Applications du LiDAR aux pratiques de sautages en mines souterraines.

Caractérisation et optimisation des processus de dinamitage pours des mines de sel gemme

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Co-auteurs: *Prof. D. J. Hutchinson and Prof. M. Diederichs (Queen's University, Kingston, On)*

Conférence: *41e Session d'étude sur les techniques de sautage - Société d'énergie Explosive du Québec (SEEQ)*

Date: *16 Novembre 2018*

Contenu de la présentation

- Objectifs et messages
- Le LiDAR et les applications courantes
- Description des sites et exploitation du sel gemme
- Applications testées à Morton Salt
- Sommaire et discussions

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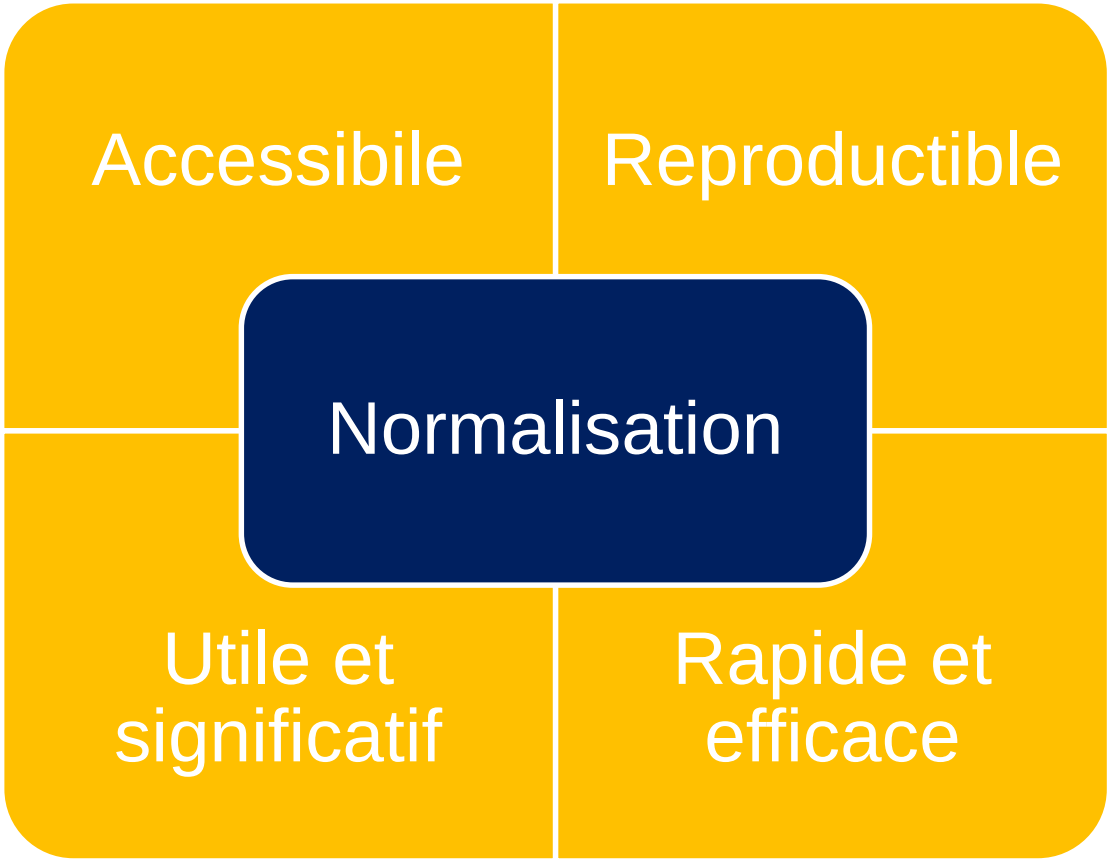
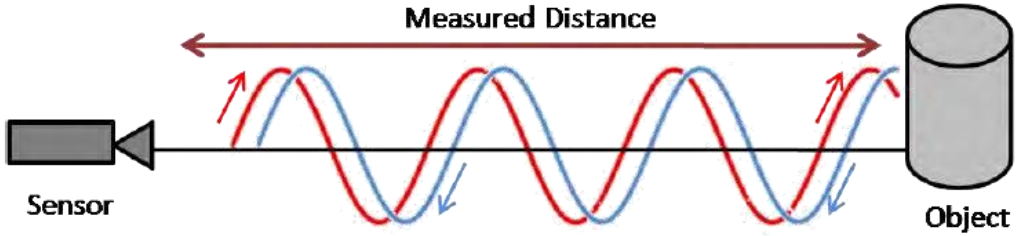
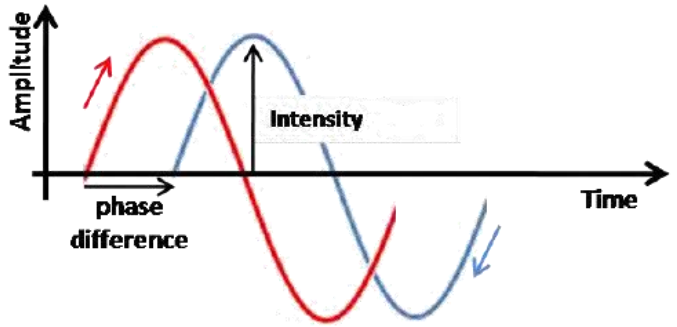


Technologie LiDAR

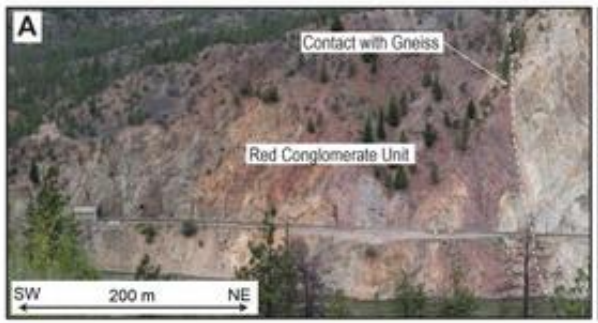
- Light / Laser detection and ranging (LiDAR)
- Arpentage 3-dimensionnel + intensité
- Terrestre vs mobile
- Photogrammétrie



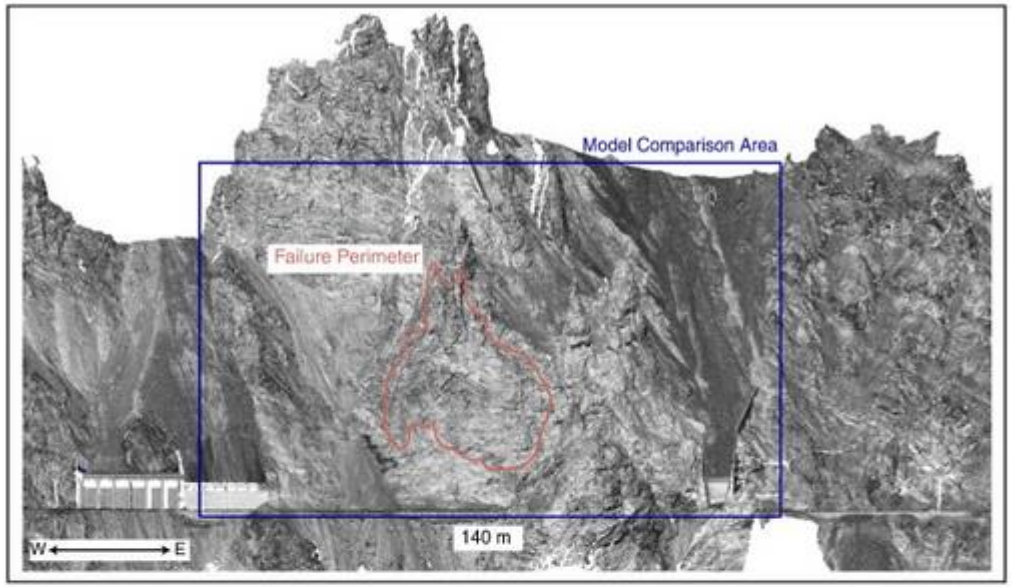


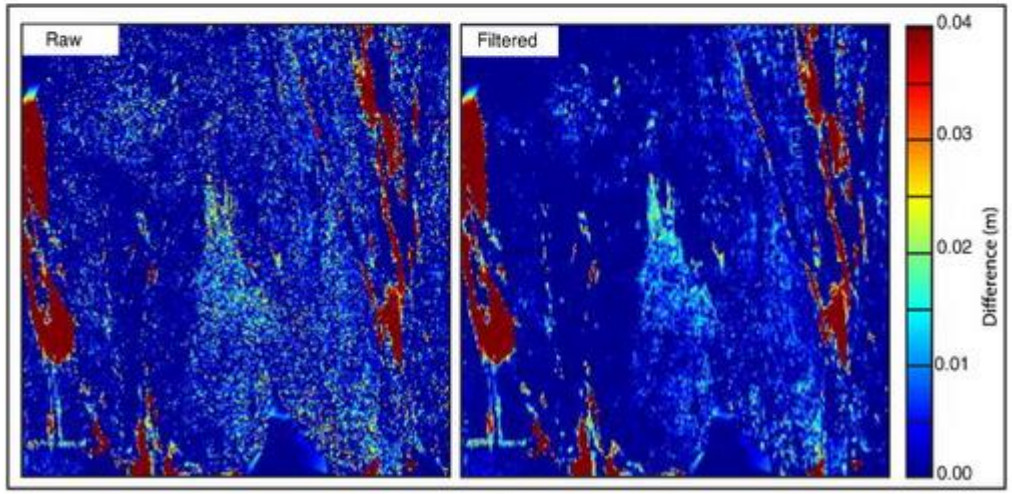
Figures provenant de Lato et al. 2009

LiDAR applications



Feature	Strike°/Dip°
Slope Face	148/66
Foliation	104/77
Joint Set 1	115/81
Joint Set 2	179/81
Joint Set 3	097/37
Joint Set 4	053/87
Joint Set 5	134/86





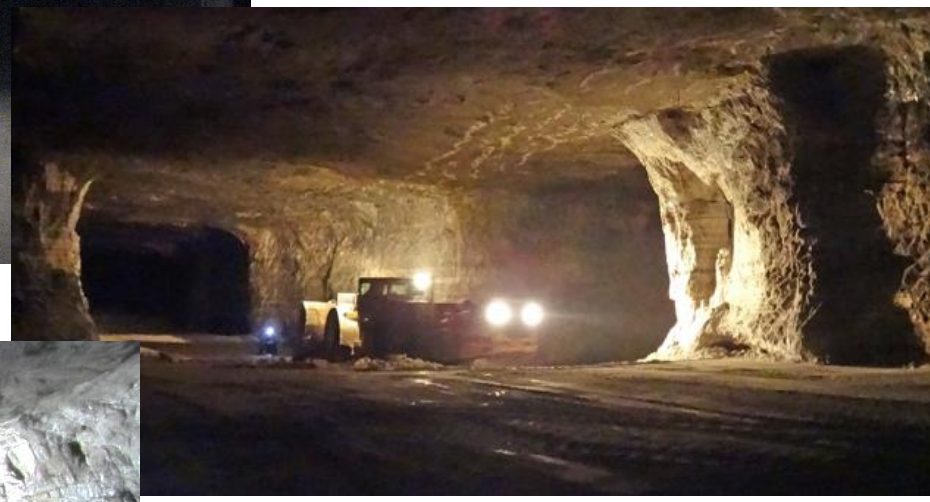
Images de Kromer et al., 2015.

