Efterbehandling av dagbrottet vid Kimheden

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Historical perspective

- *”An ounce of prevention is worth more than a pound of cure”, runs the proverb. This surely applies to the management of acid rock drainage.*

  Kwong 1993

- *Acid rock drainage / metal leaching prevention is the key to avoid costly mitigation.*

  INAP 2009 – 2014

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Performance of two decades backfilling and dry cover application

THE CASE OF KIMHEDEN

Goal of the project

(photo Boliden)

- Effectiveness
  - In-pit backfilling
  - Cover application

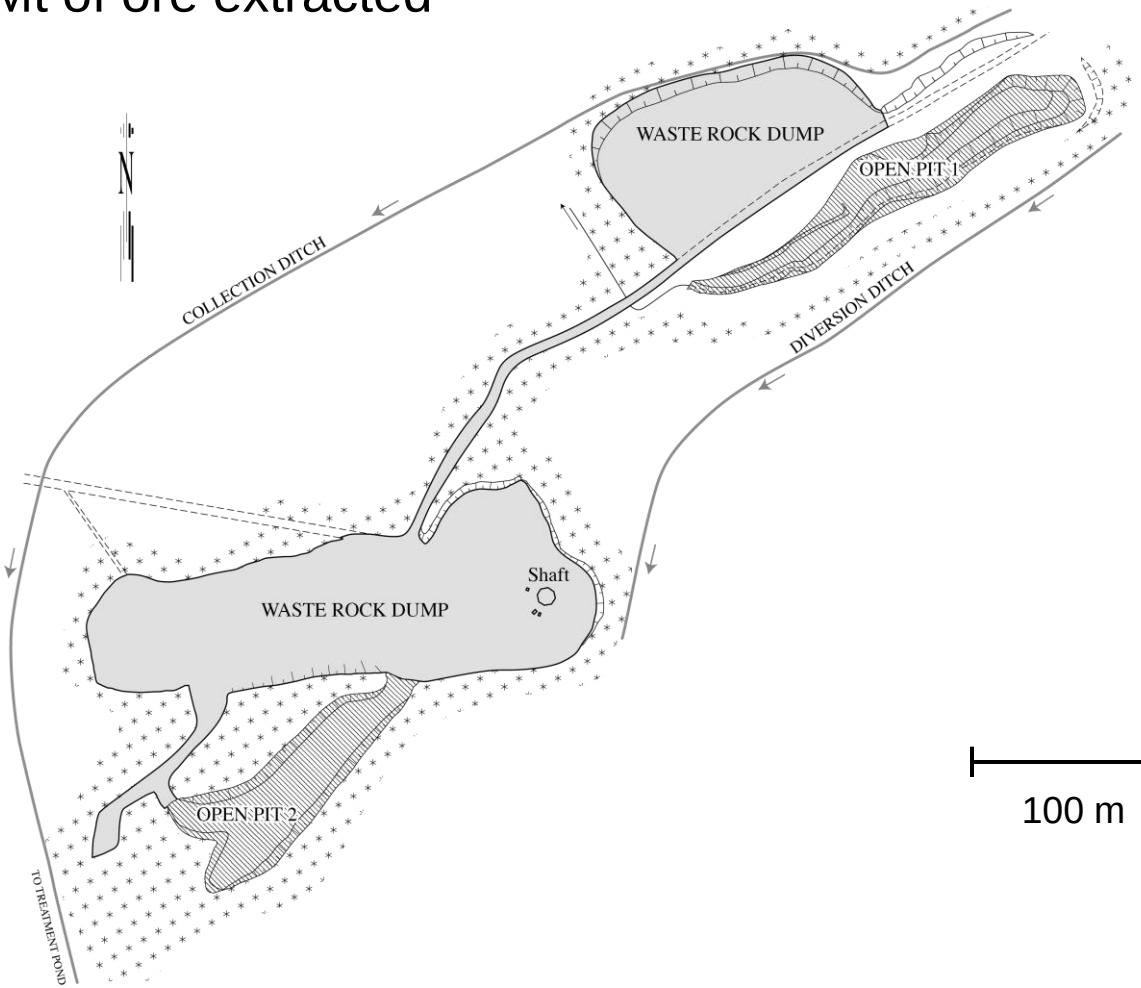
  - AMD loads
  - O_2 reduction from cover

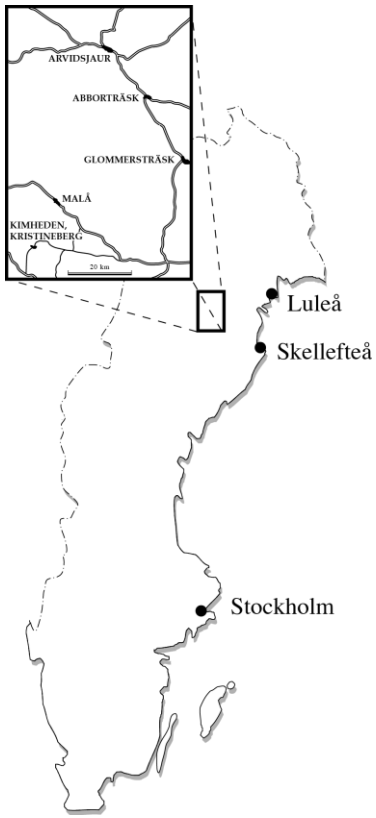
- Multidisciplinary approach
  - geochemistry
  - geophysics
  - hydrogeology
  - modelling

