Towards Holistic Resource Development

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Agenda

- Problem statement:

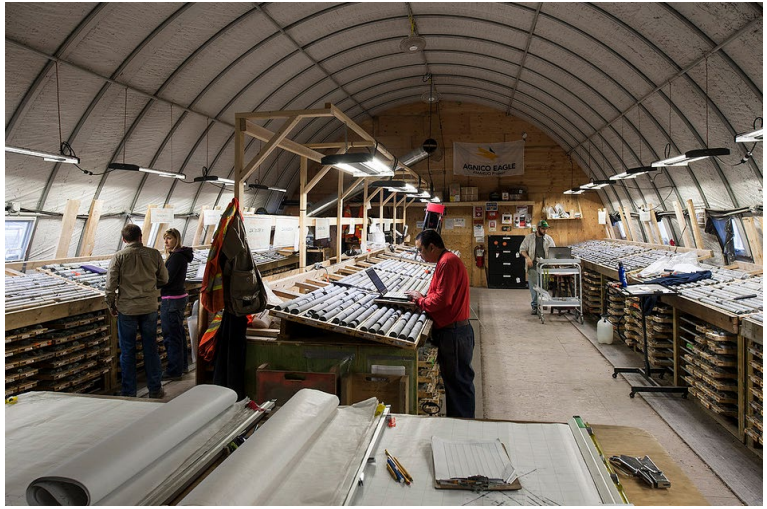
  → how do we as an industry get beyond making geochemical predictions somewhat blind and handcuffed?

- Assessment of geochemical opportunities using case studies
  - Akasaba West
  - Joutel Tailings Storage Facility

- Conclusions or “take home message”

Problem Statement

- Most mining development projects focus solely on commodity identification and extraction methods
- The consequence of this can be a detriment to economic value and increased environmental risk
- Ultimately, there is a business disadvantage to not fully understanding a resource



Problem Statement

- One of the biggest long term liabilities of a resource that is mined is the mine waste
  - Waste rock
  - Tailings and their dams
  - Pit walls and benches
  - Lay-down areas
  - Borrow sources
  - Etc.

Problem Statement

- Flipping how we think about a mining operation, they are actually waste management facilities paid for by commodity recovery

- For example:
  - 1 g/t is a decent open pit gold grade
  - 99.999% of ore is waste (tailings)
  - Millions (upwards of billions) of tonnes of rock around the ore are also waste

Problem Statement

- So not understanding the main liability on a site before its developed is risky and often costly

- No exploration program to develop a resource would rely on a couple hundred samples
  - Exploration sampling in the 10’s of thousands of samples
  - Environmental geochemistry in the hundreds (not always)

Problem Statement

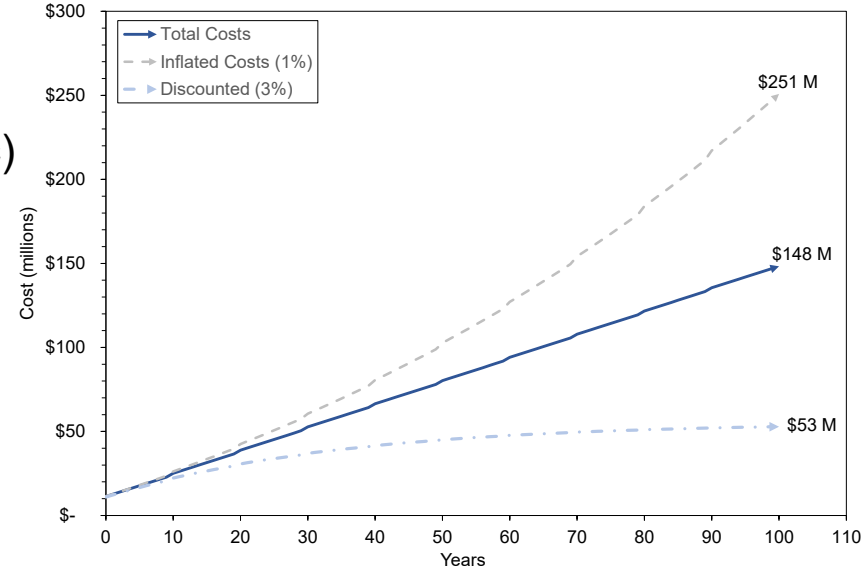
- Compounding this problem is how the long term liability is valued
- The net present value (NPV) formula is used, which is a financial tool for understanding the value of future cash flows
- Authors opinion that this approach blocks innovation and opportunities to mange liabilities more proactively by hiding real costs

