

# Collaborative Research on Environment and Mine Waste Management at the Research Institute on Mines and the Environment (RIME)

Bruno Bussière – RIME, UQAT

Thomas Pabst – RIME, Polytechnique Montréal

24th Annual British Columbia MEND ML/ARD Workshop

Simon Fraser University Campus, Vancouver – November 29-30, 2017

# History

- A 30 years old partnership between Polytechnique and UQAT
- Industrial NSERC Polytechnique-UQAT Chair on Environment and Mine Wastes Management (2001 - 2012)
- Led to developments that have been integrated in best available mining practices in Quebec, Canada and elsewhere around the world
- May 2013 : UQAT and Polytechnique Montreal launched a joint research program: the Research Institute on Mines and Environment (RIME) UQAT-Polytechnique.



# RIME UQAT-Polytechnique

- Objectives :
  - develop innovative environmental solutions for the entire life cycle of a mine
  - train students to become the future specialists in the field
- 5 industrial partners
- 7 years (2013-2019) → Renewal in preparation
- Industrial financial support of 9,45M\$
- Lever to get support from NSERC, FRQNT, CFI and others



**AGNICO EAGLE**



**RAGLAN MINE**  
A GLENCORE COMPANY

**RioTinto**

# Research team

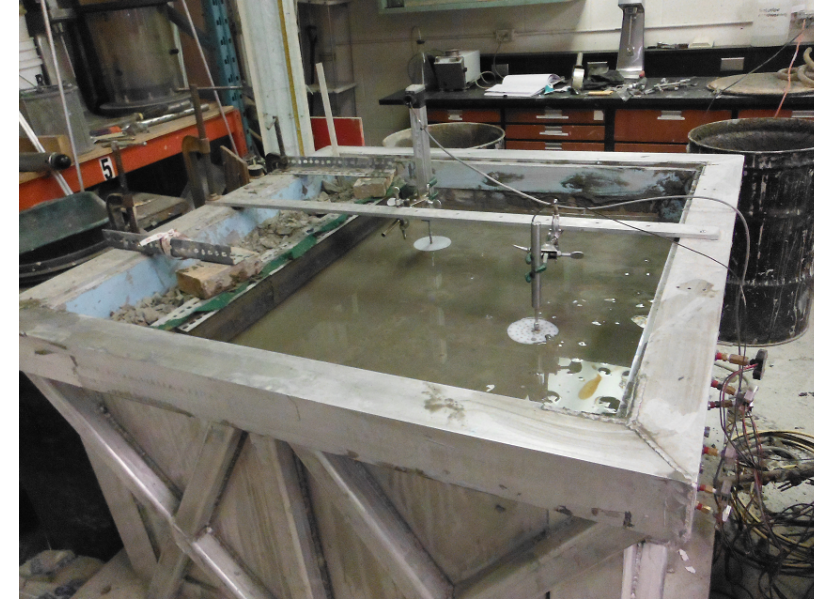
- 2 universities
- 18 professors and researchers
- 20 technicians and research professionals
- 45 MScA students, 35 PhD students and 100+ interns
- 51 graduates to date
- More than 20 different nationalities
- 3 chairs
- Over 600 publications in peer reviewed journals and conferences since 2006





# Infrastructures and laboratories - Polytechnique

Permeameters • Triaxial systems • Shear boxes • Oedometers • Consolidation setups  
Column tests (10-20 cm diam., 10-100 cm height) • Consumption/diffusion cells  
Inclined box (2 m x 1 m x 25 cm) • Physical models



# Infrastructures and laboratories - UQAT

Microscopy labs • Geophysics lab • Analytical chemistry labs • Geotechnics and hydrogeology lab  
Backfill/concrete lab • XRD lab • Freezing/refrigeration chamber  
Site characterization mobile lab