Kimheden copper mine

Operated by Boliden AB
in the 1970s

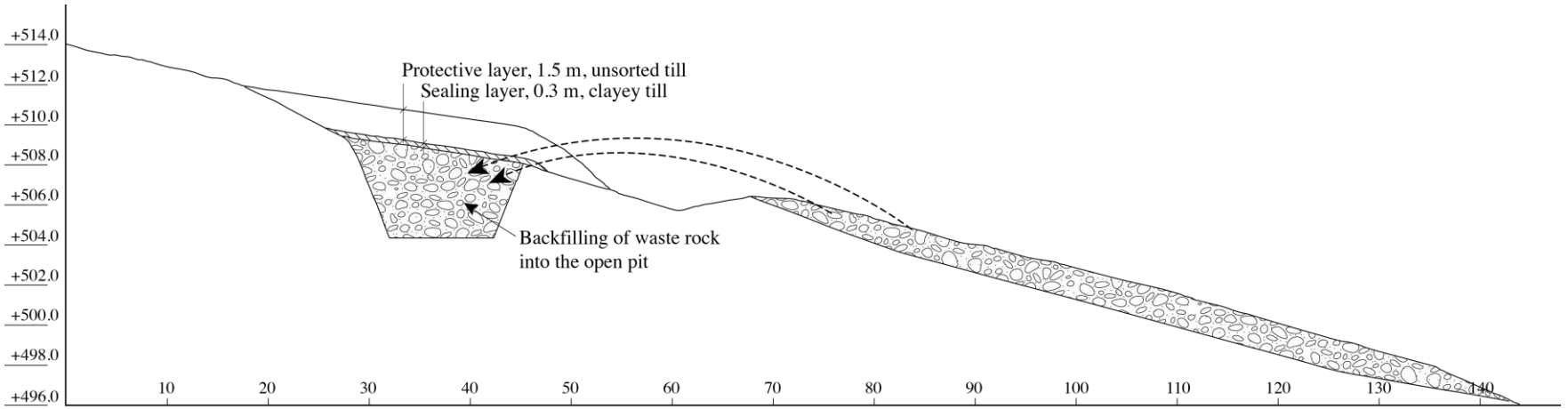
0.13 Mt of ore extracted



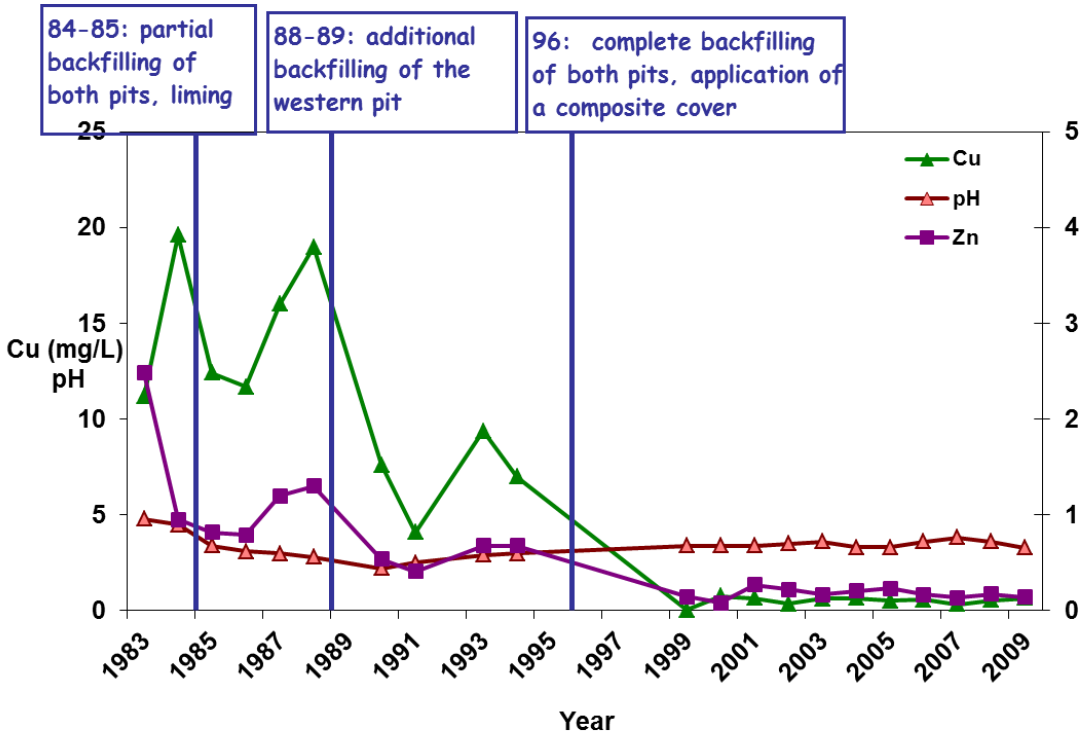


Reclamation

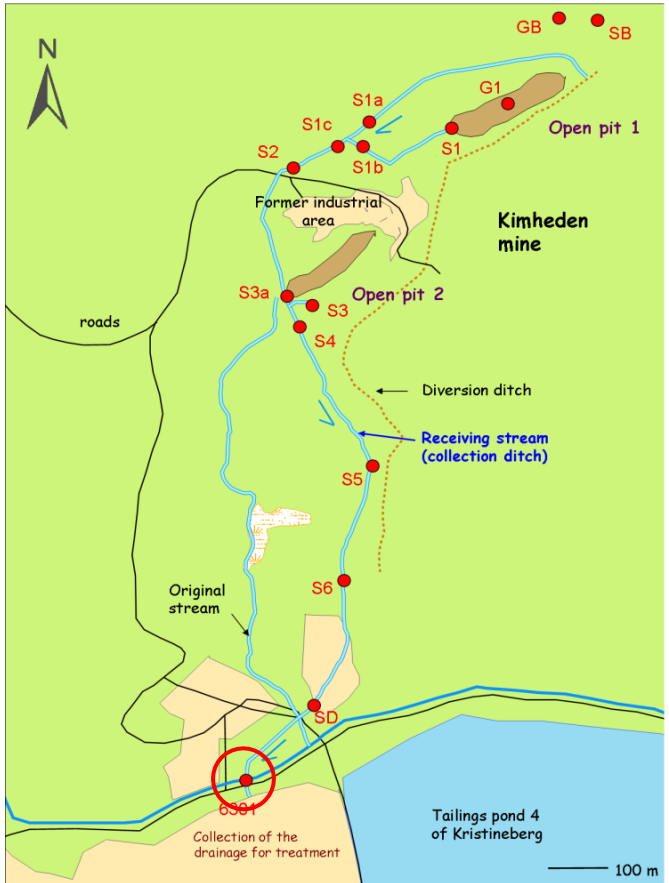
Backfilling of waste rock and application of dry cover (1995-1996)