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

Where R = net cash flow during a single period *t*
i = discount rate or rate of return that can be earned in alternative investments
t = number of time periods (e.g. years)

Problem Statement

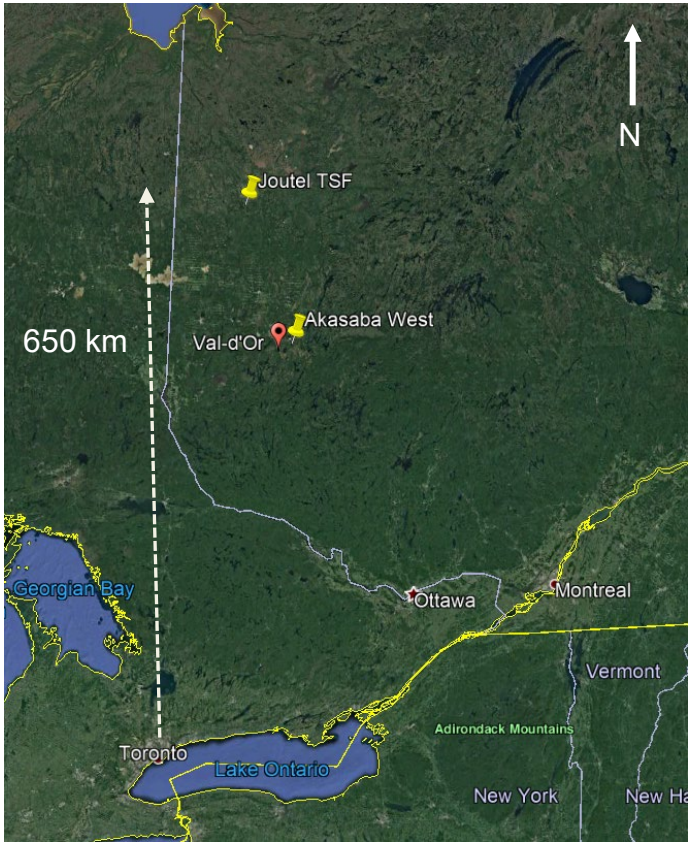
- Example – ARD Water Treatment for 100 years
  - Capital costs to build plant
  - Operating costs (people, lime, electricity, etc)
- $200M difference between minor inflation and NPV
- As time gets shorter, less impact from NPV
- Unlikely that any mining company invests to cover closure costs
- Unlikely that closure costs have ever been cheaper than predicted



Opportunities with Case Studies

- In short, those focused on identifying and managing water quality risks are left somewhat blind and handcuffed

- Two Agnico Eagle case studies are provided to show potential business advantage (cost and risk) to changes in characterization thinking
  - Akasaba West
  - Joutel tailings storage facility



Case Study One: Waste Rock Block Model

Akasaba West

- Akasaba West is a greenfield project that would feed the Goldex Mine
- Located 16 km south-east of Val d'Or
- Open pit gold resource
- Geochemical assessment found that ~50% of the rock had the potential to generate ARD, but based on low number of samples
- Impact to mine plan was overly conservative amounts of waste rock needing management