# Field work

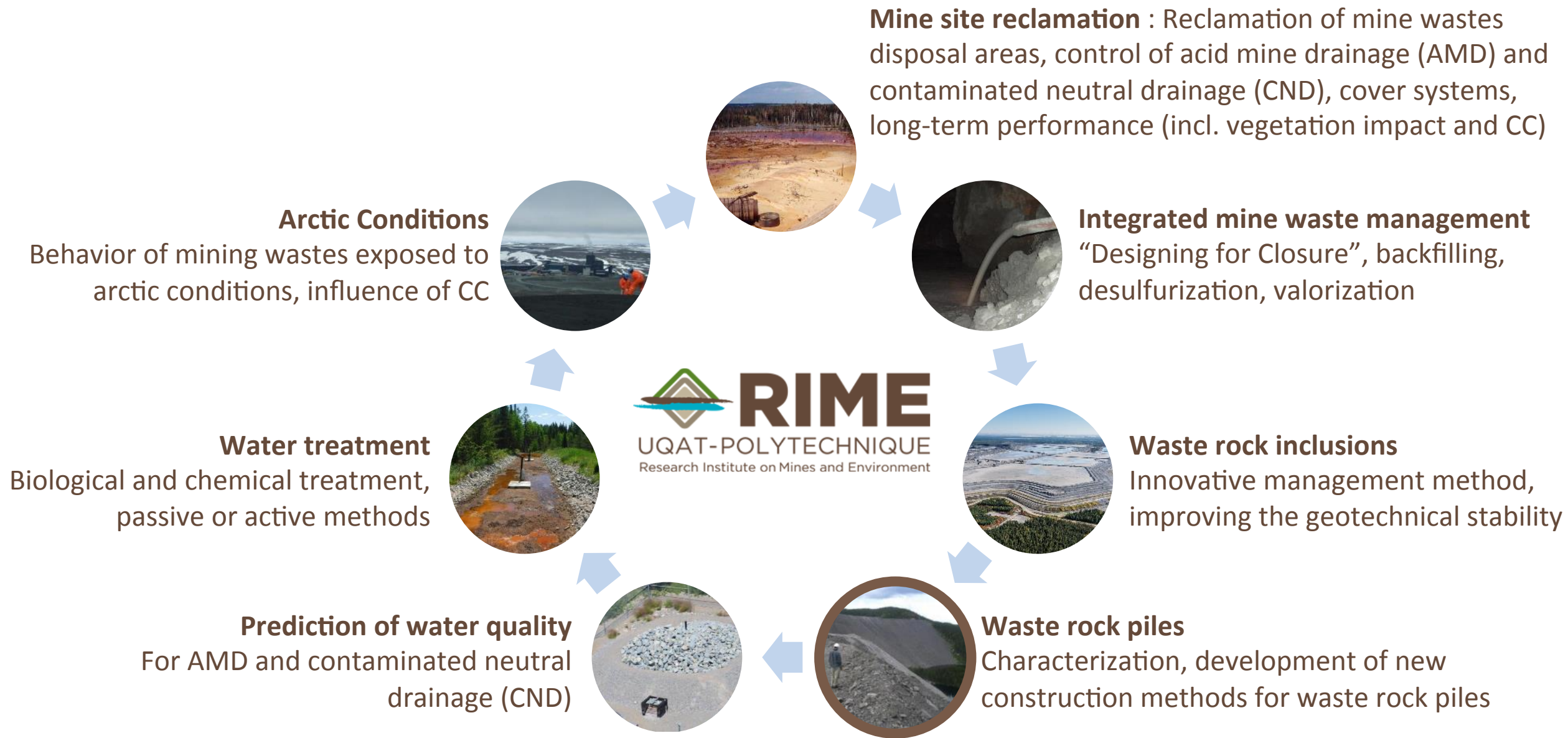
Advantage: proximity of mine sites; applied projects for students