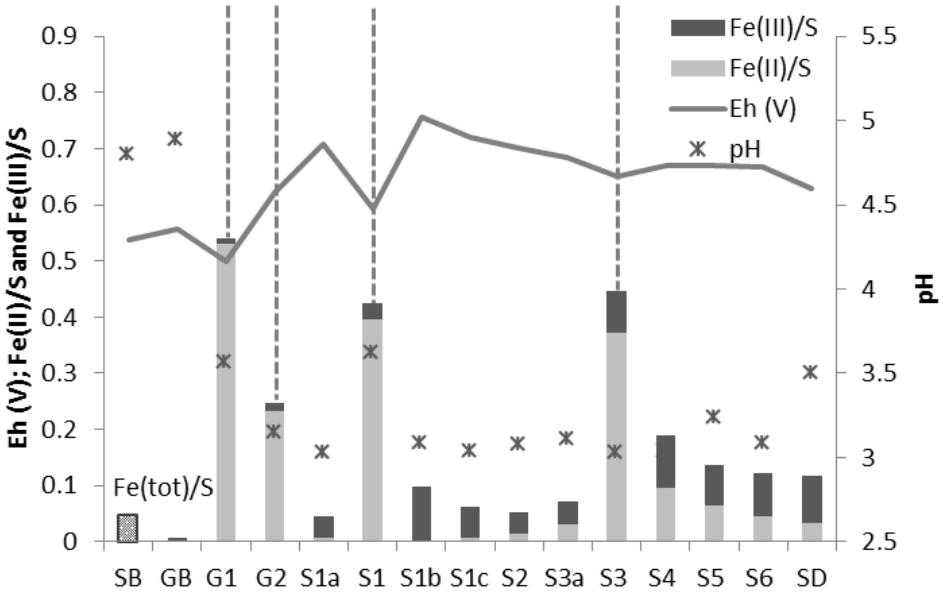
Main findings



Significant decrease of Cu and Zn concentrations downstream



Main findings



Processes of acidification in the stream

Fe(II)/S

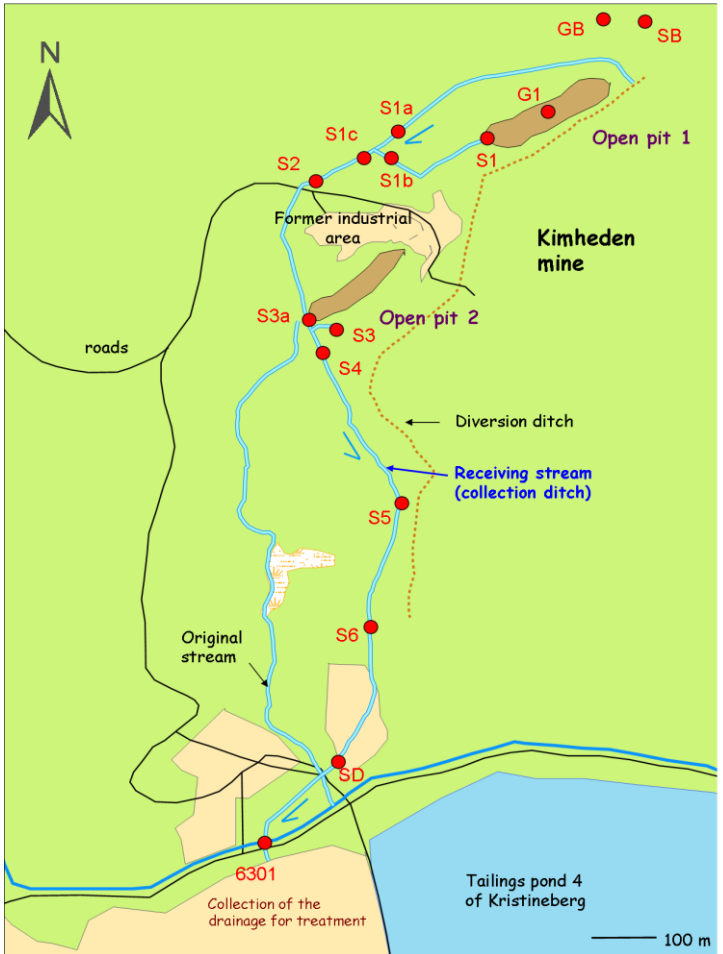
= 0.5

$$FeS_{2(s)} + 7/2O_{2(g)} + H_2O_{(l)} = Fe^{2+}_{(aq)} + 2SO^{2-}_{4(aq)} + 2H^{+}_{(aq)} \quad (1)$$

$$Fe^{2+}_{(aq)} + 1/4O_{2(g)} + 2.5H_2O_{(l)} = Fe(OH)_{3(aq)} + 2H^{+}_{(aq)} \quad (2)$$