Mines de sel gemme – les sites testés

- Weeks Island (La, USA)
  - Dôme de sel – 450 m
  - 98% NACL
- Pugwash (NS)
  - Diapir – 400 m
  - 90% NACL
  - Anhydrite
- Ojibway (On)
  - Tabulaire – 350 m
  - 96% NACL
  - Bandes d’argile

L’image du dessus provient de la mine Ojibway, Windsor, Ontario, Canada.
L’image du dessous provient de la mine de Pugwash, NS, Canada.

Exploitation du sel gemme



Les photographies sont une gracieuseté de K+S Windsor Salt et Morton Salt

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J.D. Aubertin

Création du volume de soulagement

Les photographies sont une gracieuseté de K+S Windsor Salt et Morton Salt

Explosifs utilisés

ANFO

EMULSION

Boosters

Nonels

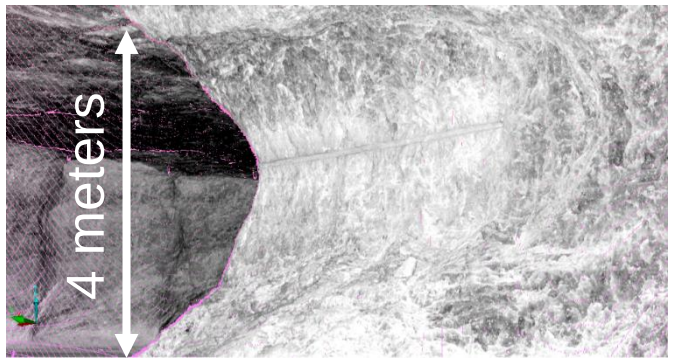
Det cord

Autre:
-ANFO en vrac
-Emulsion en cartouches
-Cap électrique

Technologies LiDAR utilisées

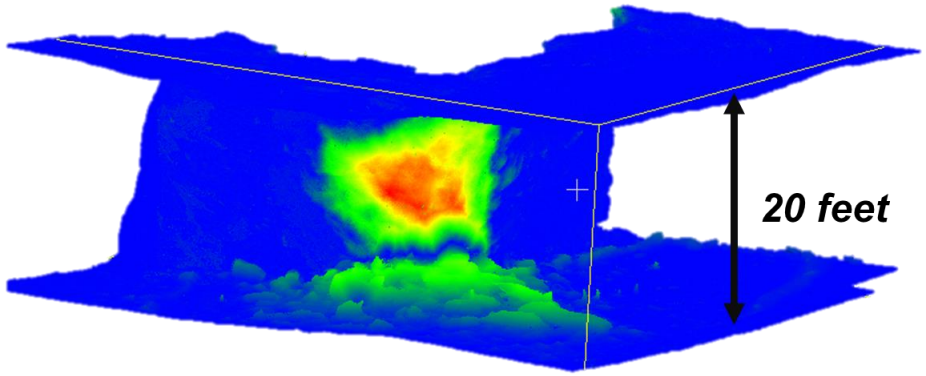
(1.)

(2.)



(3.)

- FARO X-130 laser scanner (FARO, 2010)
- Software used:
  - Scene (FARO, 2017)
  - CloudCompare (2009)



1. *Photo prise par Prof. J. Hutchinson (2015)*
2. *et 3. : arpentage LiDAR sur SCENE*
4. *Image obtenue à partir de CloudCompare*