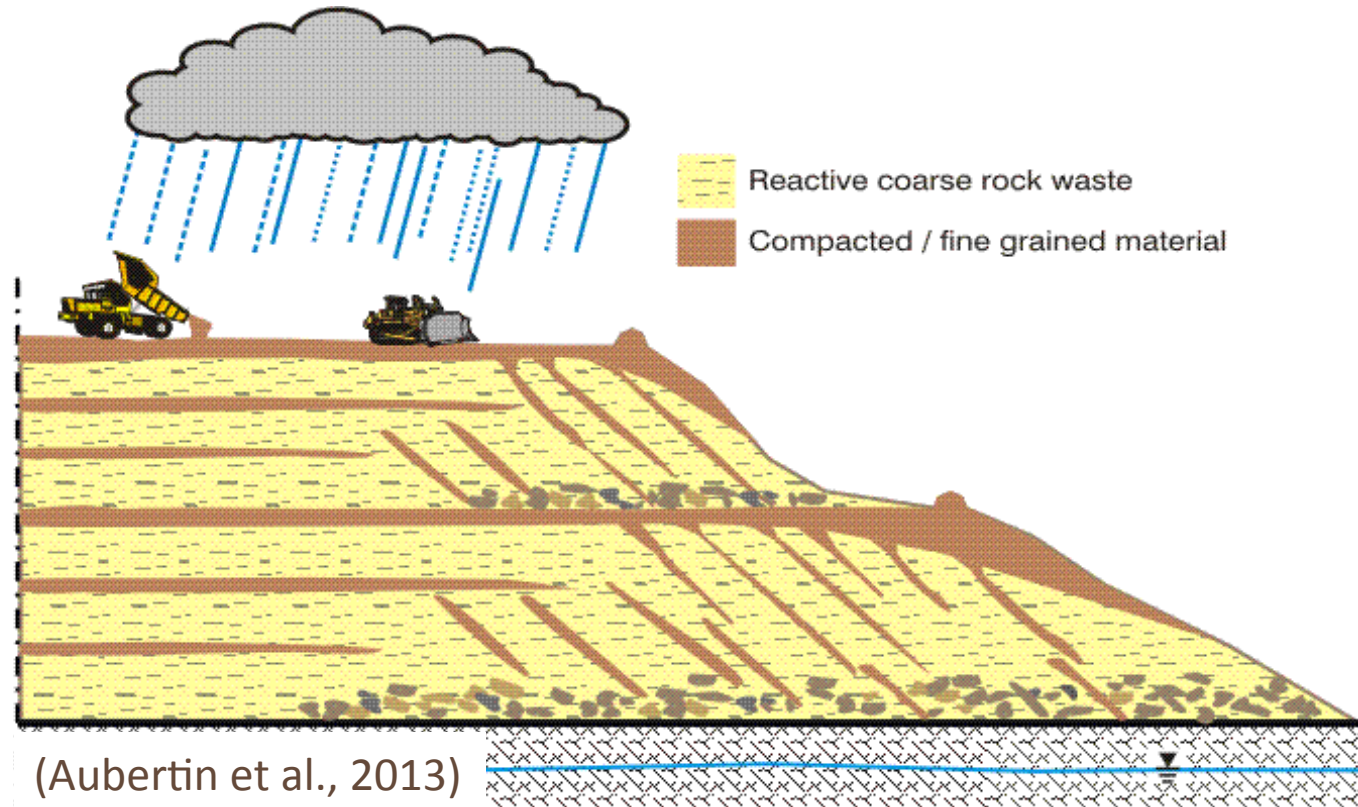




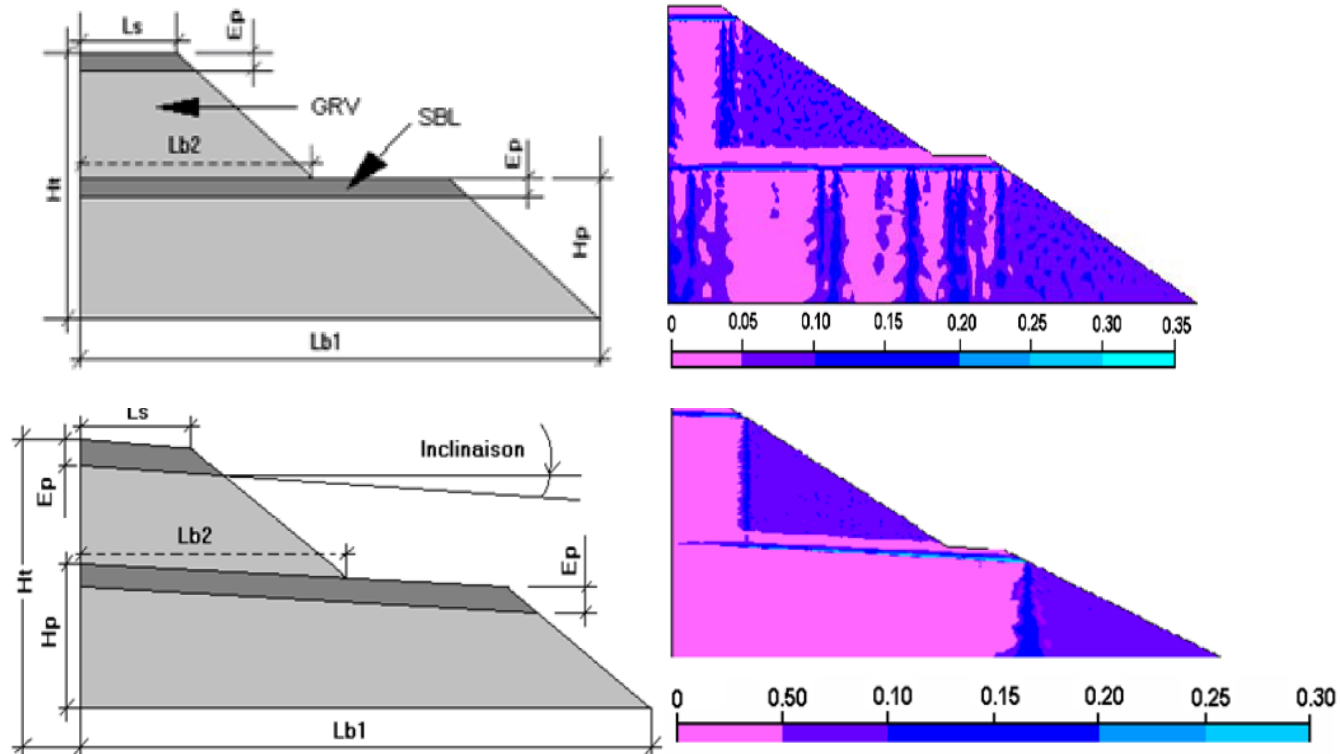
Experimental waste rock pile, Lac Tio Mine – Rio Tinto Fer & Titane (Qc)