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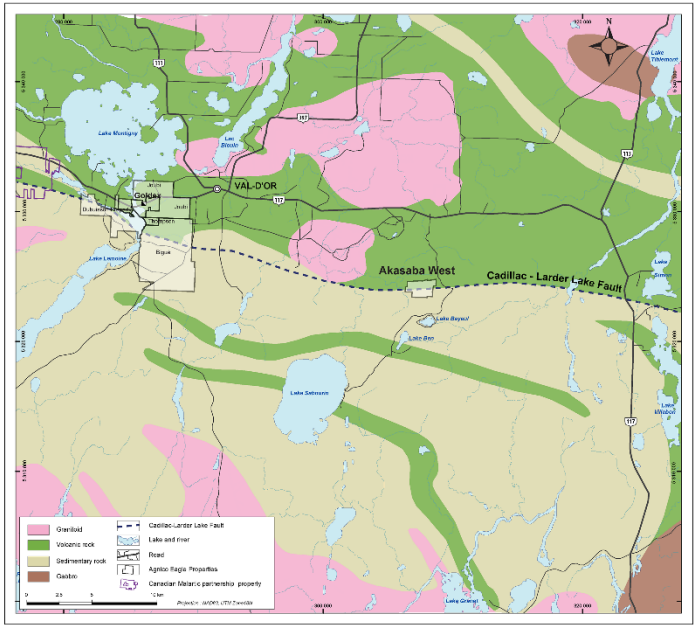
Akasaba West Project - Regional Geology Map

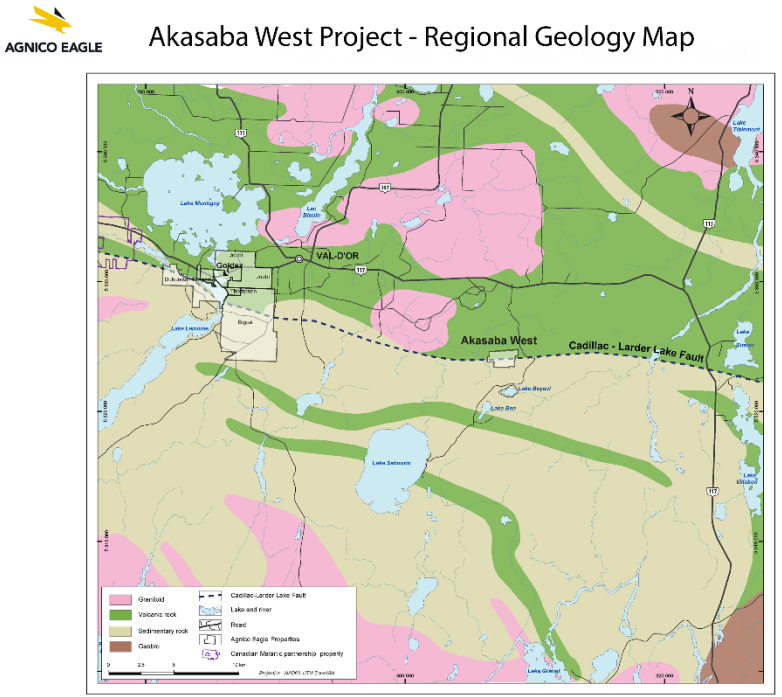


Case Study One: Waste Rock Block Model

Akasaba West

- Working with project geologists, re-sampled much of the drill core and analysed for carbon and sulphur

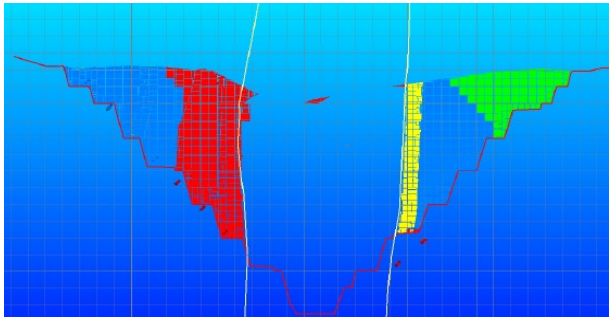
- Block model developed for waste zones using similar process as would be done for ore
  - Blocks with NP/AP < 2 = PAG
  - Blocks with NP/AP > 2 = non-PAG