Applications LiDAR

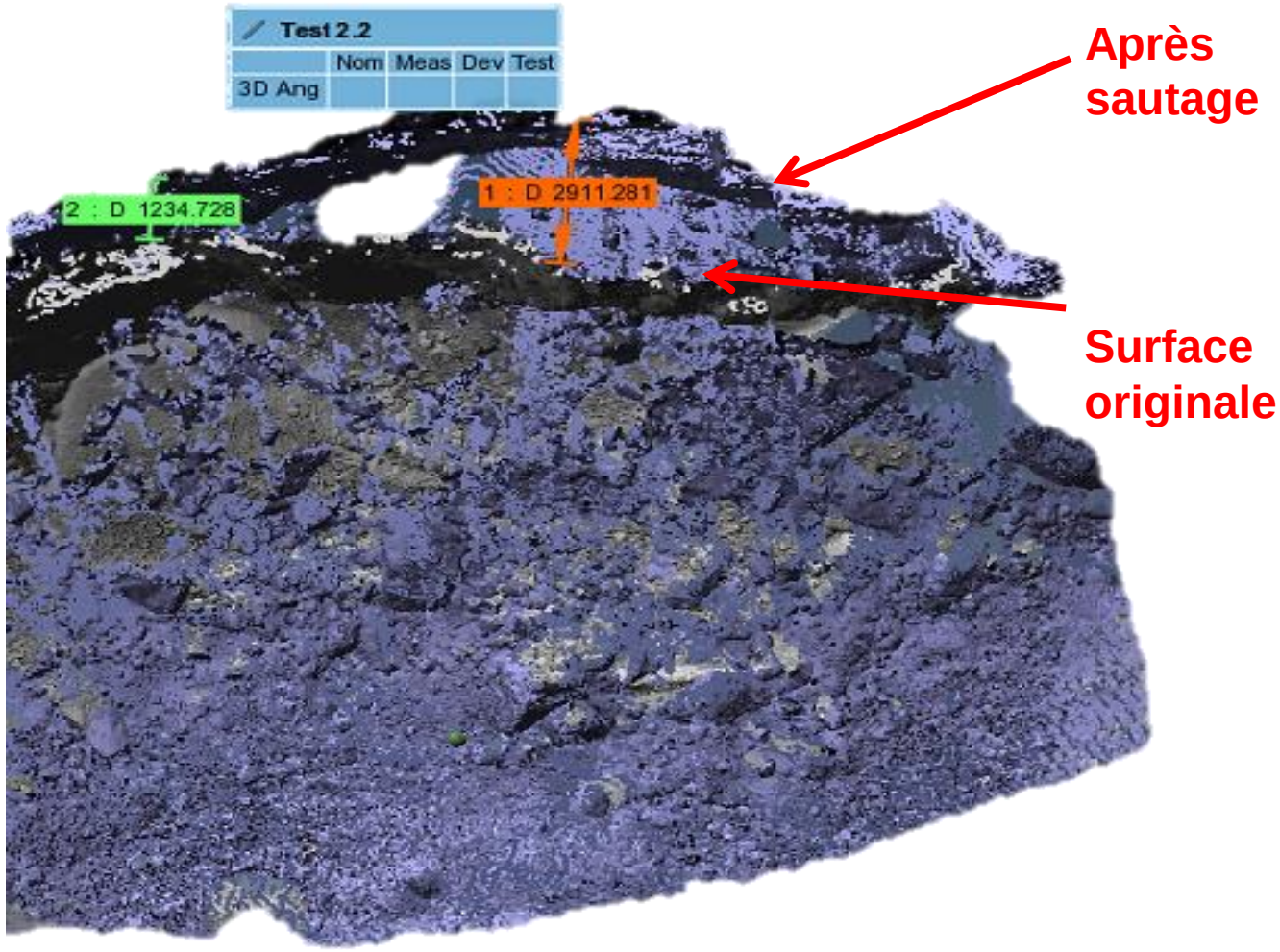
Arpentage de tirs

Évaluation de l’écaillage mécanique

Caractérisation des sautages

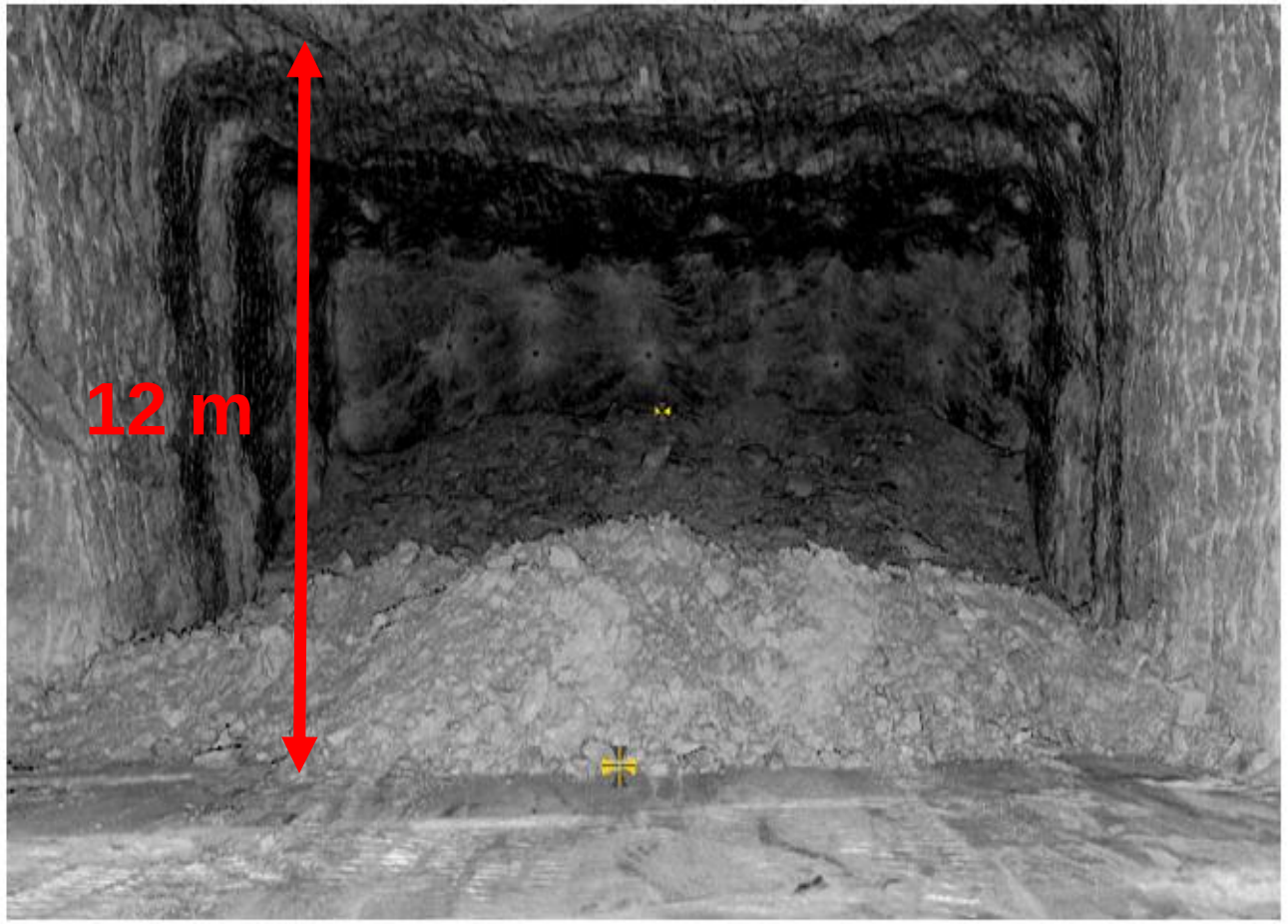
Avantages du lidar

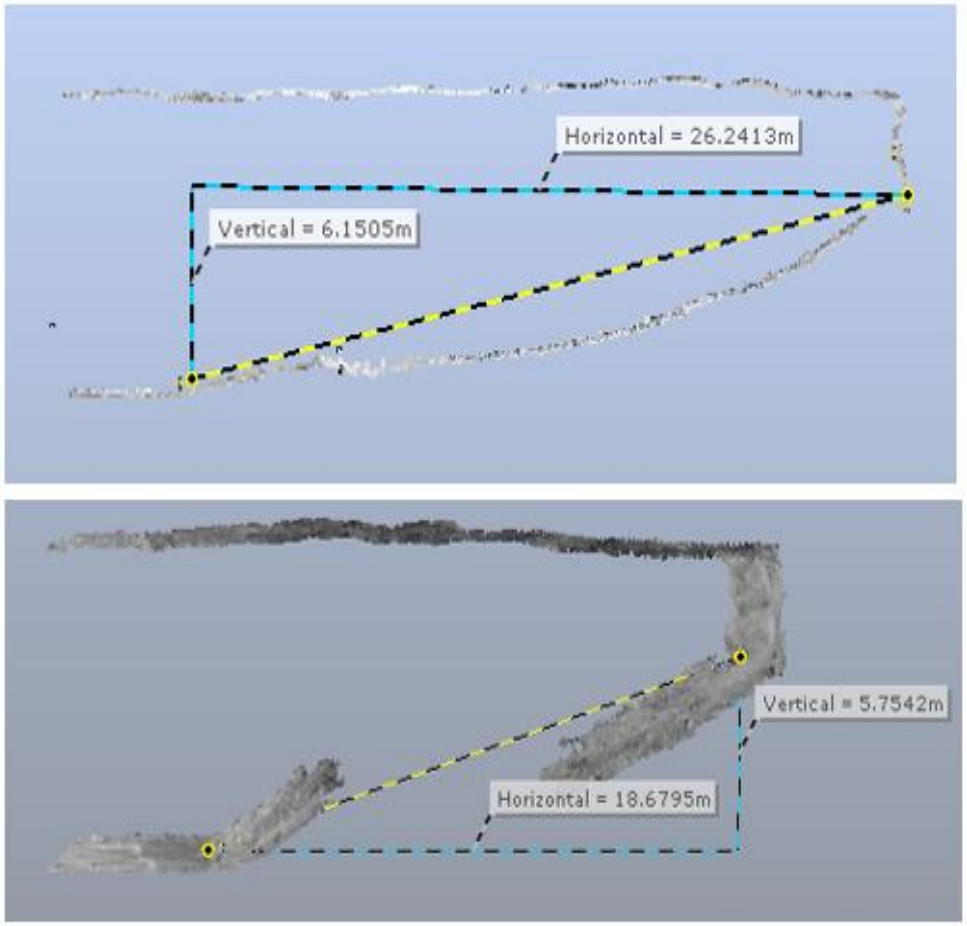
- Comparaison
  - Temps
  - Avancé
- Analyse systématique
- Détails
  - Densité
  - Image
- Portée et rayon de capture



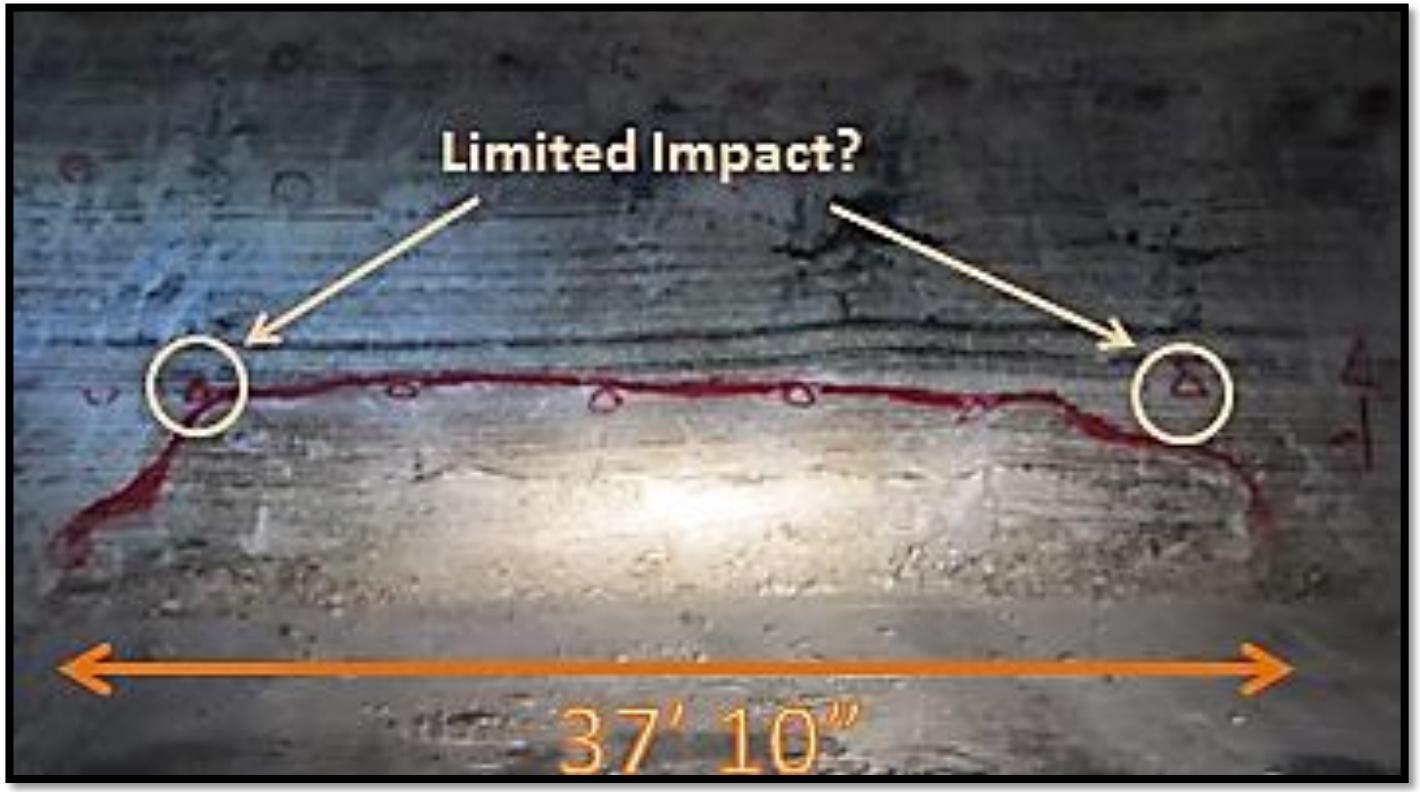
Post processing from SCENE (FARO, 2017)