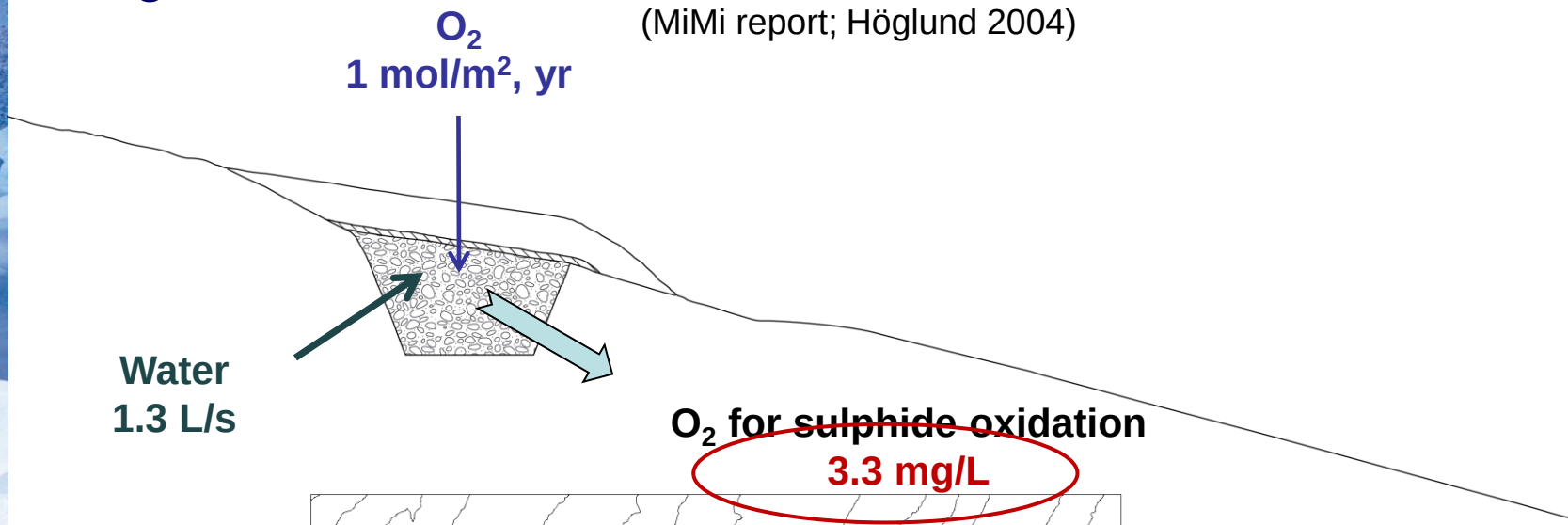
Fe(II)/S

< 0.5

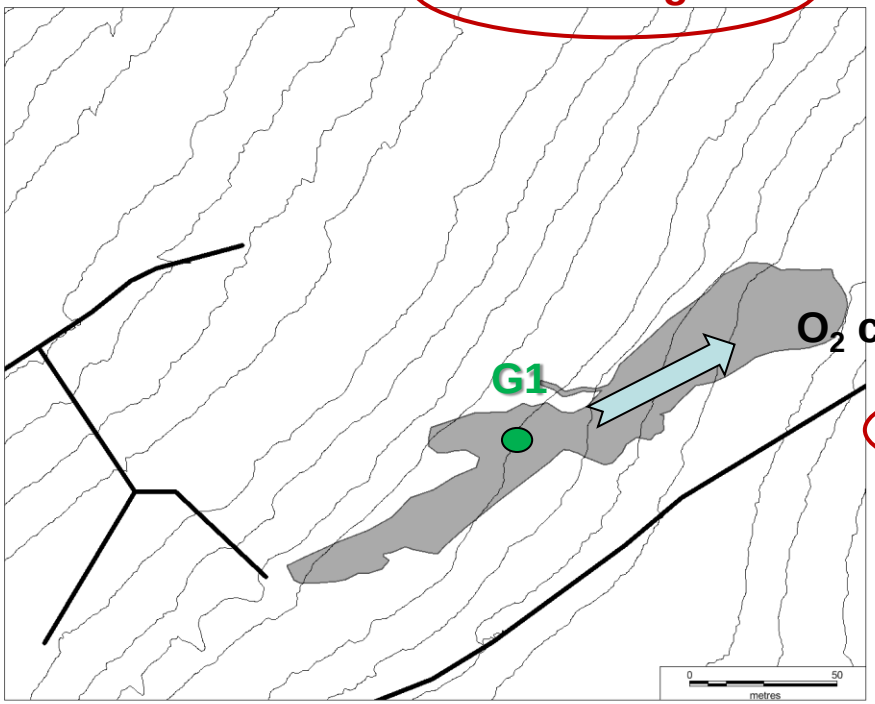


Main findings

(MiMi report; Höglund 2004)



O_2 for sulphide oxidation
3.3 mg/L



O_2 consumed by sulphide oxidation
364 mg (1 L AMD)

