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C O R P O R A T I O N

Acid Rock Drainage Management at La Mine Doyon

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November 28, 2007

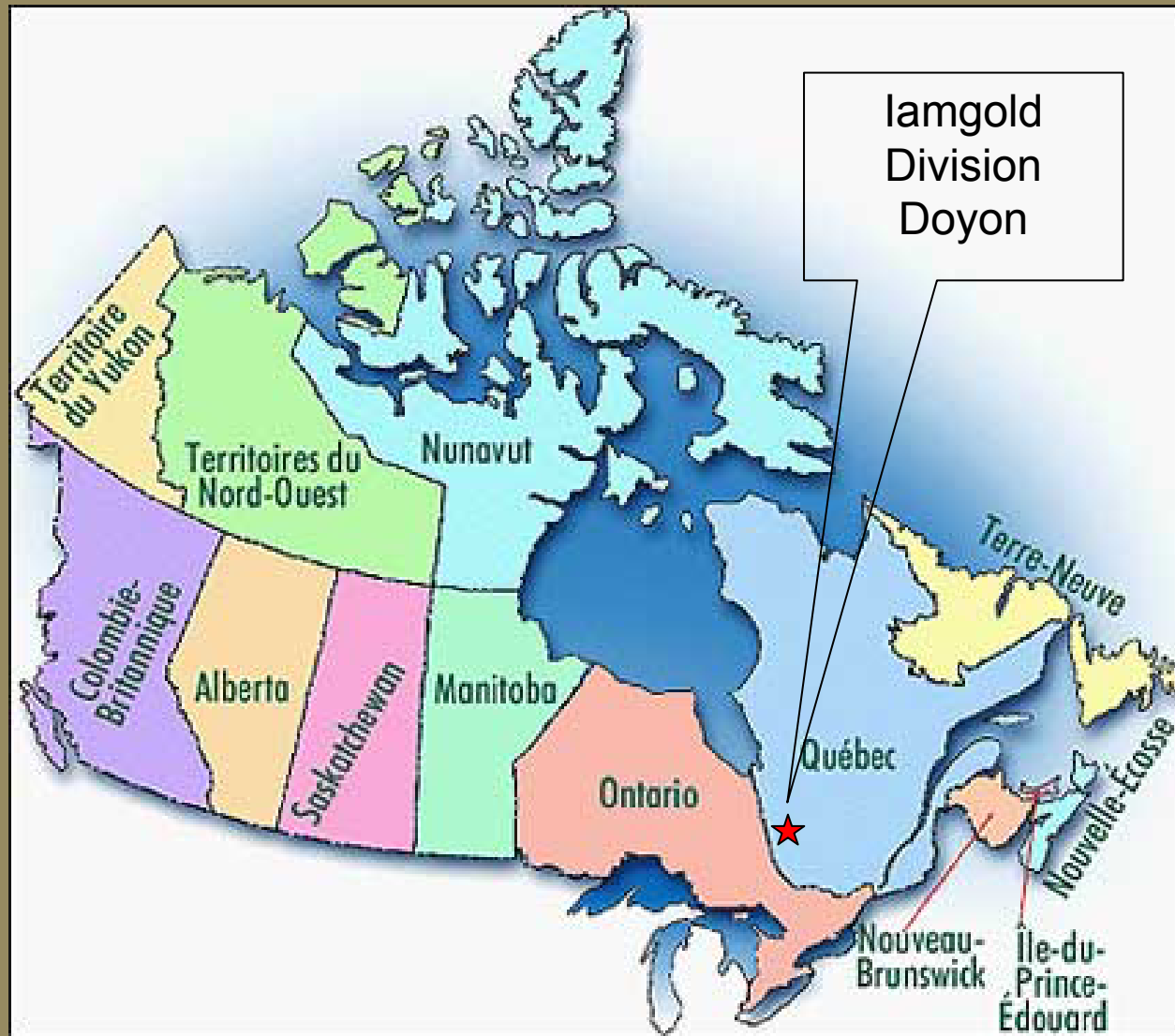


Summary

- Site location
- History of problem
- ARD info
- Water treatment
- Studies on the south waste pile
- Reclamation