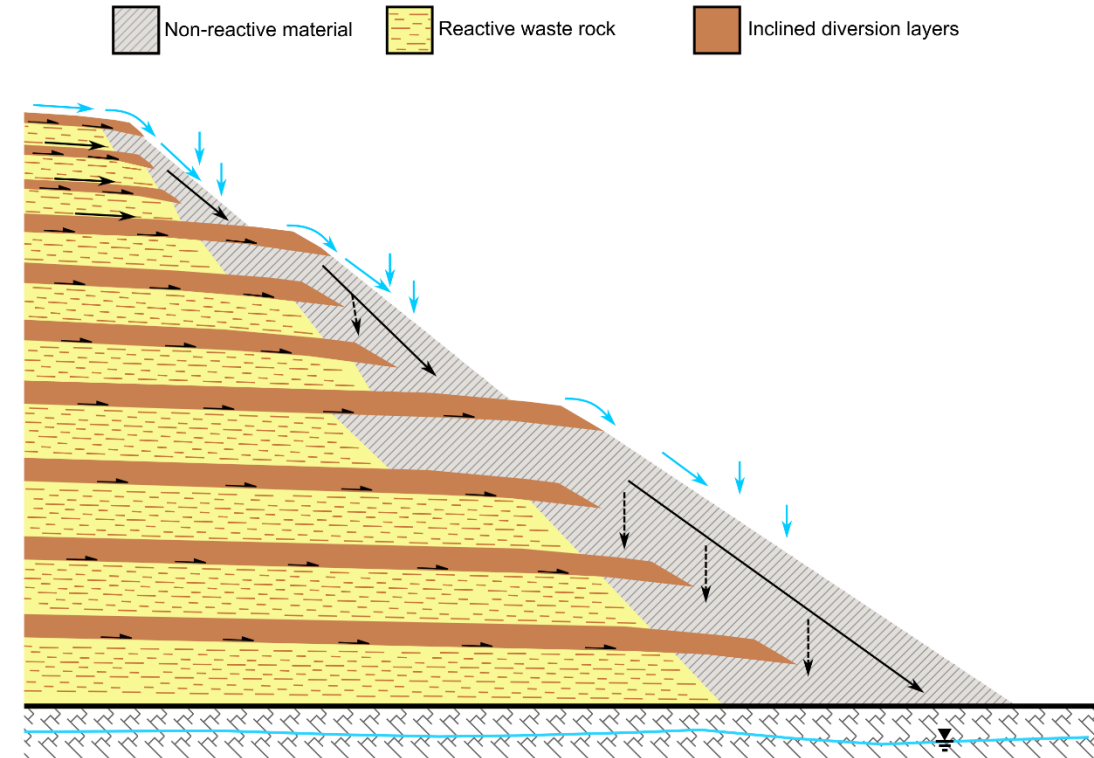
# Waste rock piles



# Water flow in waste rock piles



(Aubertin et al., 2002 ; Fala et al., 2003, 2005)



(Aubertin, 2013)

# Collaborative Research and Development Grants

- 4 years CRD project
- Industry: 280 k\$ + 430 k\$ in kind
- NSERC: 510 k\$



**RioTinto**

MINE  
CANADIAN  
MALARTIC

 **IAMGOLD**  
CORPORATION

- Many students involved (Marie-Lin Bréard Lanoix, Julien Dubuc, Adrien Dimech, Robert Wu, Bissé Poaty, Fernando Medina) and PDF (S. Broda)  
+ research associate (Vincent Martin)  
+ technicians (Yvan Poirier, Pierre-Alain Jacques)

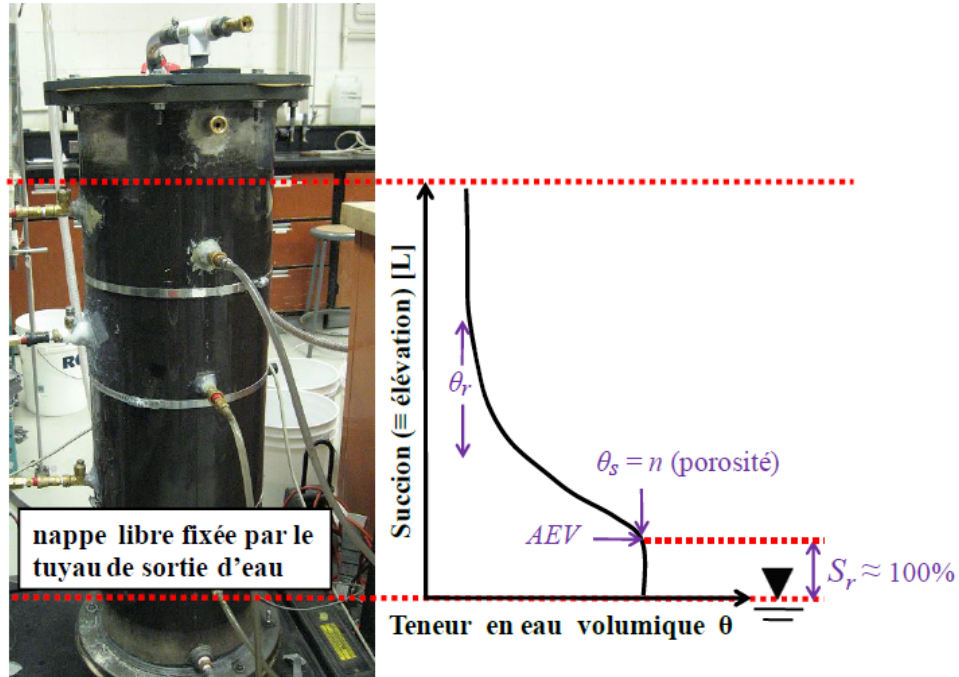


# Lac Tio Mine - Waste rock piles





# Preliminary characterization



(Peregoedova, 2012; Lévesque, 2015)



(Pépin, 2009; Plante, 2010)