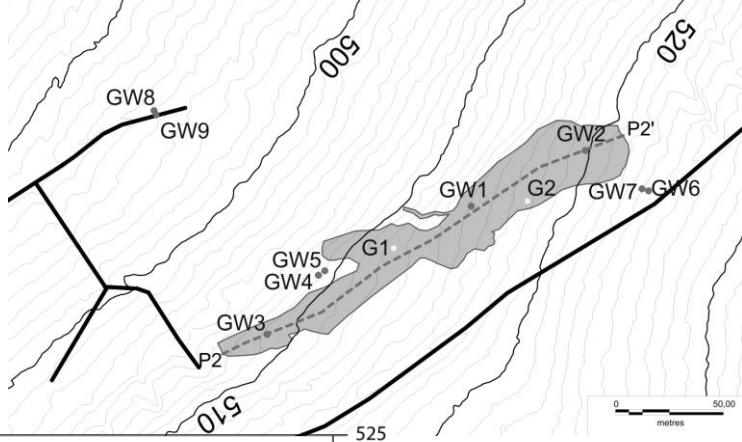
O_2 saturation in water
[7 – 13] mg/L

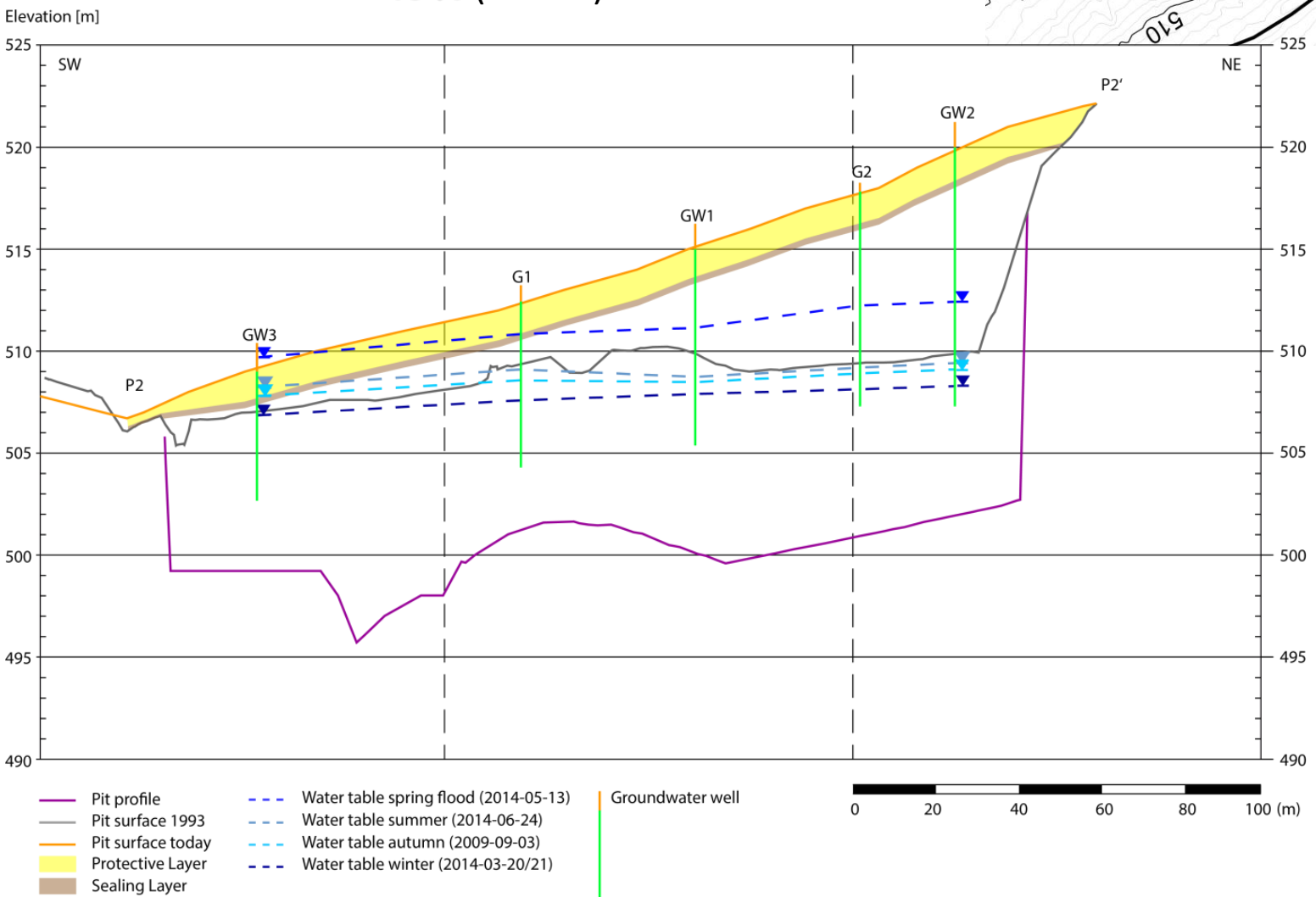
Water re-oxygenated 28 times