Arpantage de pile de minerais

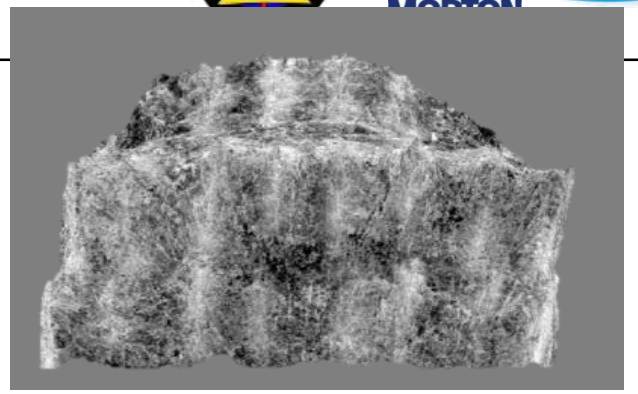


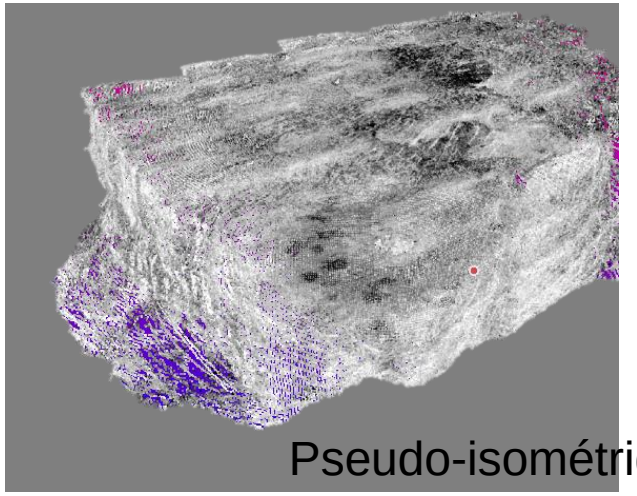


Arpentage de cratères



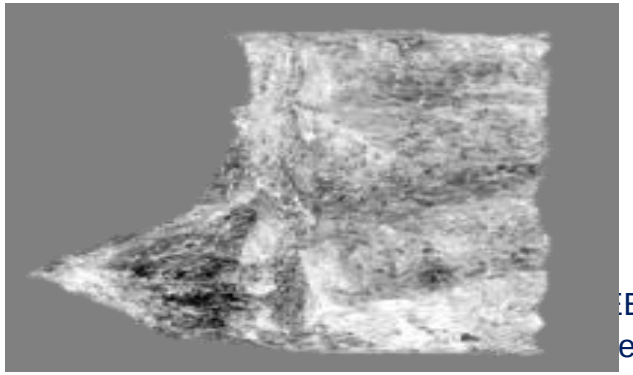
Vue en plan



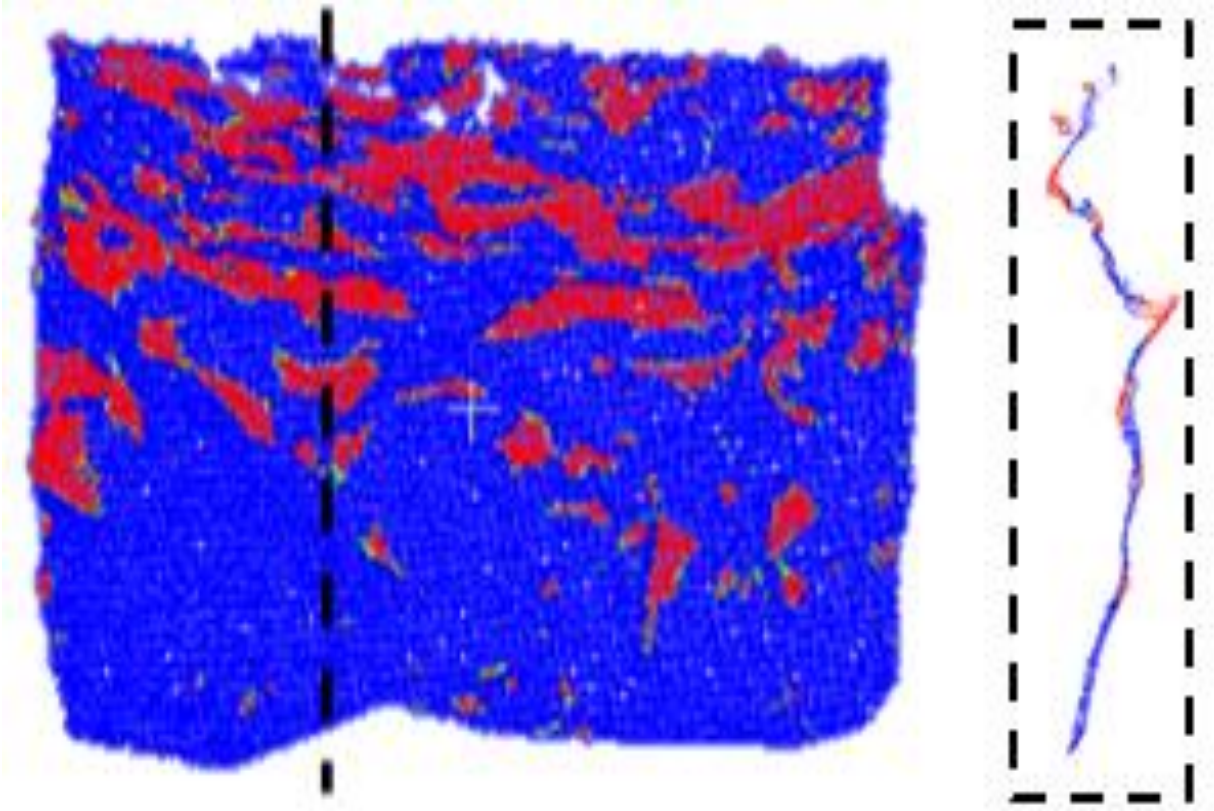


Pseudo-isométrique

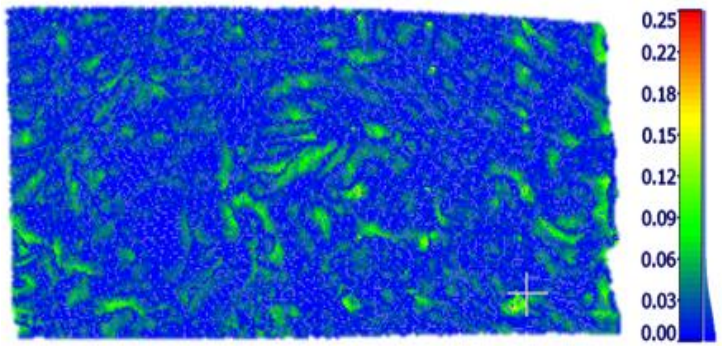
Vue de coté



Évaluation de l’écaillage mécanique

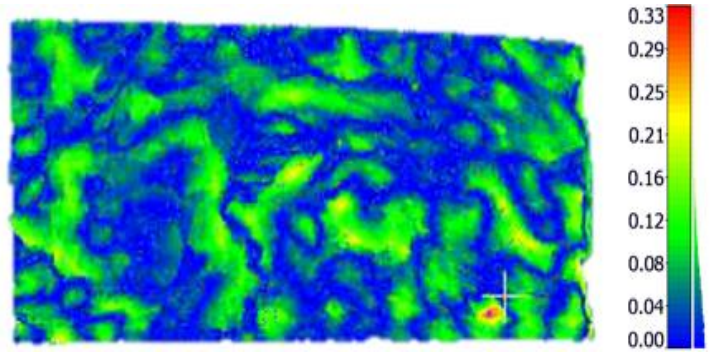


Évaluation de l’écaillage mécanique



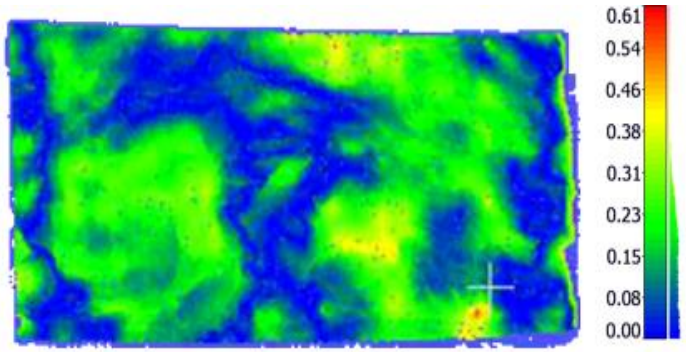
Meausrement radius : 0.5 meters

μ : 0.023 meters
σ : 0.019 meters
maximum *rc* : 0.24 meters



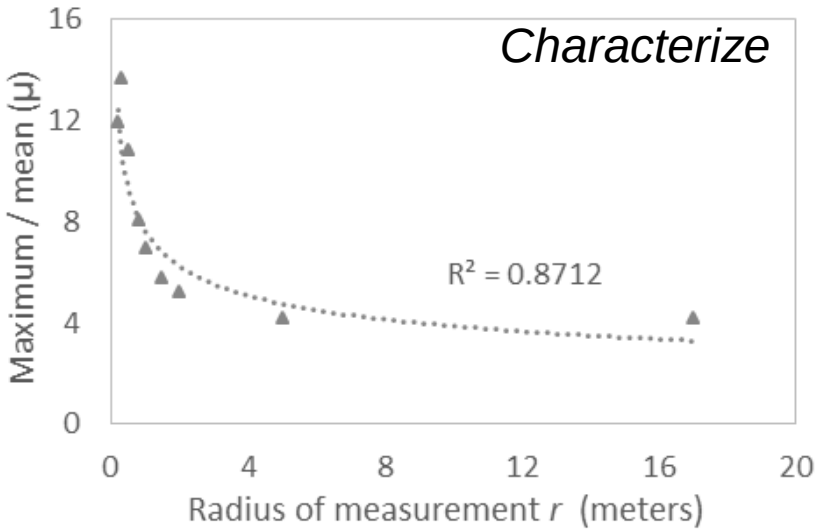
Measurement radius: 1.5 meters

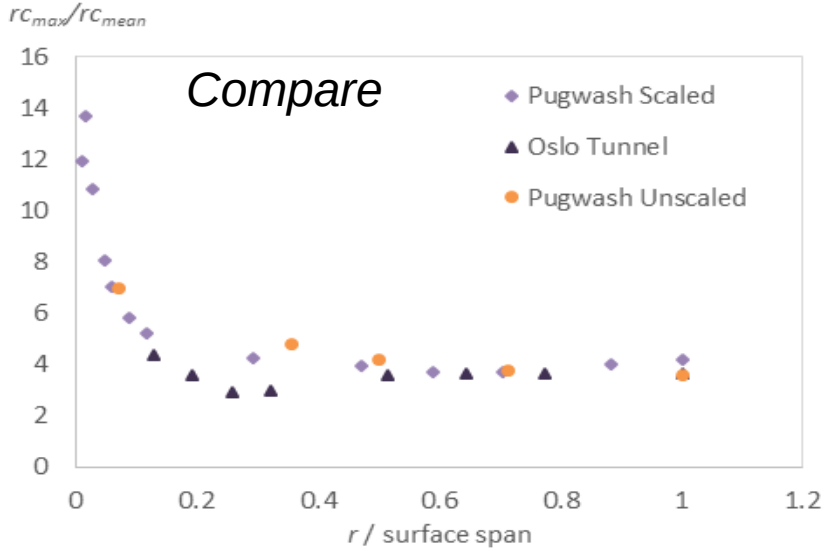
μ : 0.057 meters
σ : 0.04393
maximum *rc* :0.330



Radius of measurement : 5 meters

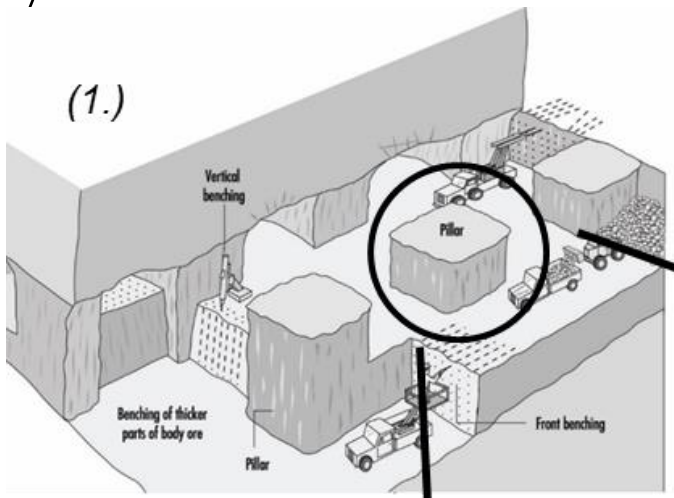
μ : 0.0.145 meters
σ : 0.094 meters
maximum *rc* : 0.614 meters