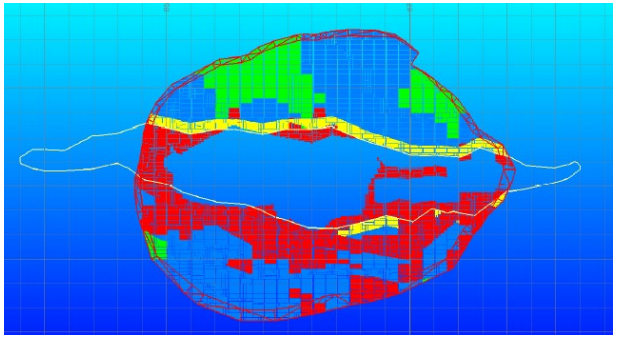


Case Study One: Waste Rock Block Model

Akasaba West

- Outcome was a 30% reduction in the amount of PAG waste rock needing to be handled
- Other benefits include:
  - Sequencing/timing of when PAG will need to be managed
  - Cover cost reduction (if used)
  - Better availability of construction rock
  - Backfill options for PAG rock if NPV approach is changed
  - Less risk and less cost (~$1M to $10M)





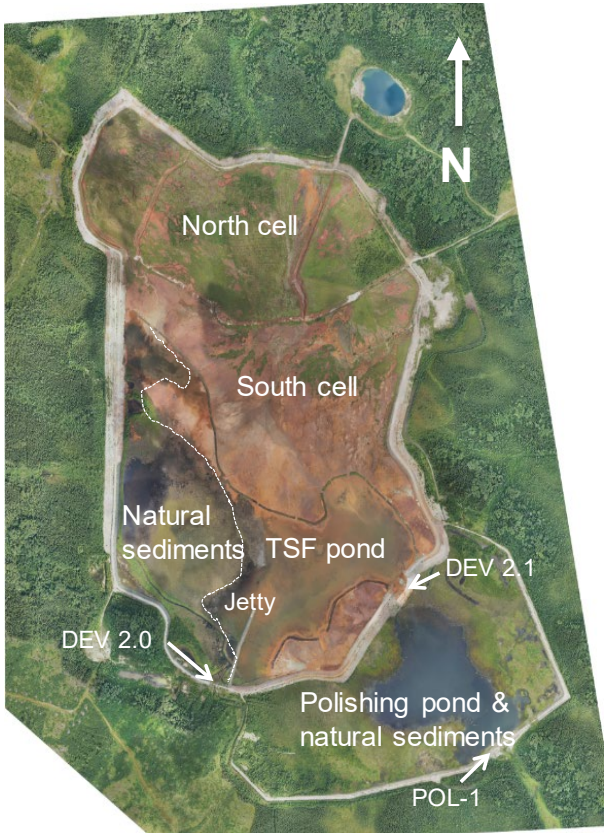
Colour code for the blocks:

- blue and yellow = non-PAG
- yellow = proximal to ore
- red = PAG
- green = no information.

Case Study Two: Tailings Management

Joutel TSF

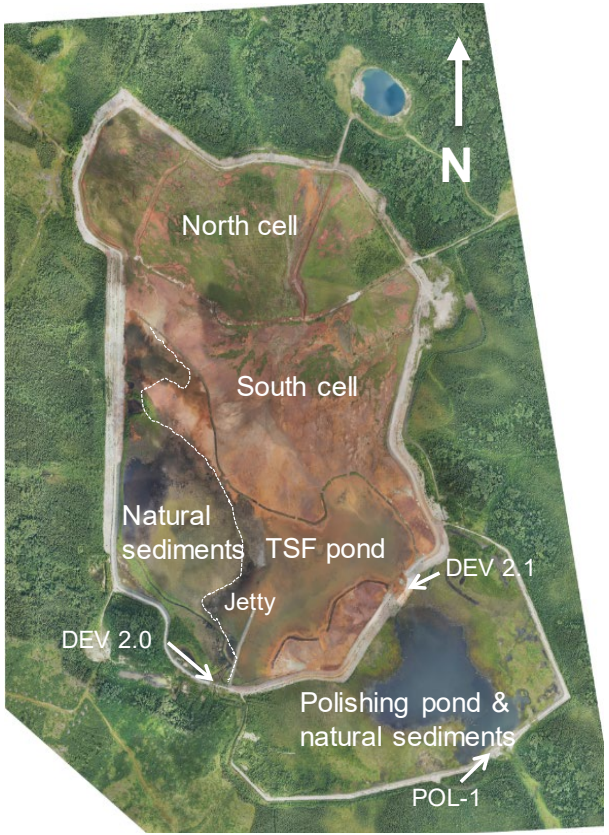
- Former tailings facility for the Eagle and Telbel mines, located near Joutel, Quebec.
- Operated between 1974 and 1993, floting a sulphide concentrate to extract gold
- A lot of the carbonate in the tailings is an iron carbonate (siderite), which does not consume acidity under atmospheric conditions