Main findings

Partly unsaturated backfill:

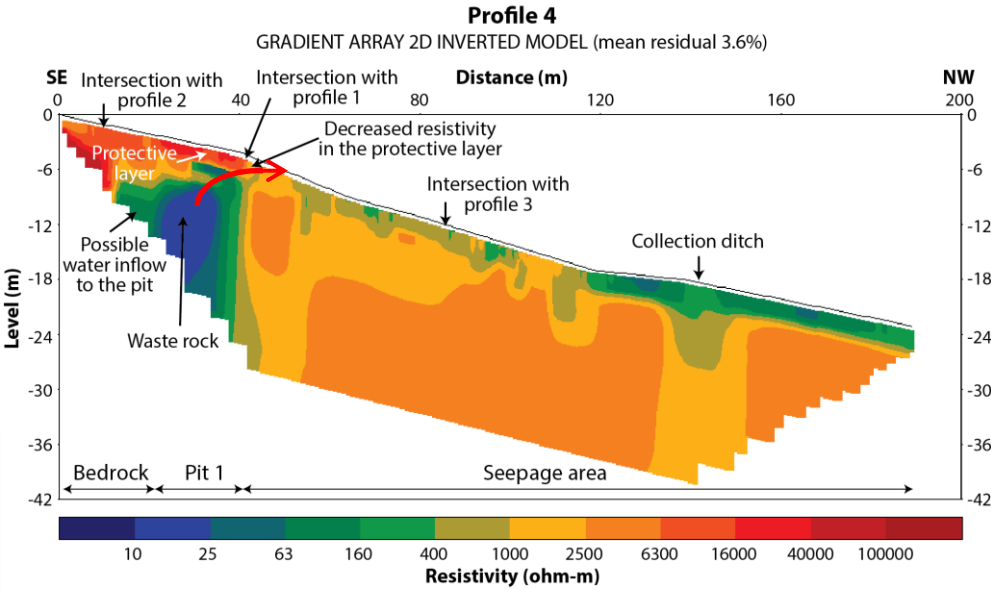
- 15 % (spring flood)
- ***40 %*** (winter)