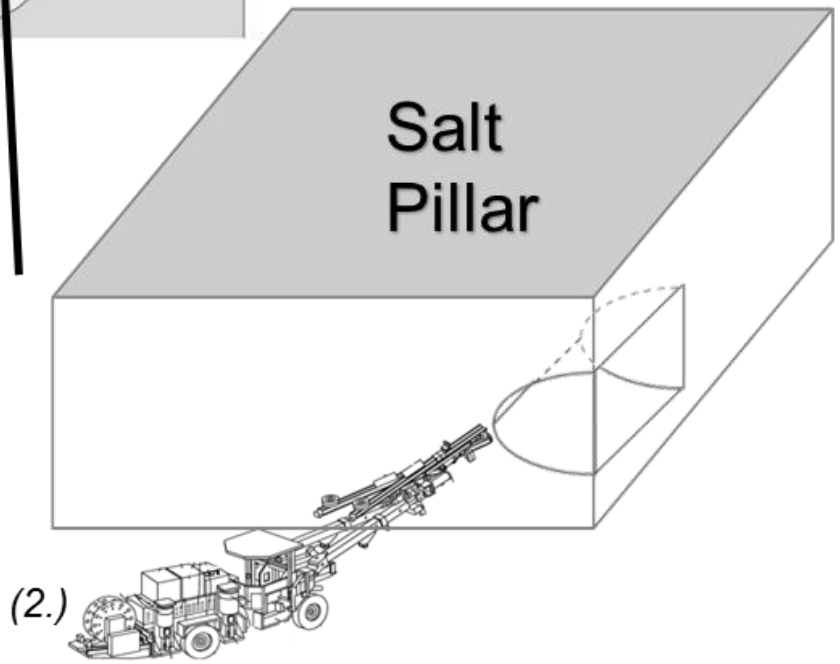




Tests de cratères

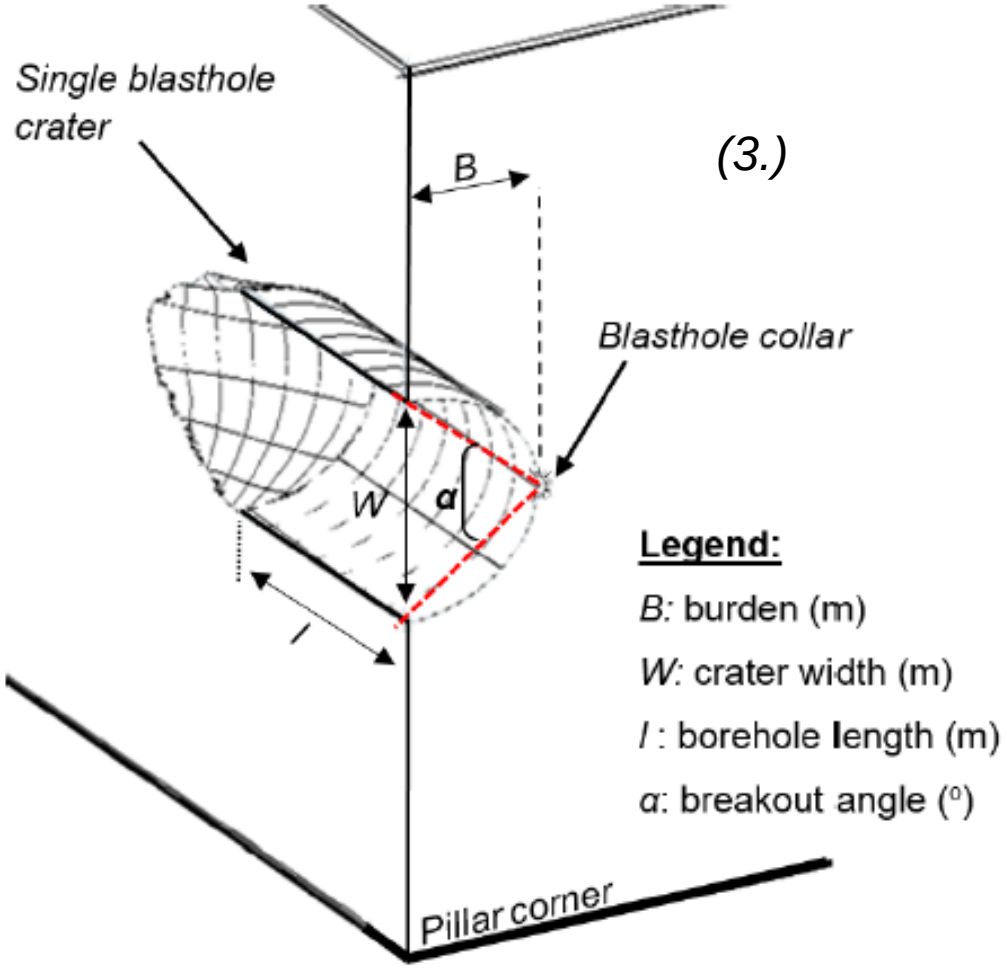
(1.)





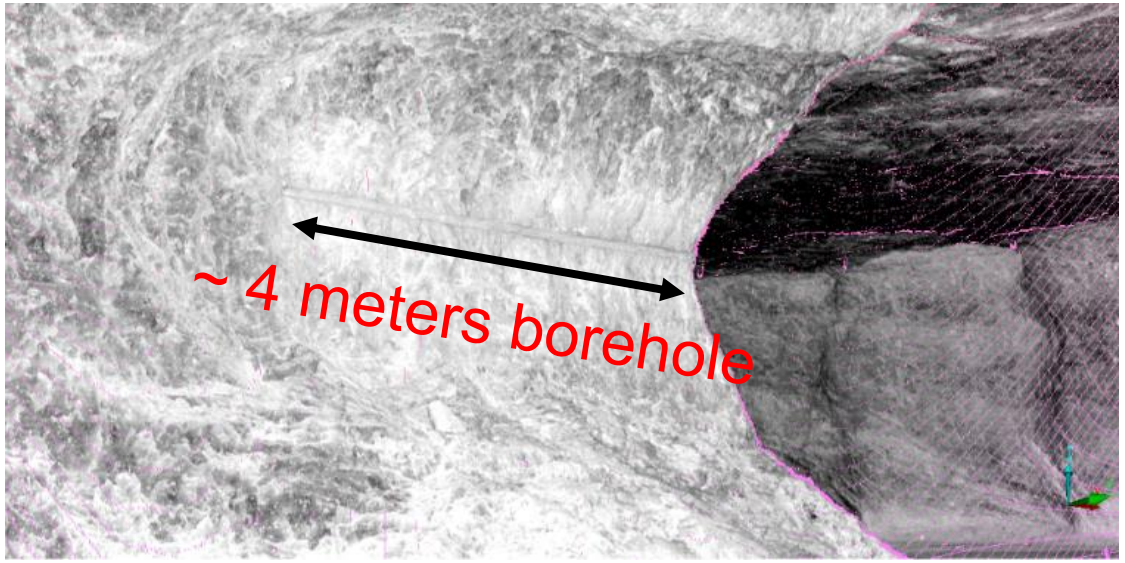
(2.)

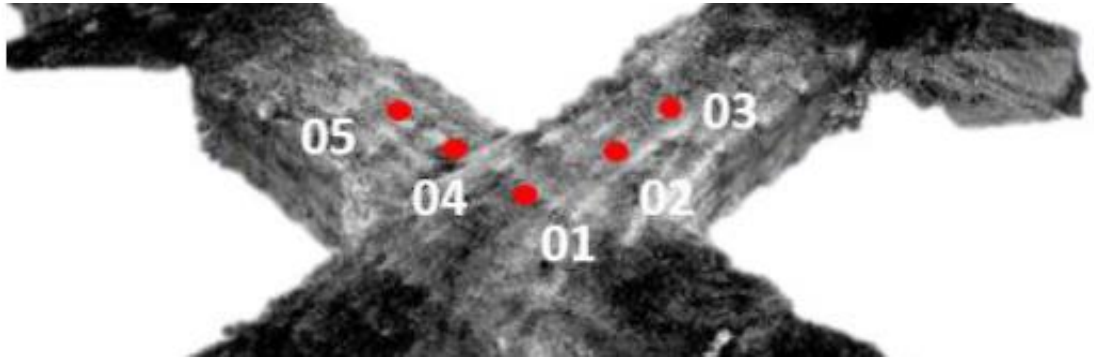
(3.)



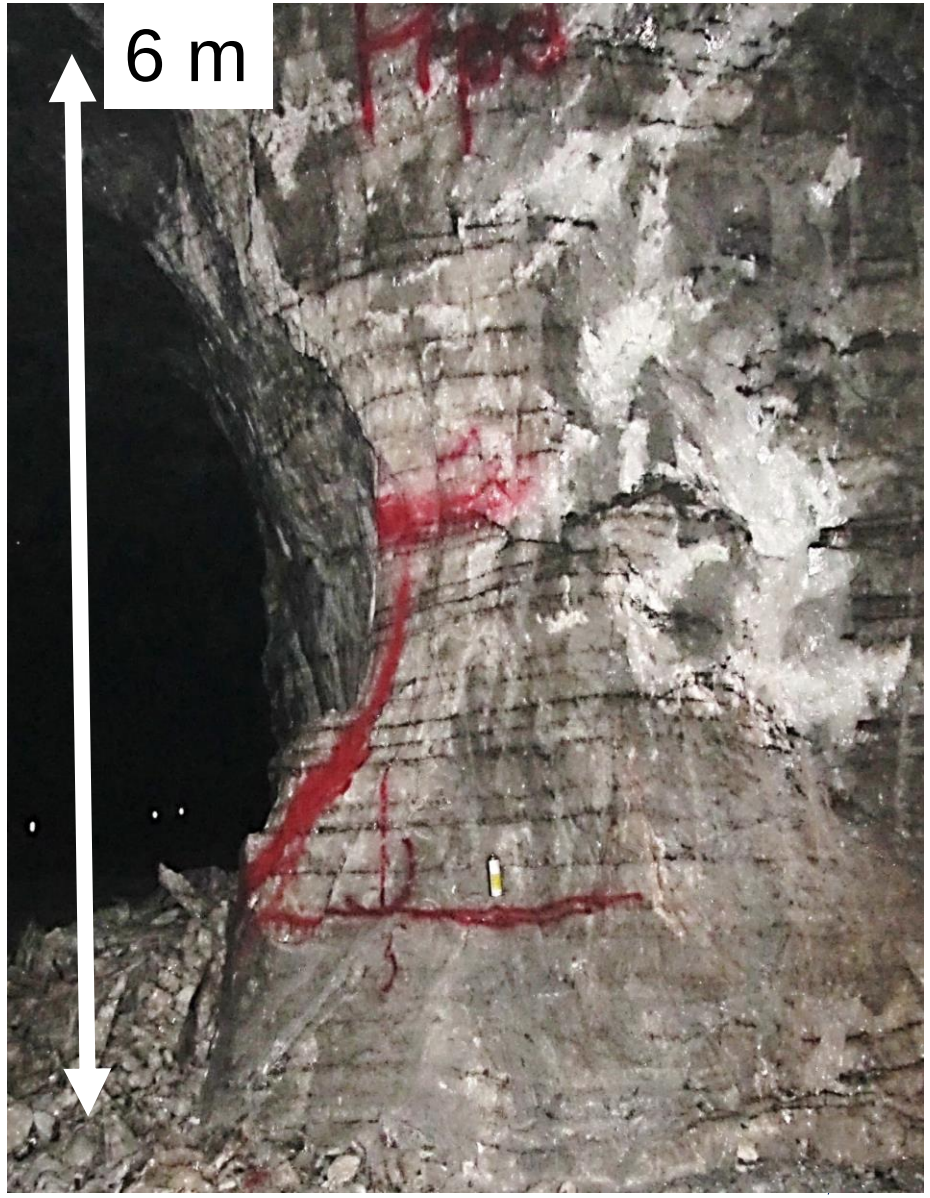
1.Stellman et al.,1998
2.Jumbo drill US 20130048382 A1
3. Aubertin et al. (2018)