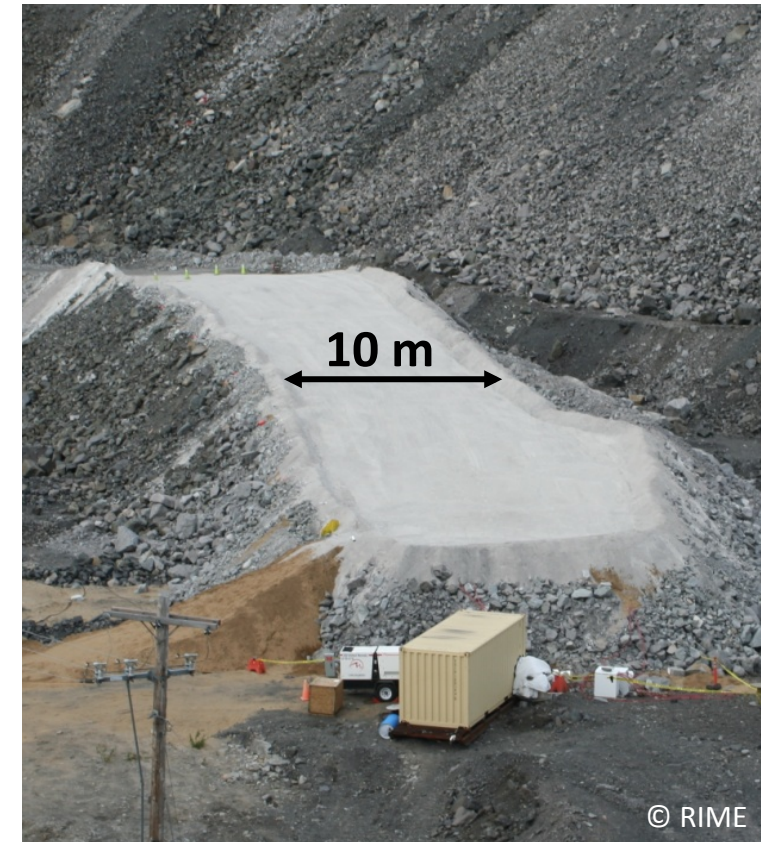


# Experimental waste rock pile - Construction



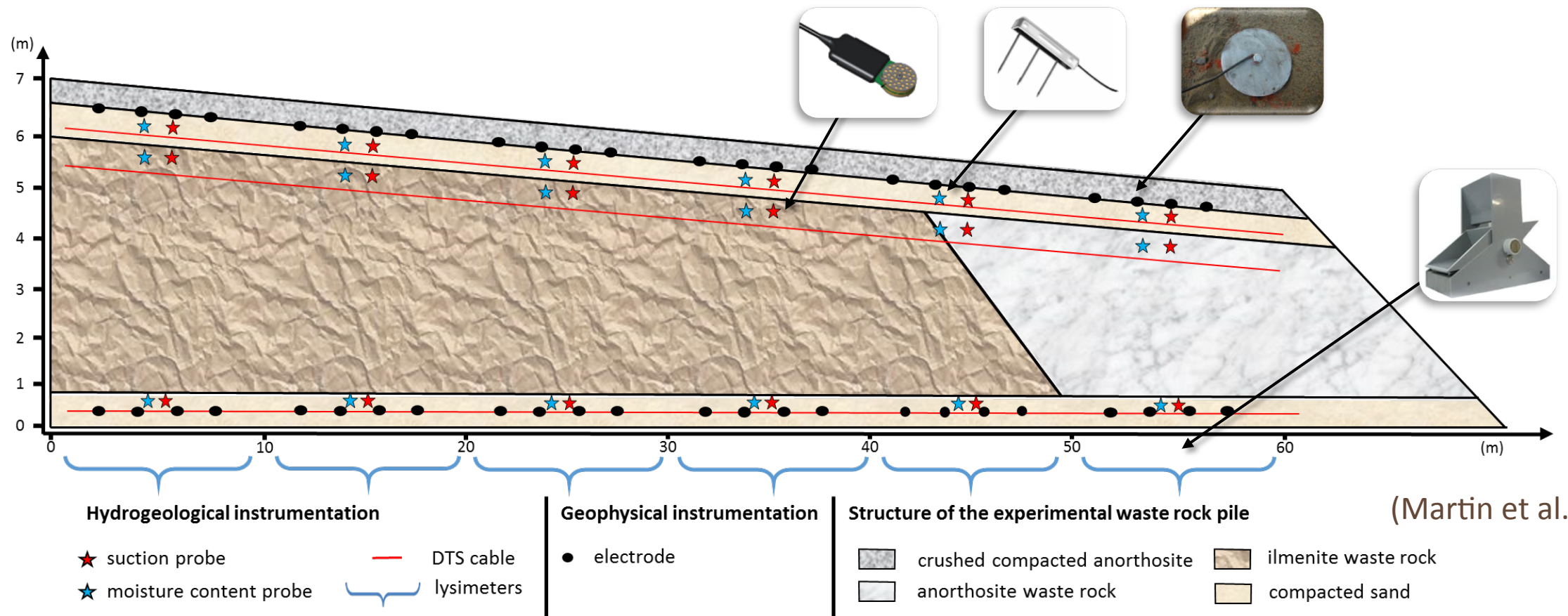


# Experimental waste rock pile

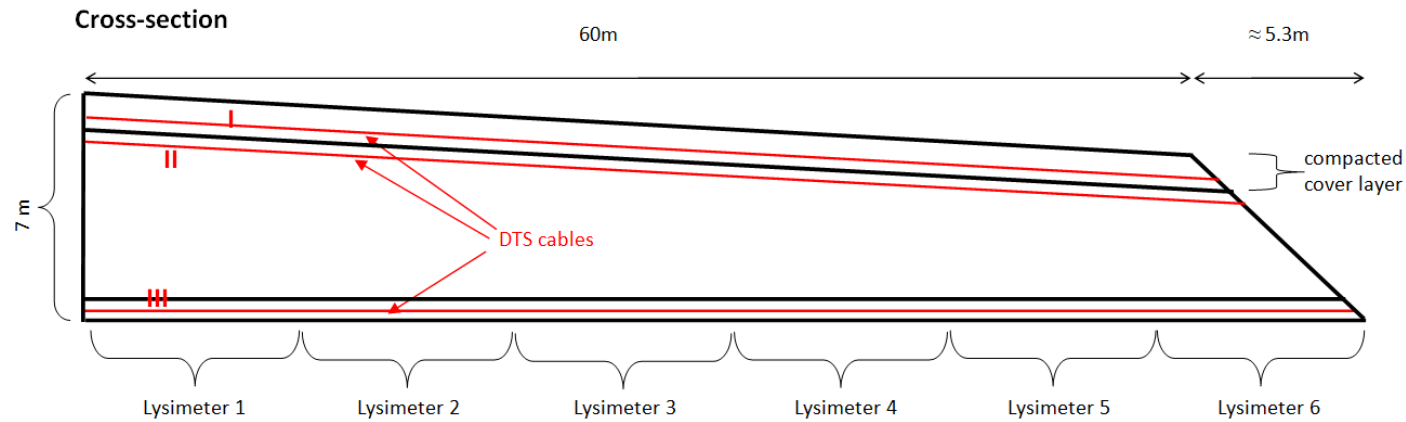




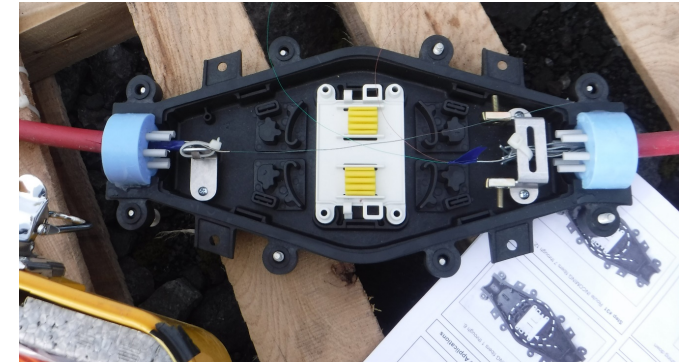