Location



Iamgold, Doyon division

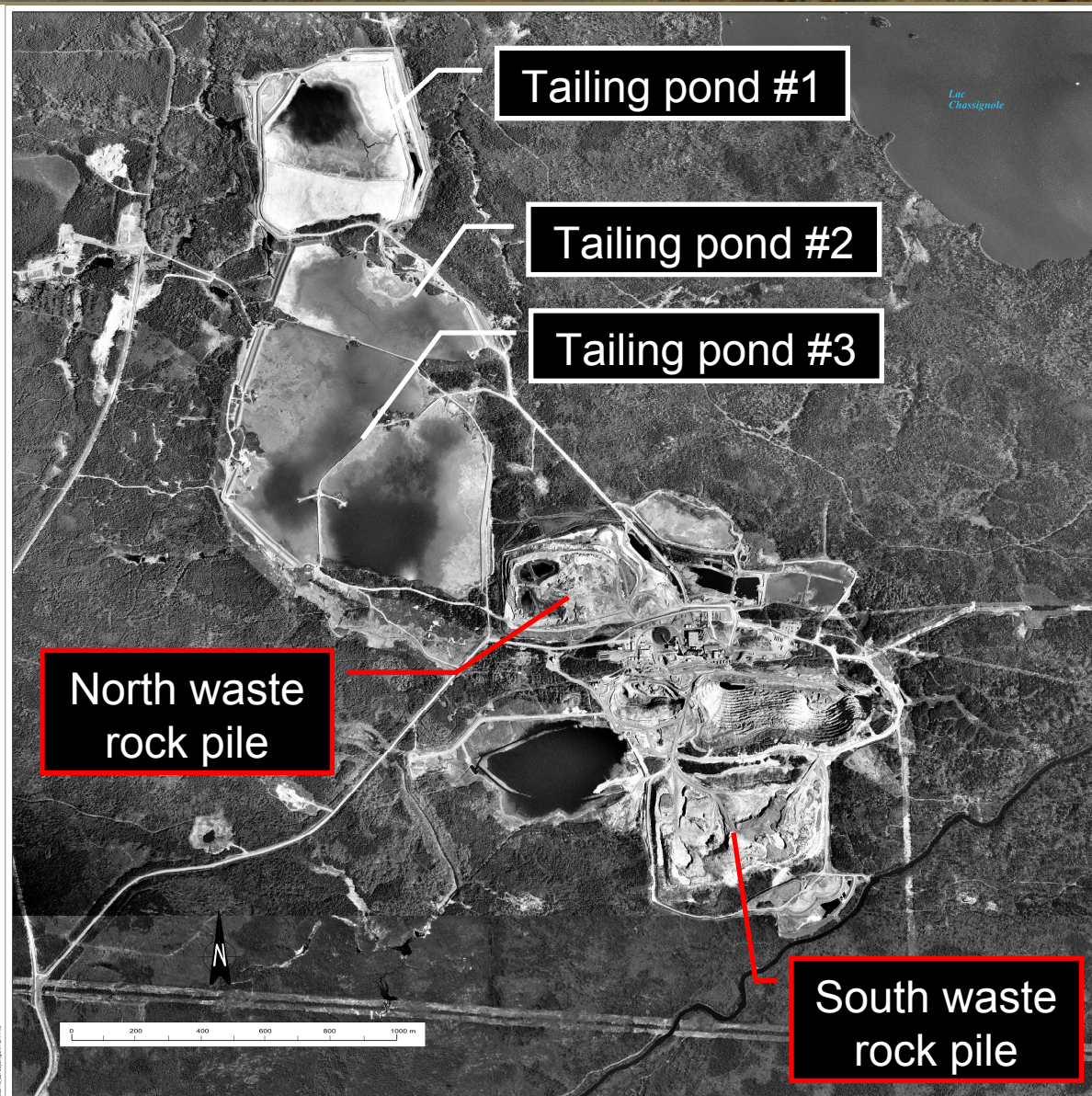


Figure 2 - Plan de surface de la mine Doyon et schéma de gestion des eaux

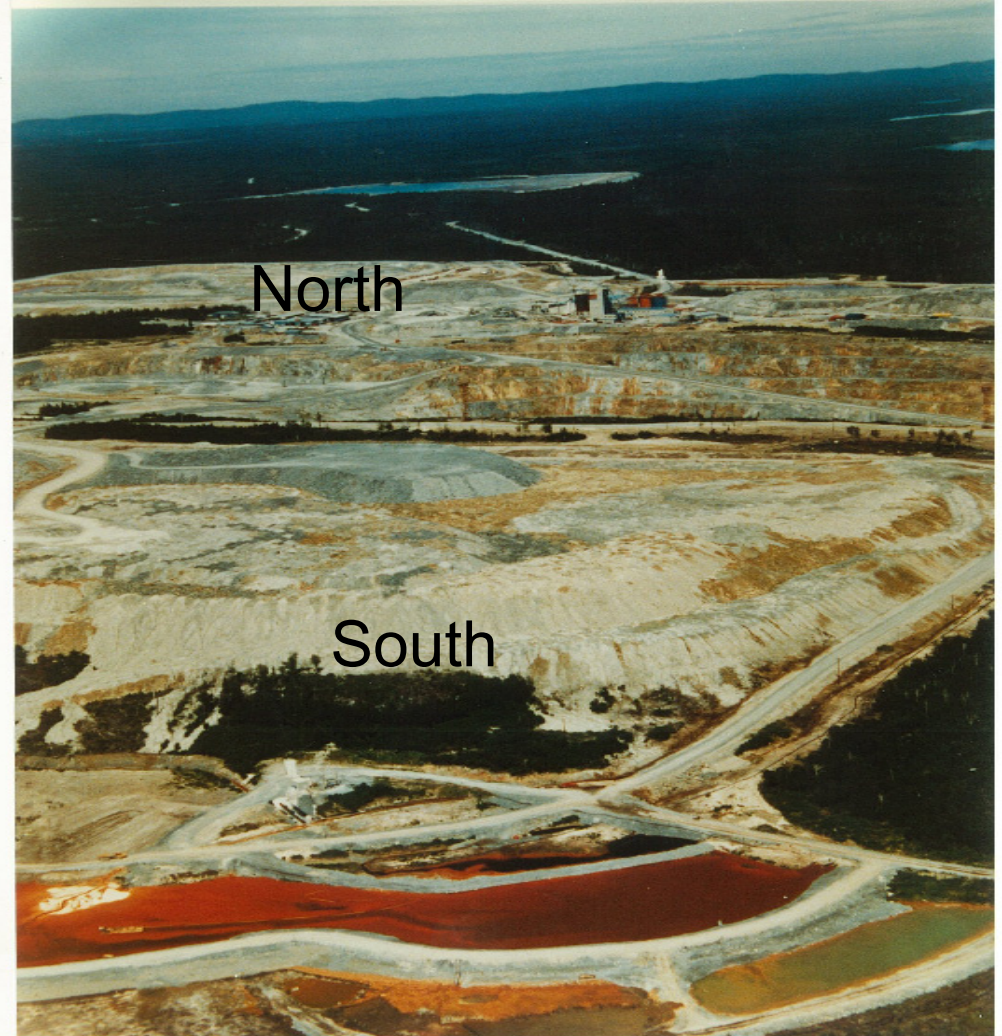
Doyon Production Stats

- Open pit operation from 1978 to 1989
- Underground from 1985
- Gold > 5.1 M oz
- Mill capacity of 3300 tons/day
- Doyon and Mouska ores are milled at Doyon
- Copper flotation circuit since April 2007



Waste Rock Dumps

- >50 M tons of PGA rock
- 2 waste rock piles covering 106 Ha
- North rock pile was first build and received the overburden and PGA rock
- Most of the PGA rocks are in the south waste rock pile
- ARD collection system to contain drainage





Waste Rock Types

Types	sulfite content (% pyrite)	Proportion of the waste piles (%)	NNP (kg/ton)
Sericitic schists	7	50	-97
Intermediate tuffs	1.8	30	+25
Felsic volcanoclastics	5.5	15	-71

- A weighted average gives 5 % pyrite.
- Based on the relative proportion of the waste rock types, the total mass of pyrite in the whole dump is 1 million tons.

Waste Rock Types

Sericitic schists



ARD historic

- 1984 : After five years of production and 2 years after beginning the construction of the south pile:
- First observation that the waste rocks oxidized and produced ARD
- 1985 - 1989 : Conventional Treatment Processing with 2 lime plans
- 1990 : Construction of the High Density Sludge (HDS)



ARD



	ARD Average	ARD Max	Treated Water
pH	2.5	2.0	7 - 8
Acidity mgCaCO ₃ /l	3 400	52 000	0
Cu mg/l	4.4	5.8	0.04
Fe mg/l	650	12 250	0,32
Zn mg/l	2.2	3.5	0.02
SO ₄ mg/l	4 300	86 900	2 200
Volume m ³ /year	3.8 M	4.8 M	---



Acid water breakdown

- Waste rock stripped from the initial pits was used for backfill in the plant site
- More $> 5 \text{ M m}^3$
- Dams and road of the tailings pond # 1 were constructed using acid generating waste rock