Arpantage des tests de cratère

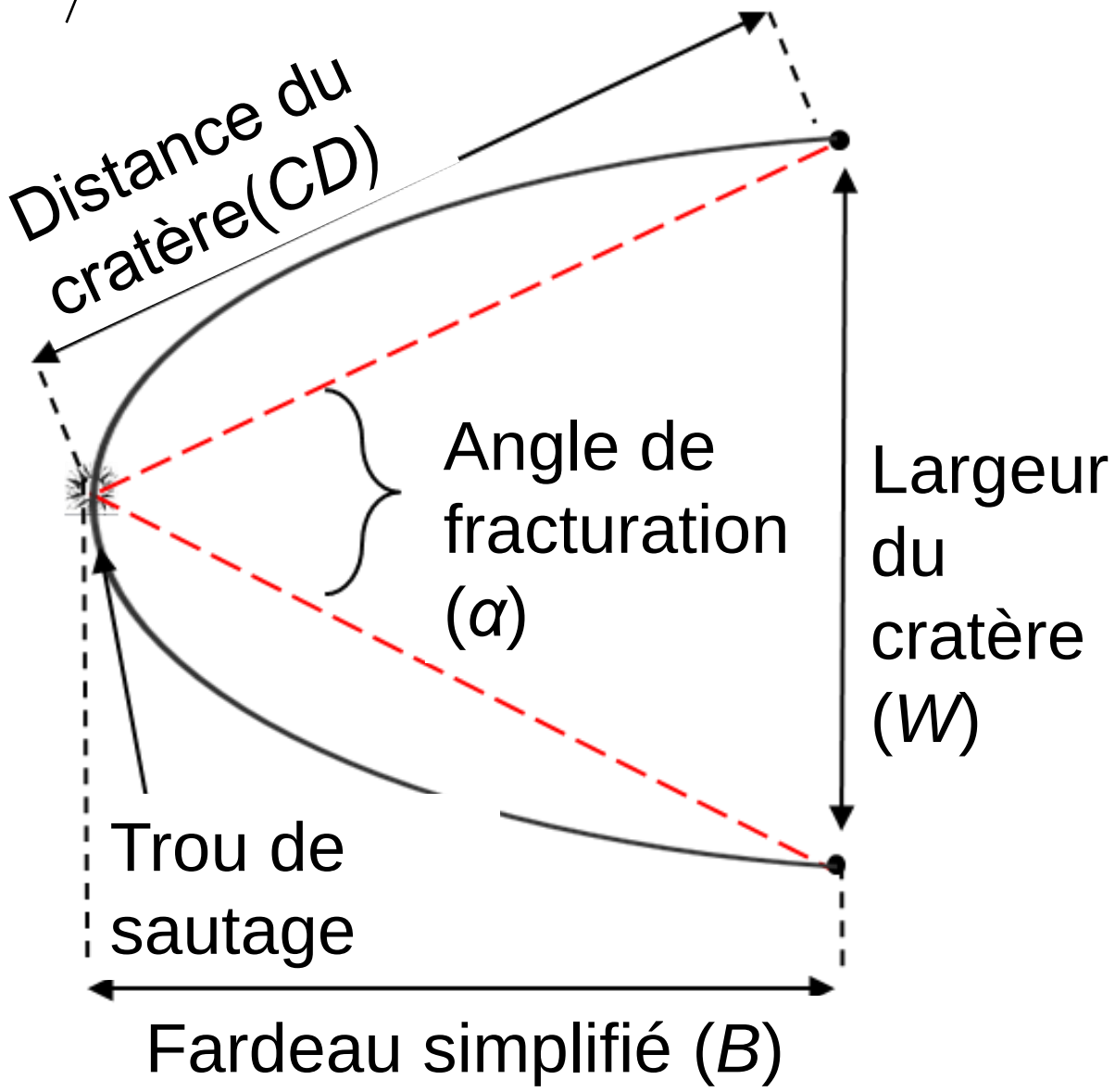


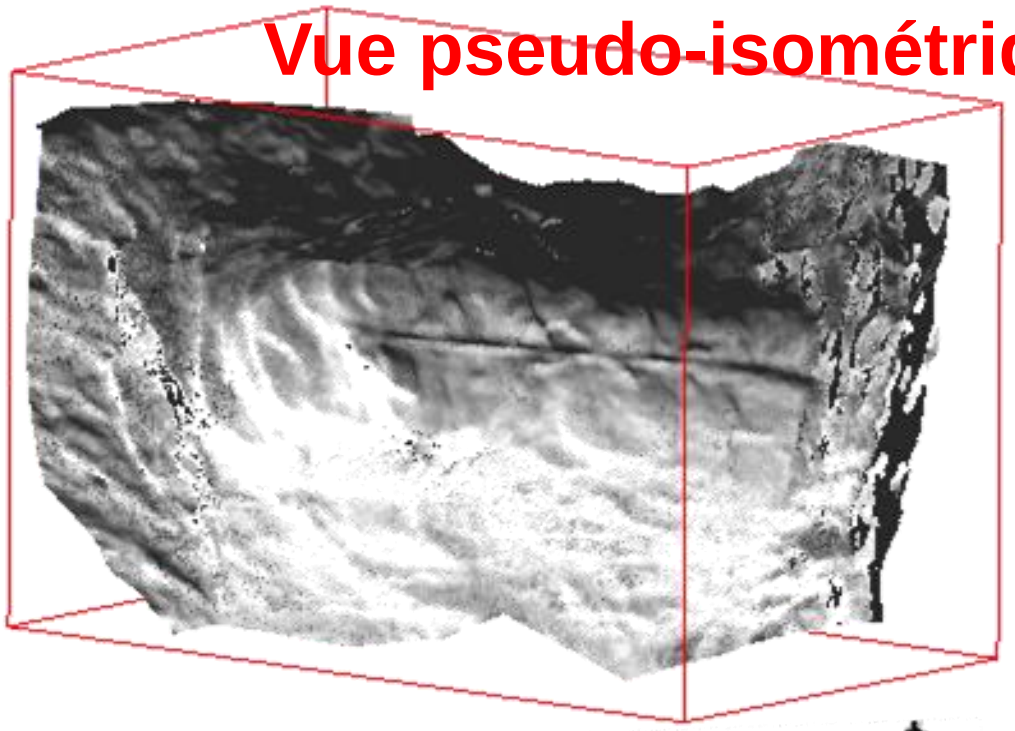


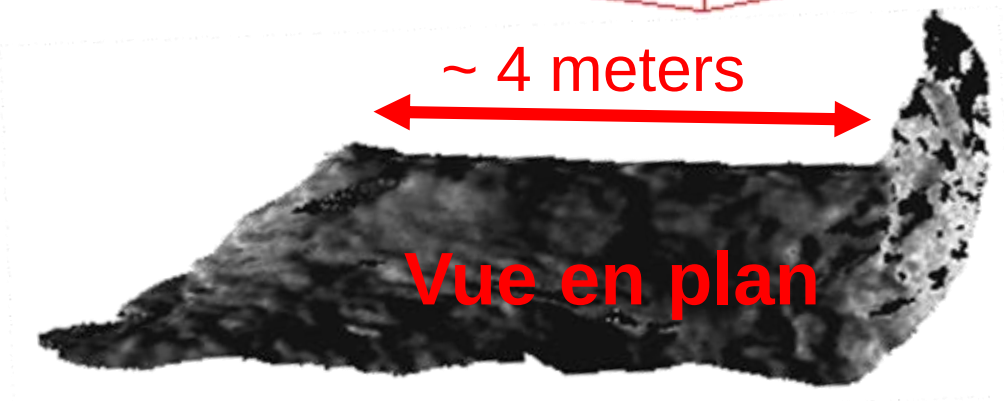
Vue pseudo-isométrique
Excavations de 14 x 7 mètres



Analyse des tests de cratères

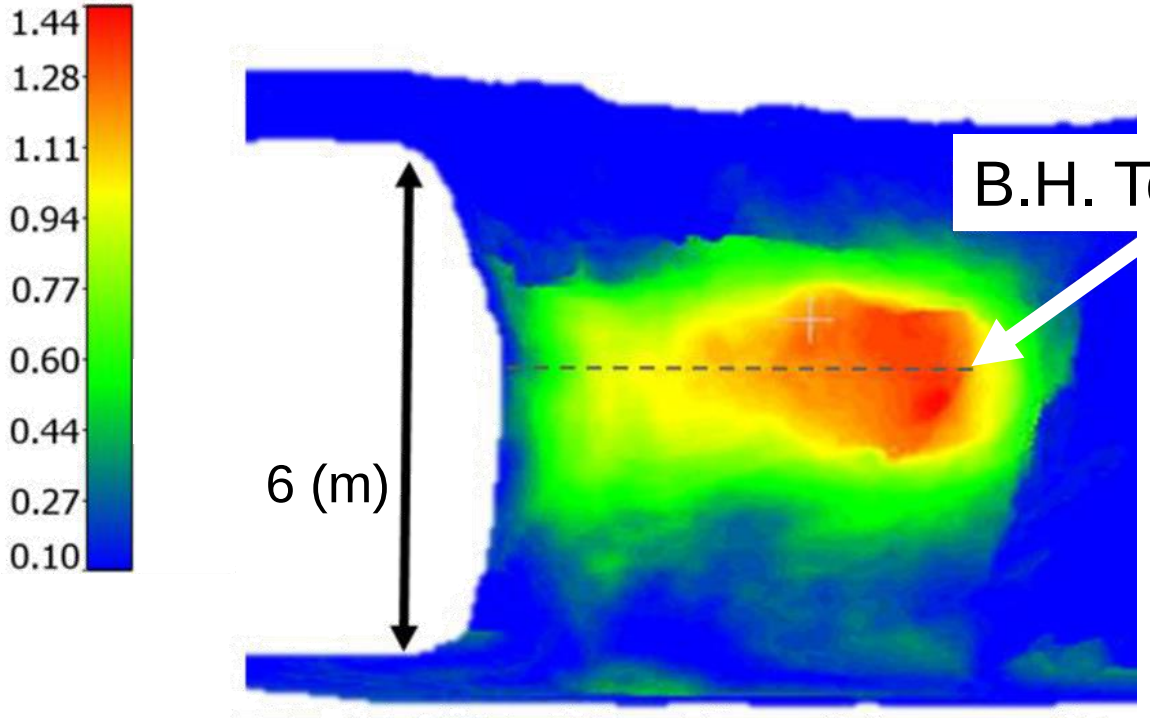






Analyse des tests de cratères

(1) Variation (m)



(2)