Case Study Two: Tailings Management

Joutel TSF

- ARD developed eventually, although natural alkalinity in the polishing pond maintains discharge at neutral conditions
- The site provides an opportunity to evaluate at least three scenarios to compare costs based on potential tailings management scenarios
  - Business as usual
  - Actual case
  - Optimized case



Case Study Two: Tailings Management

Joutel TSF

- The closure cost estimation tool “Reclaim” was used to estimate reasonable costs in the evaluation

- **Scenario 1: Business as usual (BaU)**
  - Assume developed today with today’s regulatory context, but existing practice
  - PAG management would have been needed and a geomembrane cover assumed

Case Study Two: Tailings Management

Joutel TSF

- **Scenario 2: Actual Costs**
  - Approximate costs incurred since operations ended, including annual maintenance, research fees, consulting fees, trials to manage ARD, etc
  - Biggest cost difference is removal of geomembrane as weathered out surface needs to have water removed, not have oxidation stopped

Case Study Two: Tailings Management

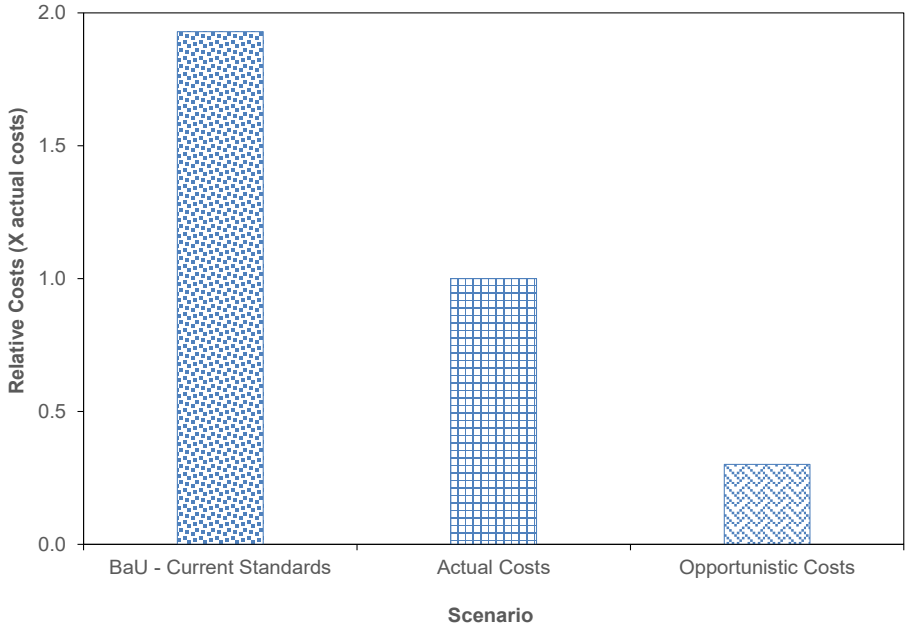
Joutel TSF

- **Scenario 3: Opportunistic**
  - This scenario assumes the tailings were placed today with leading practice and the ore geochemistry was well understood
  - Tailings separation (flotation removes sulphides, but during operations were co-mingled)
  - PAG tailings for paste backfill or sub-aqueous disposal (paste backfill practice did not exist during project life)
  - CAPEX and OPEX included new tailings lines to separate PAG tailings
  - Only a vegetation cover required

Case Study Two: Tailings Management

Joutel TSF

- Potentially a 70% cost decrease could have been realized
- Also lower risk and less resources from mining company
- NPV cost estimation would have made the closure costs seem insignificant at the time (> 20 years out)



Take Home Messages

aka Concluding Remarks

- Geochemical management of mine waste can positively impact a mining business and lower environmental risk.
- These case studies are just two of what are likely countless opportunities in the mining industry.
- How we as an industry look at closure costs needs to change if innovative ideas are going to have a chance to be put into practice.

Thank-you!

- Questions & Discussion