risk management infrastructure
- Robustness and resilience
- Closing comments

Definitions

- For risk assessment:
  - Risk = likelihood x consequences
- In terms of risk communication (Peter Sandman)
  - Risk = hazard + outrage
- Risk Management
  - Manage the components of risk

Tailings Management Infrastructure

- Regulations
- Design guidelines
- Design standards (compliance required and voluntary)
- Tailings design (typically by consultants)
- Tailings operations (mining company)

Regulations

- Tailings siting and management – Best Applicable Technology
- Stability (static and seismic)
- Hydrology, flood controls
- Professional qualifications of designers and operators, such as Engineer of Record (EOR)
- Independent Tailings Review Board (ITRB)
- Operations, Maintenance and Surveillance (OMS) Documentation
- Enforcement

http://leg.mt.gov/bills/mca_toc/82_4_3.htm

Montana Code Annotated 2015

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TITLE 82. MINERALS, OIL, AND GAS
CHAPTER 4. RECLAMATION

Part 3. Metal Mine Reclamation

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REVISIONS TO PART 10 EFFECTIVE AS OF JULY 20, 2016

SCHEDULE

1 ***Part 10 of the Health, Safety and Reclamation Code for Mines in British Columbia is repealed and the following is substituted:***

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Definitions

"*best available technology*" means the site specific combination of technologies and techniques that most effectively reduce the physical, geochemical, ecological and social risks associated with tailings storage during all stages of operation and closure.

"*dam*" means a barrier on the surface preventing uncontrolled release of either water, slurry or solids or a barrier underground to prevent the uncontrolled flow of water, slurry or solids.

"*dump or stockpile*" means the accumulation of deposited rock fragments or other unconsolidated material

"*engineer of record*" means the Professional Engineer who is retained under section 10.1.5 (1) of this code.

BRITISH COLUMBIA

Guidance Document

Health, Safety and Reclamation Code for Mines in British Columbia

Version 1.0

Updated July 2016

Design Guidelines

- Association of Professional Engineers and Geoscientist of BC (APEGBC) – Site Characterization for Dam Foundations in BC
- Canadian Dam Association (CDA)
- Australian National Committee on Large Dams (ANCOLD)

Design Standards

- International Standards Organization (ISO) and country specific (e.g. South Africa)
- Voluntary standards
  - Mining Association of Canada – Towards Sustainable Mining tailings guidelines and requirements
    - Importance of Executive responsible for tailings
  - International Council on Mining and Metals
    - Position statement on preventing catastrophic failure of tailings storage facilities (Accountability, Responsibility and Competency; Planning and Resourcing; Risk Management; Change Management; Emergency Preparedness and Response; Review and Assurance)
  - Cyanide Code

Tailings Design

- Qualified personnel
  - Education
  - Mentoring
  - Experience
- Design Reviews
- EOR
- Apply regulations, guidelines and standards

Tailings Operations

- Compliance with Regulations
- Qualified personnel
- Training
- OMS
- Instrumentation

Robustness

- Robust Geotechnical Design (RGD) - A design is considered robust if the variation in system response (e.g. failure probability) is insensitive to the statistical characterization of noise factors, such as uncertain geotechnical parameters

Resilience

- Resilience is the intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions

Resilience Engineering and Management

- Resilience engineering and management is based on the following four components:
  - **Monitoring** – knowing what to look for – timely measurement and analysis
  - **Performance prediction** – knowing what is expected – identifying when performance is not meeting expectations and critical control actions are triggered
  - **Implementing critical control actions** – knowing what to do – implementing in a timely manner
  - **Learning from performance** and critical control responses to improve the system model, assess residual risks and apply resilience engineering and management to increase robustness and post failure resilience.

Robustness and Resilience (2)

- Robustness and resilience changes over the life of a facility, e.g.
  - The exceedance of pre-consolidation pressure of glaciofluvial layer at Mount Polley
  - Changes of drainage conditions at Samarco
- The level of risk management must increase over the life of the tailings facility
- Critical controls must be re-evaluated all the time

Closing Comments

- Risk management of tailings facilities is an ongoing task throughout the life of the mine and is not a uniform process with time – it always changes and must be renewed consistently
- The whole infrastructure for tailings risk management is currently in flux and more changes are expected to follow
- Robustness and resilience are concepts that must be further developed in tailings and mine rock management
- The education of tailings and mine rock professionals must become an integral part of the overall risk management infrastructure

Education of Tailings and Mine Rock Professionals