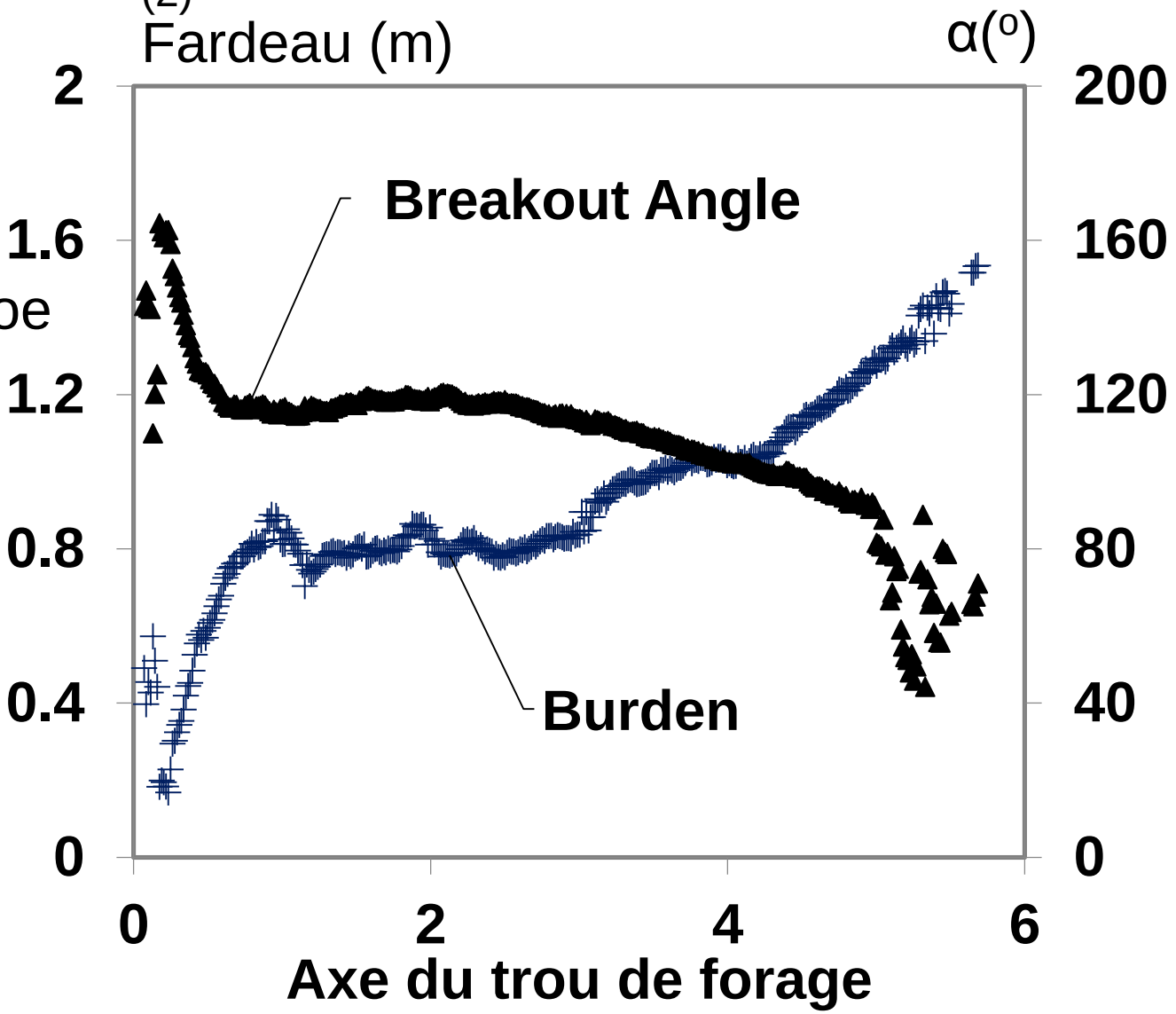
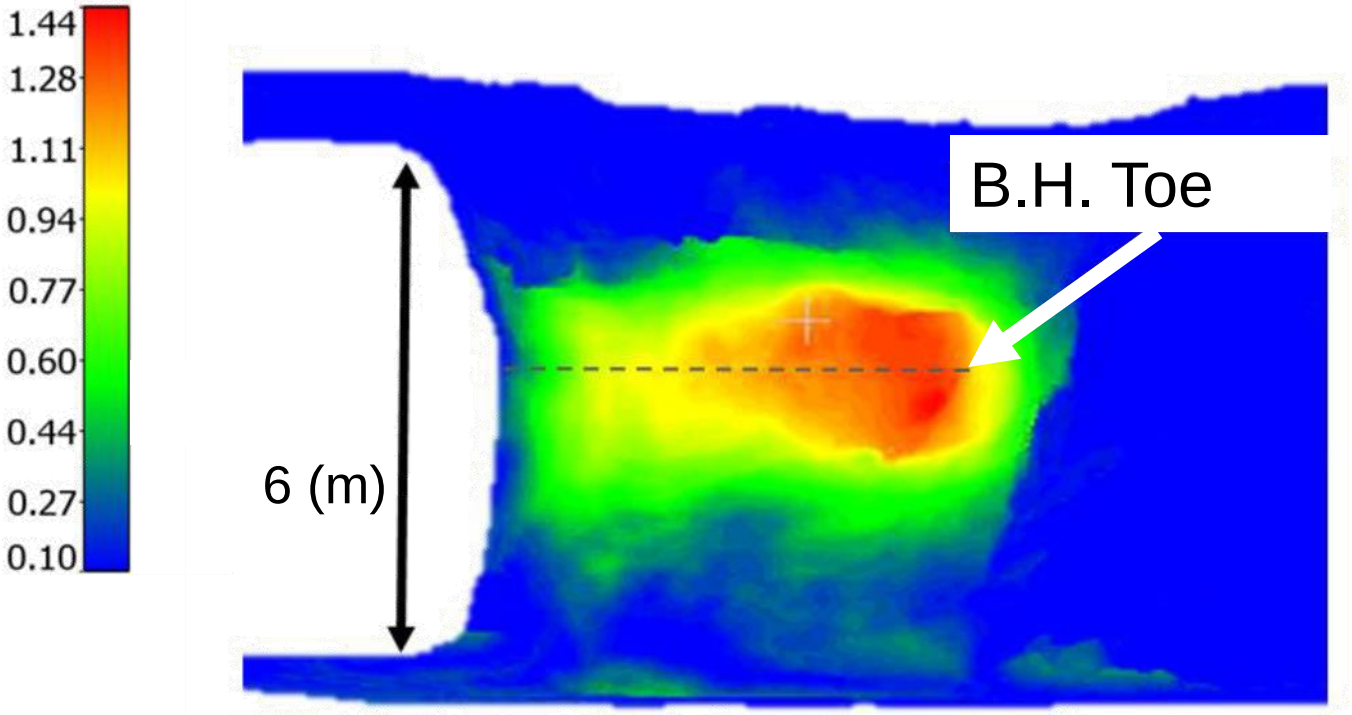


Figure 1: obtenue en utilisant le logiciel “cloudcompare”
Figure 2: Aubertin et al. (2018)

Analyse des tests de cratères

(1) Change detection (m)



(2)