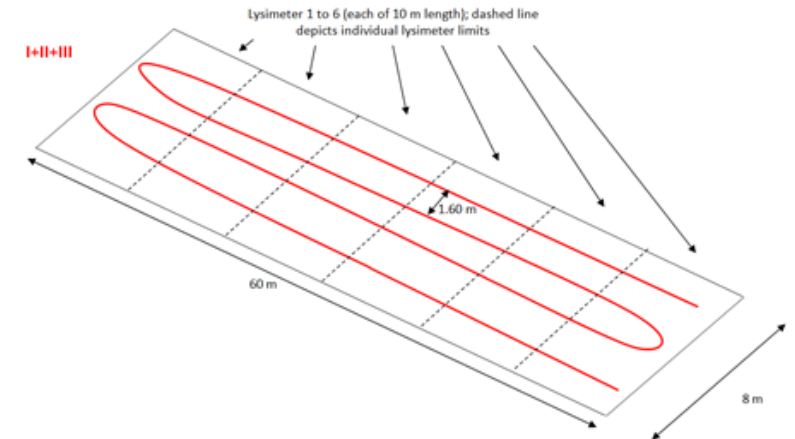
# Experimental waste rock pile - Instrumentation



# Innovative instrumentation - DTS



**Plan-view**





# Field tests



FCL characterization (ML. Bréard Lanoix)



Large scale infiltration tests (J. Dubuc)