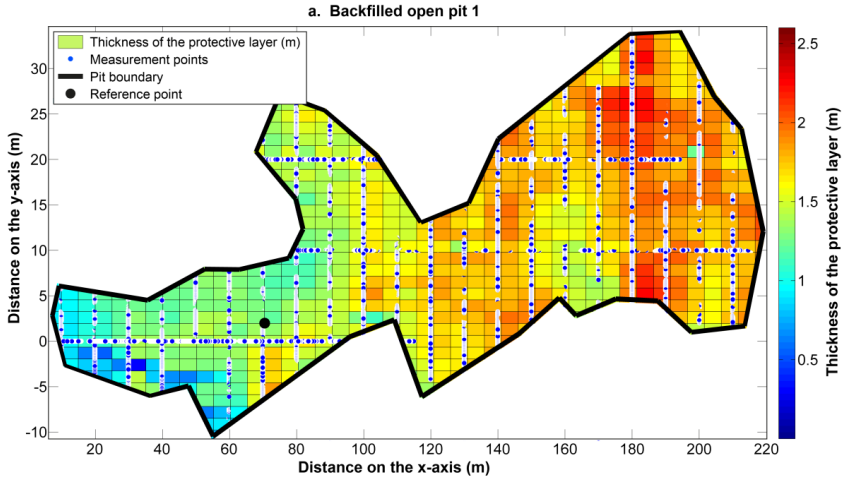


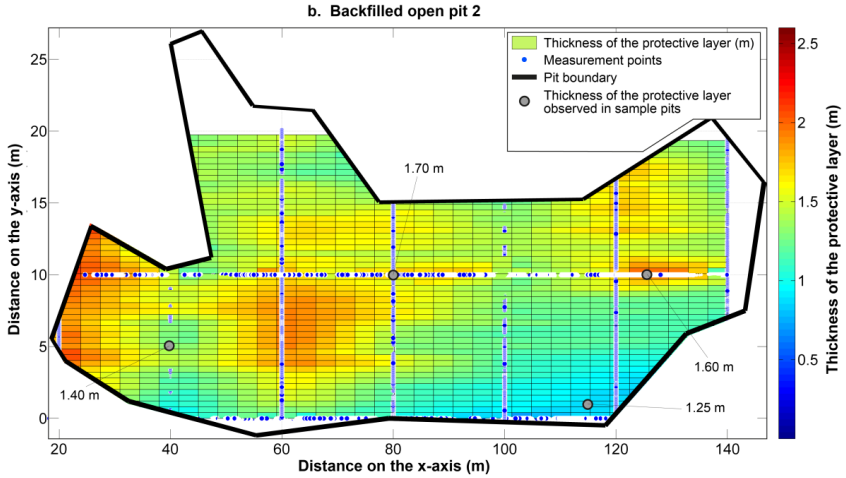


Main findings

Seepage through the dry cover







Regions of **insufficient thickness** of protective layer

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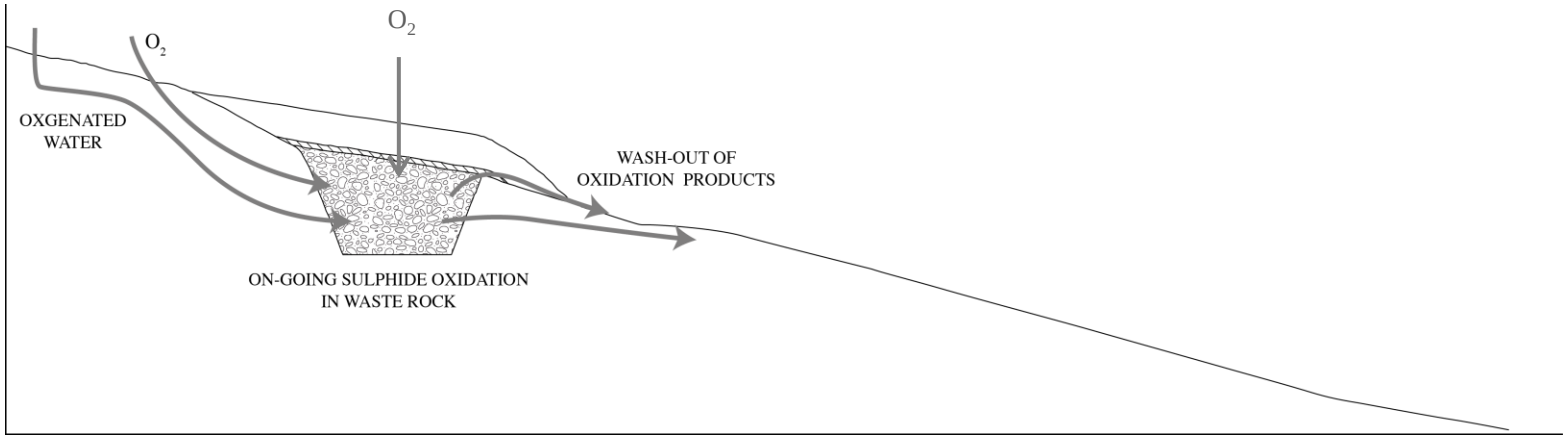
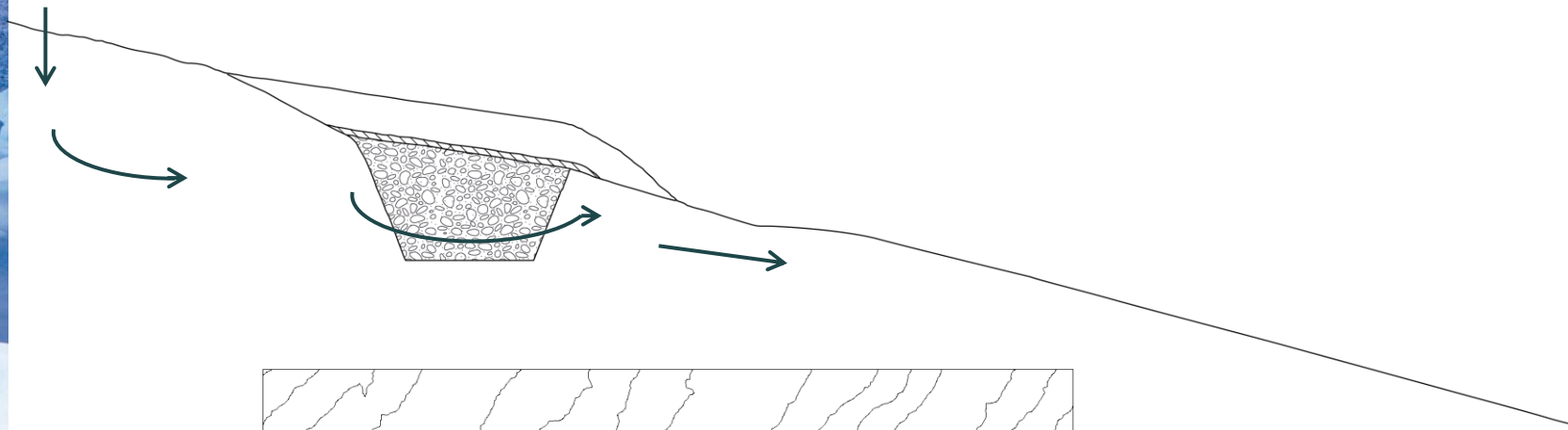
CONCLUSIONS

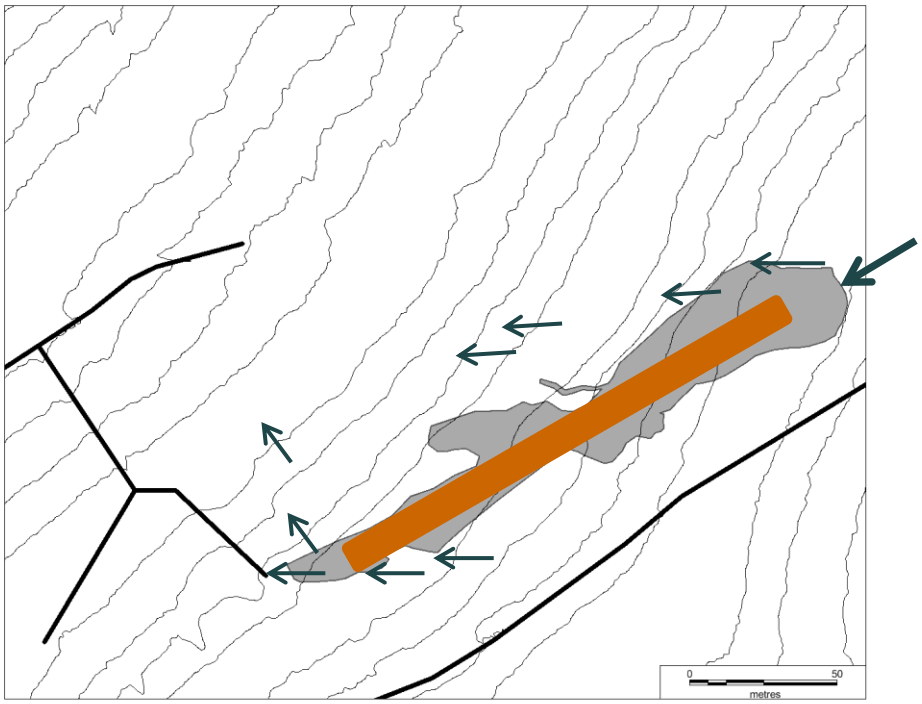
Pathways of oxidation



Conceptual model of oxygenation and wash-out processes

Suggested alternative





SOLIDIFICATION

- Reduce oxygen intrusion
- Modify water pathways

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Key issues

- Challenges with the use of dry covers on mine waste
- Backfilling does not necessary ensure isolation of the waste
- Knowledge about hydrogeology is essential before mine site reclamation
- Increasing amount of reclaimed sites is an excellent opportunity to learn from the past

Tack!

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