ARD Breakdown

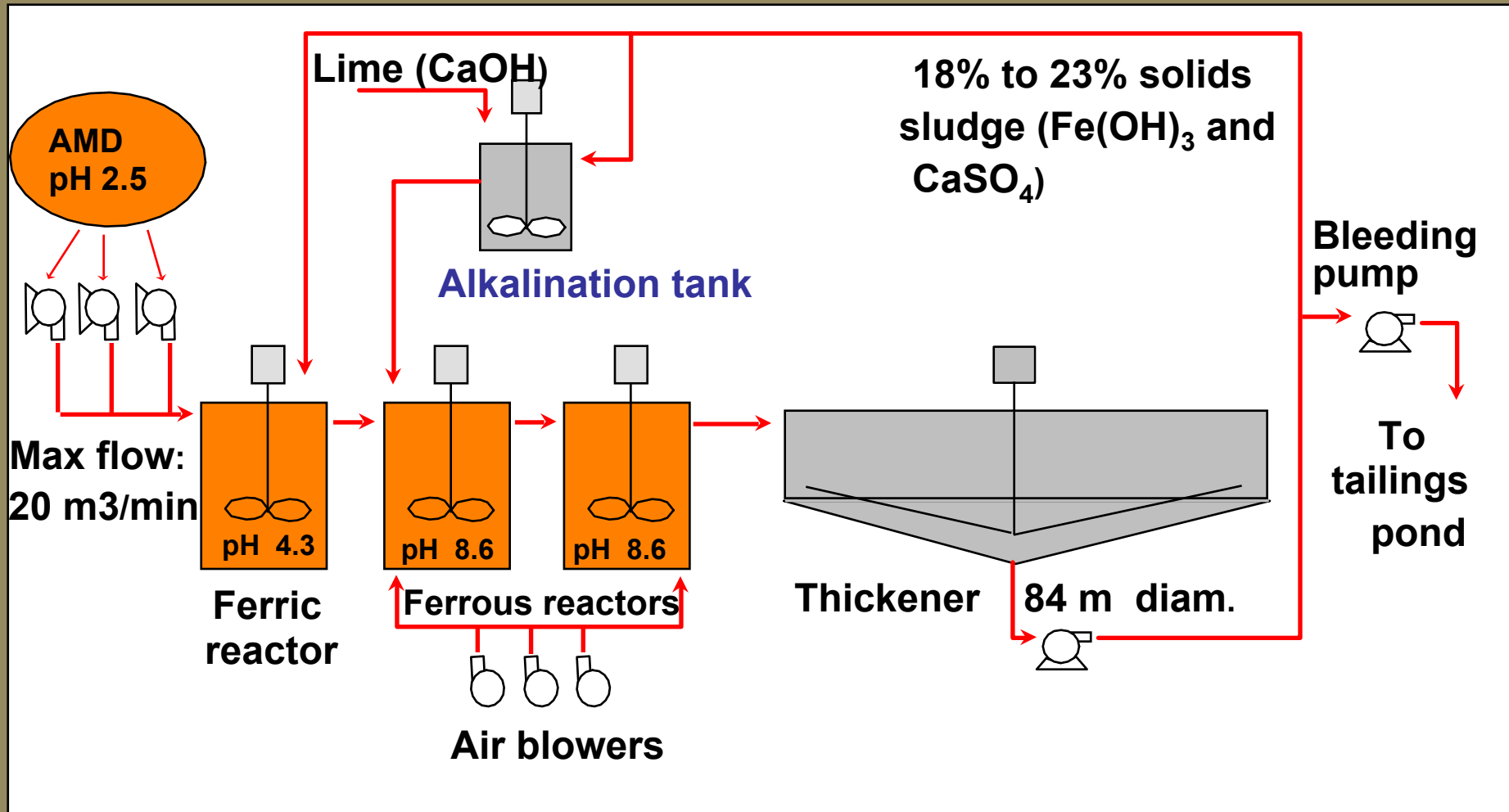
Origin	Annual Volume m ₃	Acidity MgICaCO ₃	Acidity charge Tons CaCO ₃	Acidity Charge %
South Dump	205 000	42 000	8 610	65 %
North Dump + Yard and roads	1 612 000	1 803	2 906	22 %
Underground water + pits	1 000 000	1 600	1 600	12 %
Pond #1	375 000	380	143	1 %
Other Ponds	608 000	5	3	0 %
Total	3 800 000	3 490	13 262	

High Density Sludge Plant (HDS)



- Normal operating flow rate of 2 500 USG/m 7.2 m³/min
- Maximum capacity of 5,000 USG/m emergency flow rate
- 84 m diameter tickener, flocculants addition
- Operate at 8.2 to 8.5 pH for optimum metal removal
- Sludge 25 % solid
- Sludge disposal at the tailings ponds with the tail of the mill
- Treated water to the polishing pond → final effluent