© RIME



# Field tests



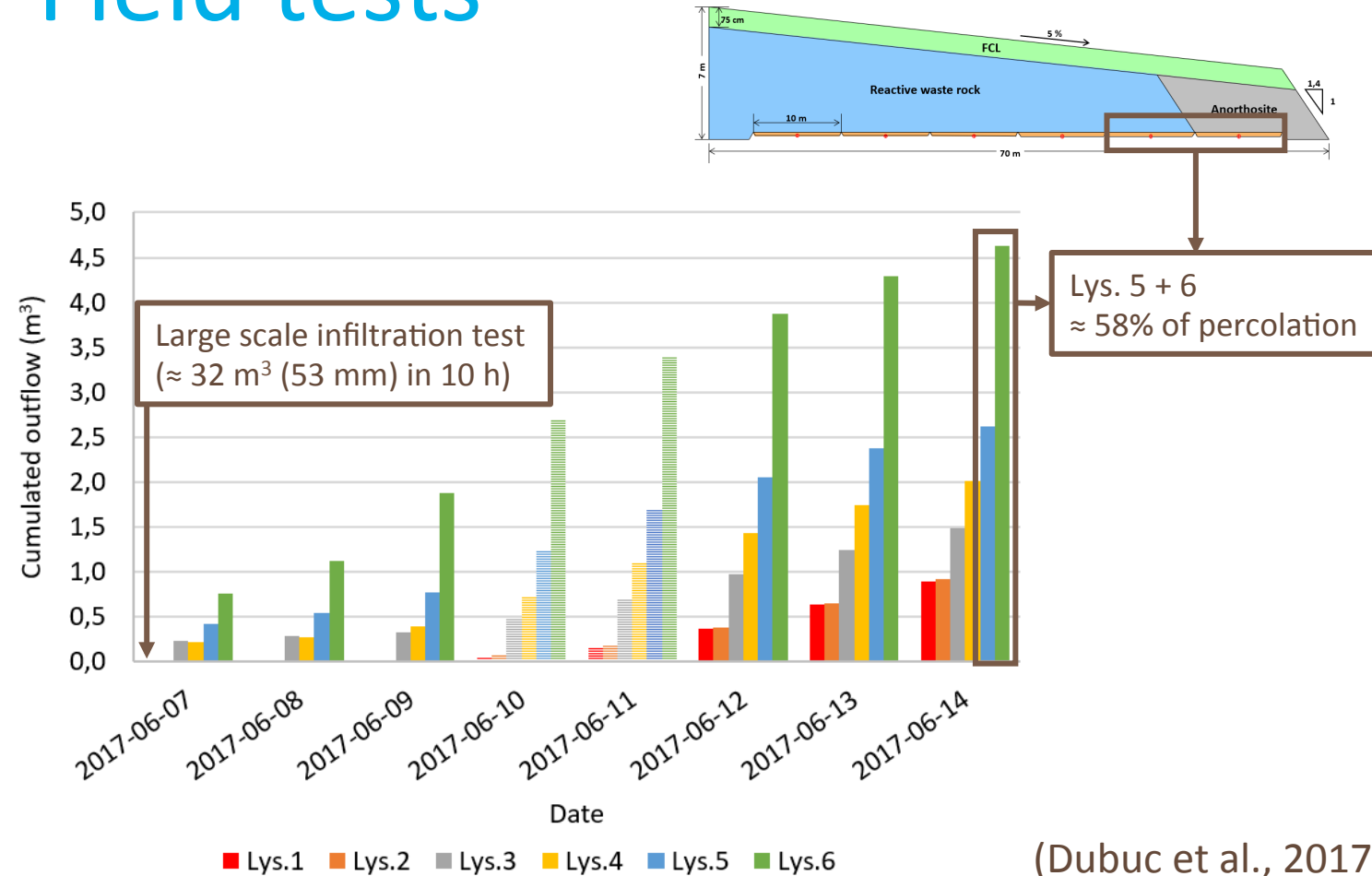
Night shifts (summer 2017)

© RIME



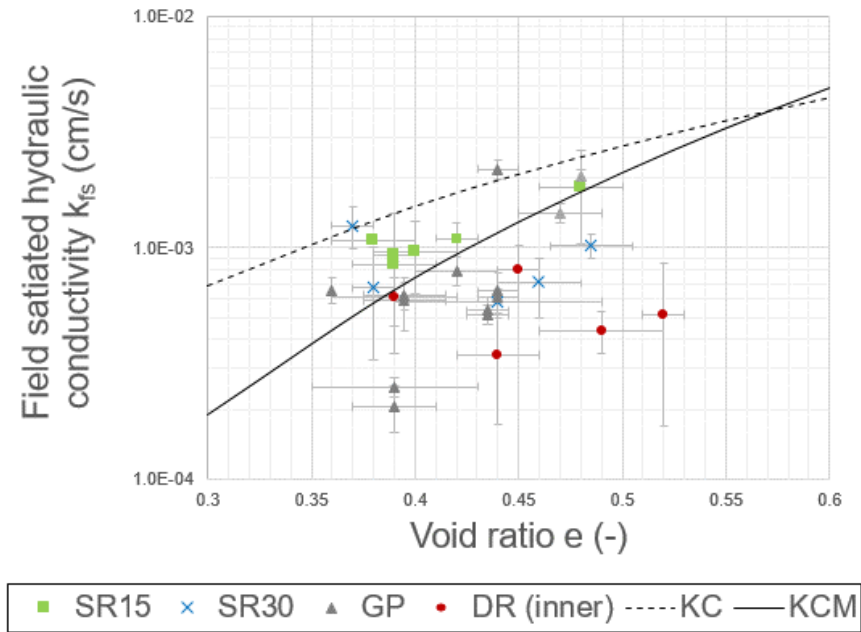
Installation of a plastic membrane (impermeable top-boundary)

# Field tests





# Field tests

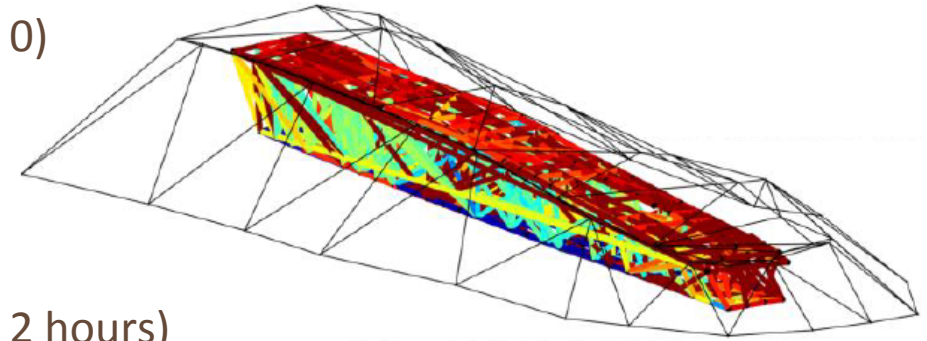


(Bréard Lanoix et al., 2017)