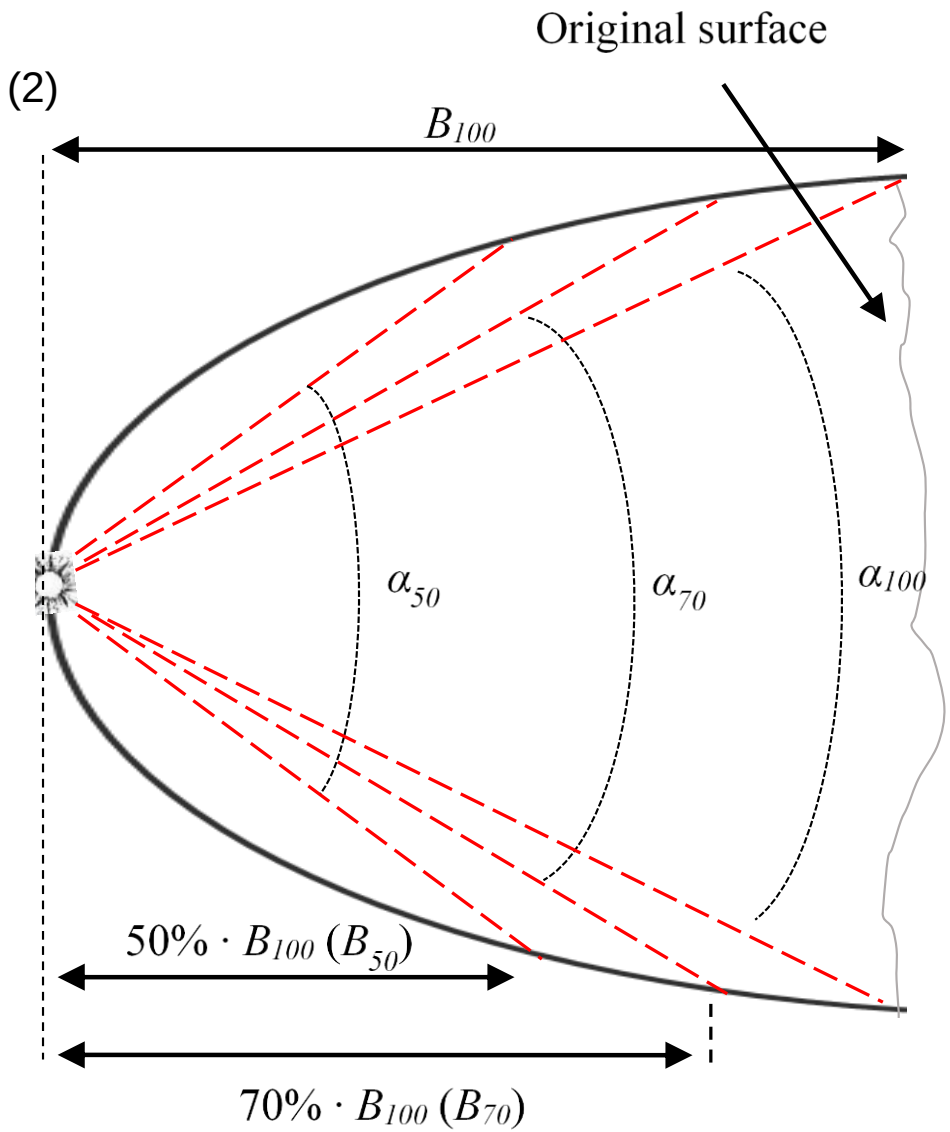


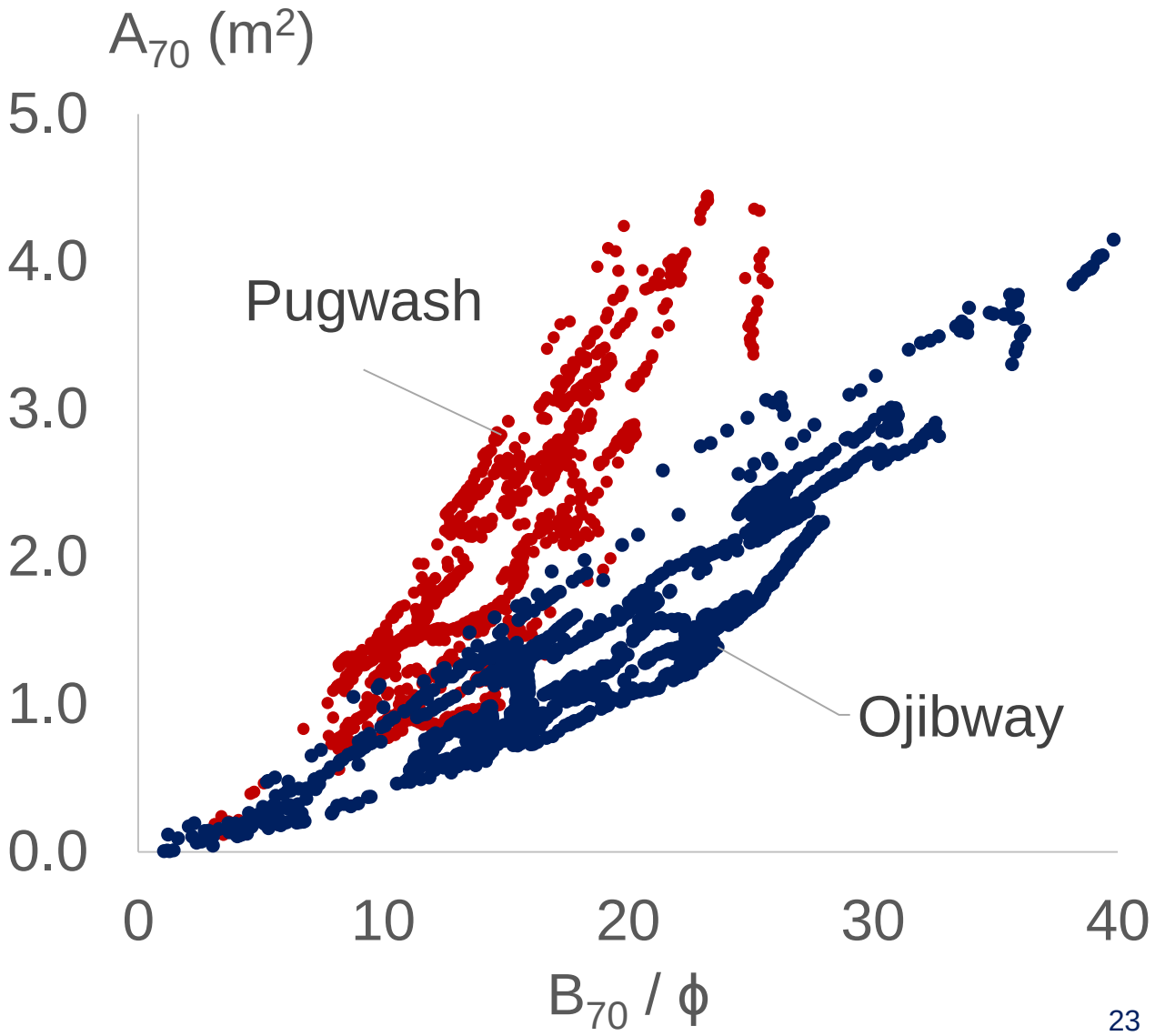
Figure 1: obtenue en utilisant le logiciel “cloudcompare”
Figure 2: Aubertin et al. (2018)

Comparaison de gisements

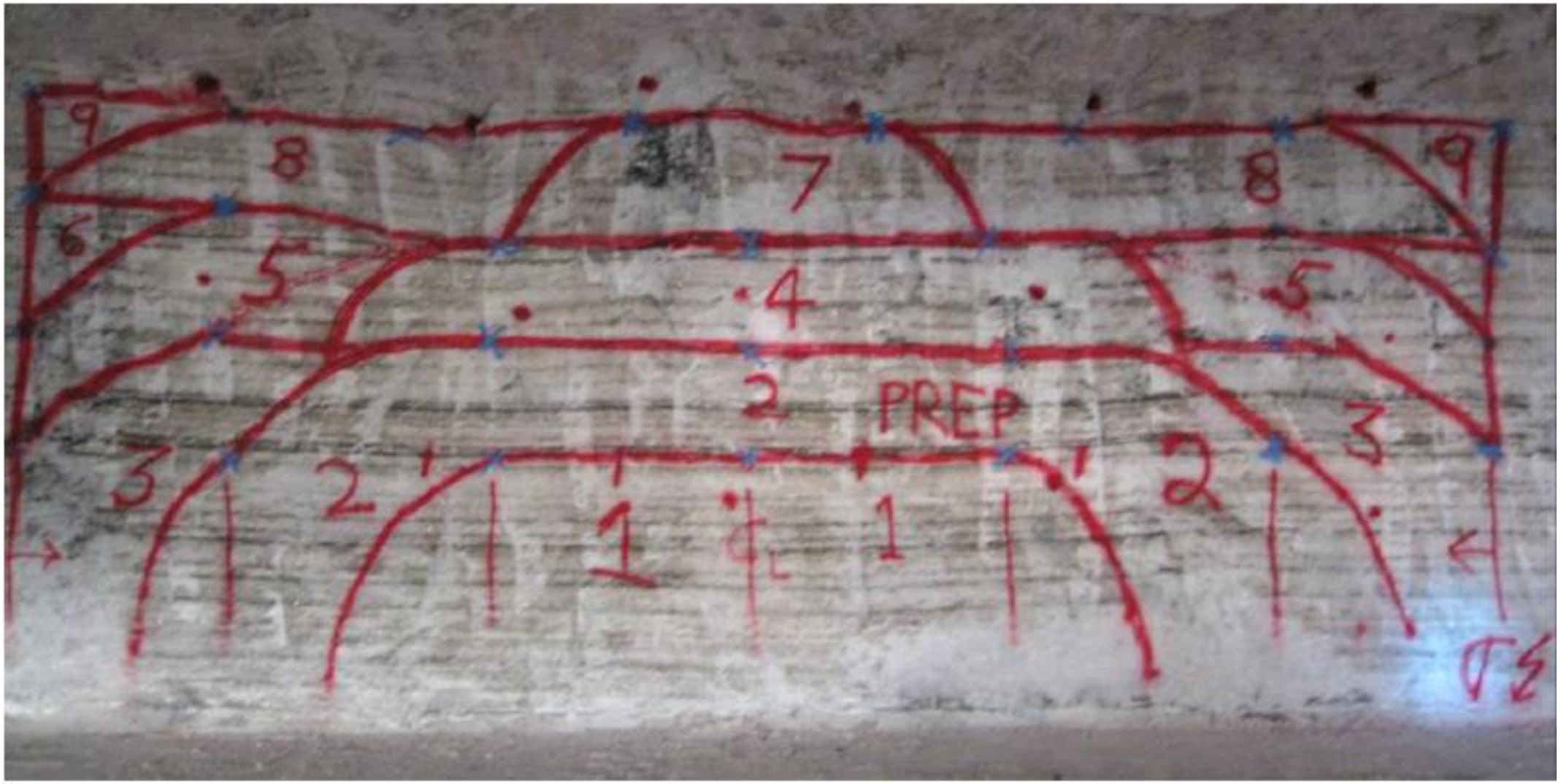
- Relations caractéristiques
- Facteur poudre

➔ Analyse paramétrique

➔ Tendance de fracturation

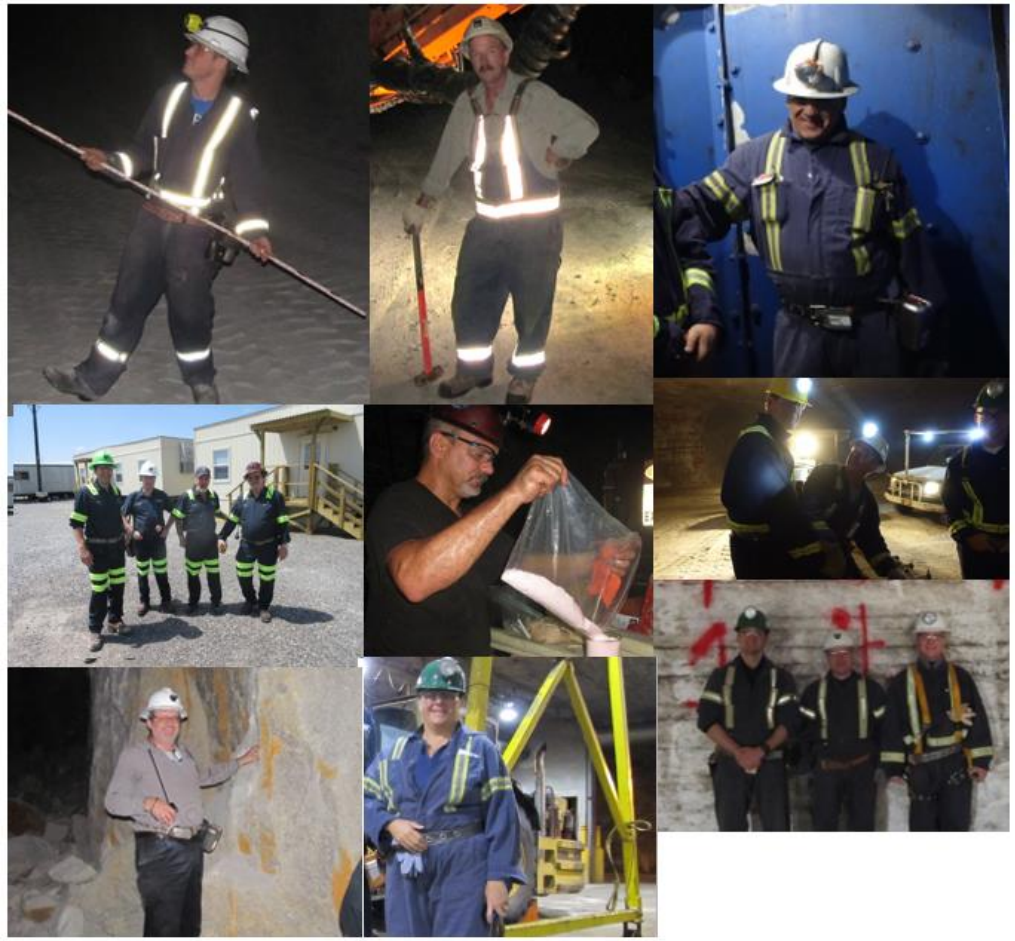


Visualiser l’application



Remerciements

- CRSNG - IPS scholarship program
- Queen’s University Geological Sciences and Engineering Department
- K+S Windsor Salt and Morton Salt
- Les mines Ojibway, Weeks Island et Pugwash
  - Opérateurs et bout-feu
  - Départements d’ingénierie
  - Équipe de direction



Références

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Kromer, R. A., Hutchinson, D. J., Lato, M. J., Gauthier, D., & Edwards, T. (2015). Identifying rock slope failure precursors using LiDAR for transportation corridor hazard management. *Engineering Geology*, *195*, 93-103.

Lato, M., Hutchinson, J., Ball, D., & Harrap, R. (2009). Engineering monitoring of rockfall hazards along transportation corridors: using mobile terrestrial LiDAR. *Natural Hazards and Earth System Sciences*, *9*(3), 935.

Questions?