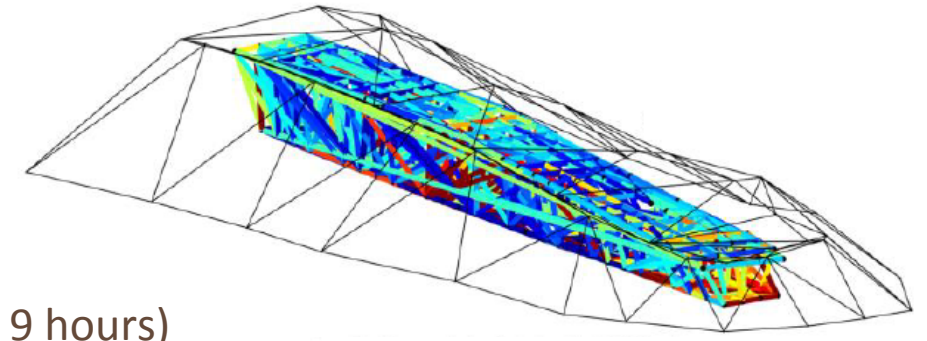


+ water qualities (B. Poaty), DTS investigations (R. Wu) and numerical simulations (J. Dubuc)

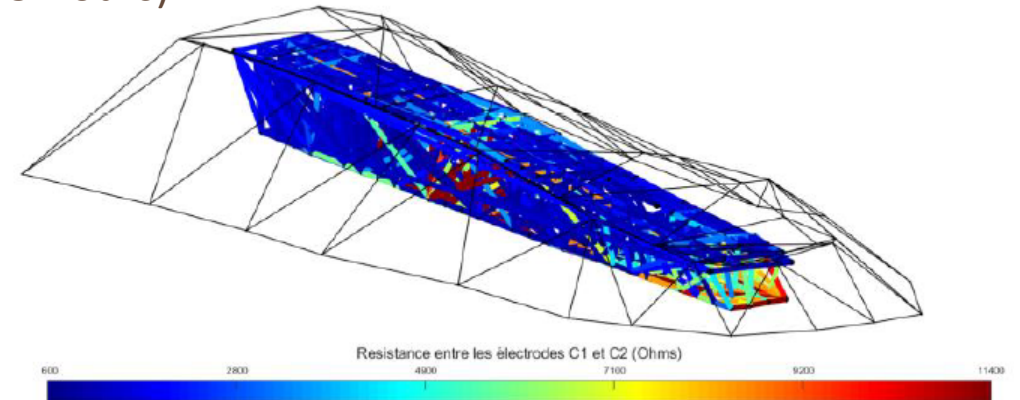
Infiltration test starts  
( $t = 0$ )



( $t = 2$  hours)



( $t = 9$  hours)



(Dimech et al., 2017)

# Diffusion and communications

- 1 scientific committee per year
  - Regular meetings (once a week or more) while in the field
  - Presentations at the mine
  - Conference presentations →  
+ journal papers to come
  - Collaboration with other universities and experts
- ➡ “Spin-off” project at another partner’s mine

## Characterization of the Hydrogeological Properties of a Sand Layer Placed on an Experimental Waste Rock Pile

Marie-Lin Bréard Lanoix, Thomas Pabst & Michel Aubertin  
*Research Institute on Mines and Environment (RIME), Montréal, Qc, Canada*  
*Department of Civil, Geological and Mining Engineering – Polytechnique Montréal, Qc, Canada*

## An assessment of the hydrogeological response of the flow control layer installed on the experimental waste rock pile at the lac Tio mine

Julien Dubuc, Thomas Pabst & Michel Aubertin  
*Polytechnique Montréal, Montréal, Québec, Canada*

## Controlling water infiltration in waste rock piles: Design, construction, and monitoring of a large-scale in-situ pilot test pile

Vincent Martin<sup>2</sup>, Bruno Bussière<sup>1</sup>, Benoît Plante<sup>1</sup>, Thomas Pabst<sup>2</sup>, Michel Aubertin<sup>2</sup>, Fernando Medina<sup>2</sup>, Marie-Lin Bréard Lanoix<sup>2</sup>, Adrien Dimech<sup>2</sup>, Julien Dubuc<sup>2</sup> & Bissé Poaty<sup>1</sup>  
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Robert Wu<sup>3</sup> & Jeffrey McKenzie<sup>3</sup>

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Stefan Broda<sup>4</sup>

<sup>4</sup>*Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Berlin, Germany*

Dan Chen<sup>5</sup>

<sup>5</sup>*Rio Tinto Iron and Titanium, Sorel-Tracy, Québec, Canada*





# Last remarks

- The partnership between mining companies and universities is beneficial for both parties
- Results are also used by government to improve guidelines and methodologies
- The quality of the training is significantly improved by the close collaboration
- More funds can be invested with the partnership of research organization (estimated at 20-23 millions for the 7 years)
- The renewal is in progress (end in 2019); integration of a new partner in 2018 – Goldcorp Mine Éléonore
- The work is performed with other universities and organizations (e.g. TERRE-NET)