HDS Neutralization Plant Flowsheet



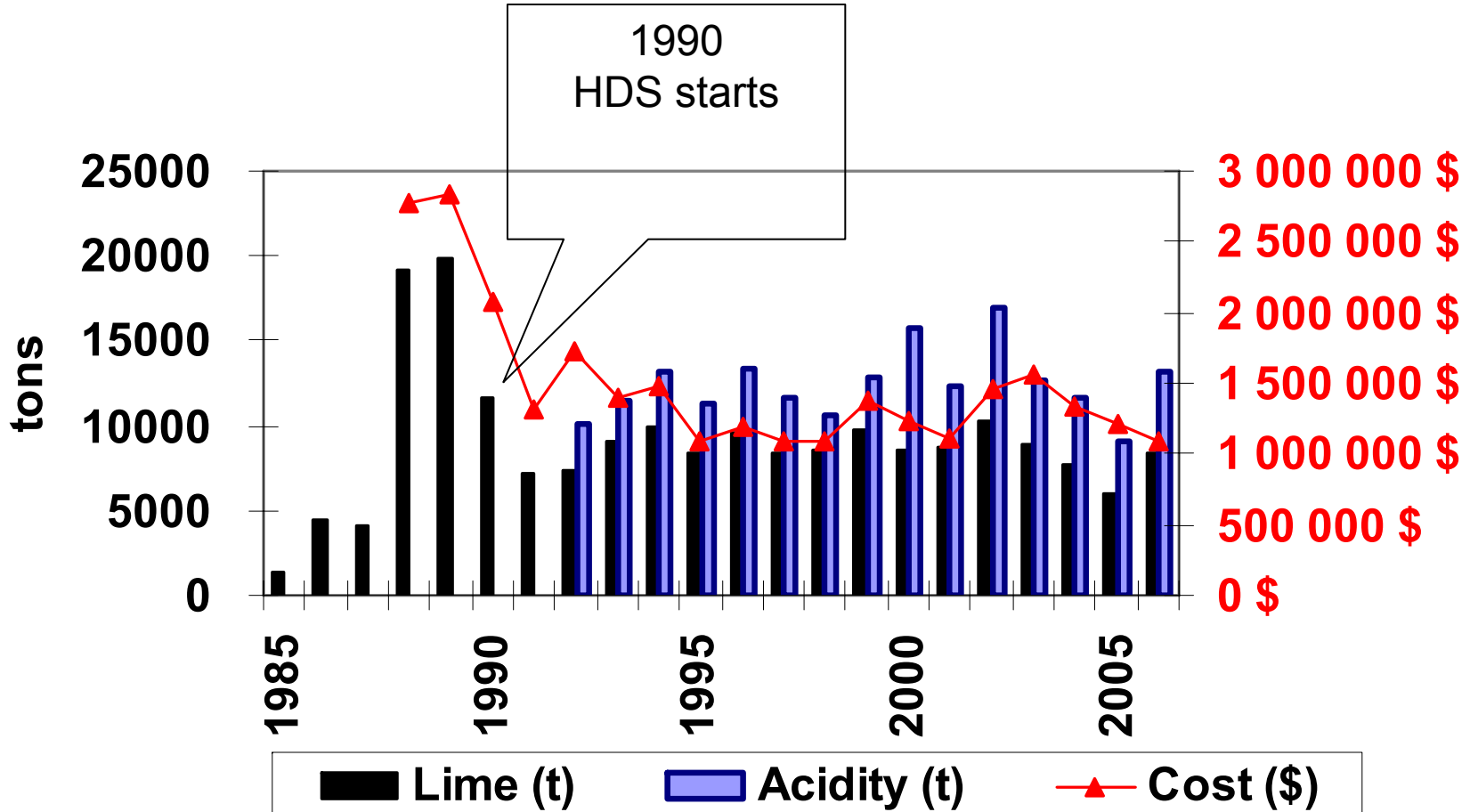
ARD Management

- ARD collection system to contain drainage all over the site
- Storage ponds
- Design respect recurrence 1/100 years
- Automatic pumping systems for the pumps and the sumps.



Lime Consumption

HDS treatment plan



Environmental Effects Monitoring

- Biological Monitoring Studies : Every 4 years (MMER)
- Beginning in 2004, made this fall (2007)
- Environmental health of the Bousquet river with a reference and an exposure areas
- Includes:
 - Sublethal toxicity testing
 - Water quality monitoring
 - Fish: population, health, metal levels
 - Benthic Invertebrates community: population and diversity

Ceriodaphnia and Rainbow trout bioassays quarterly



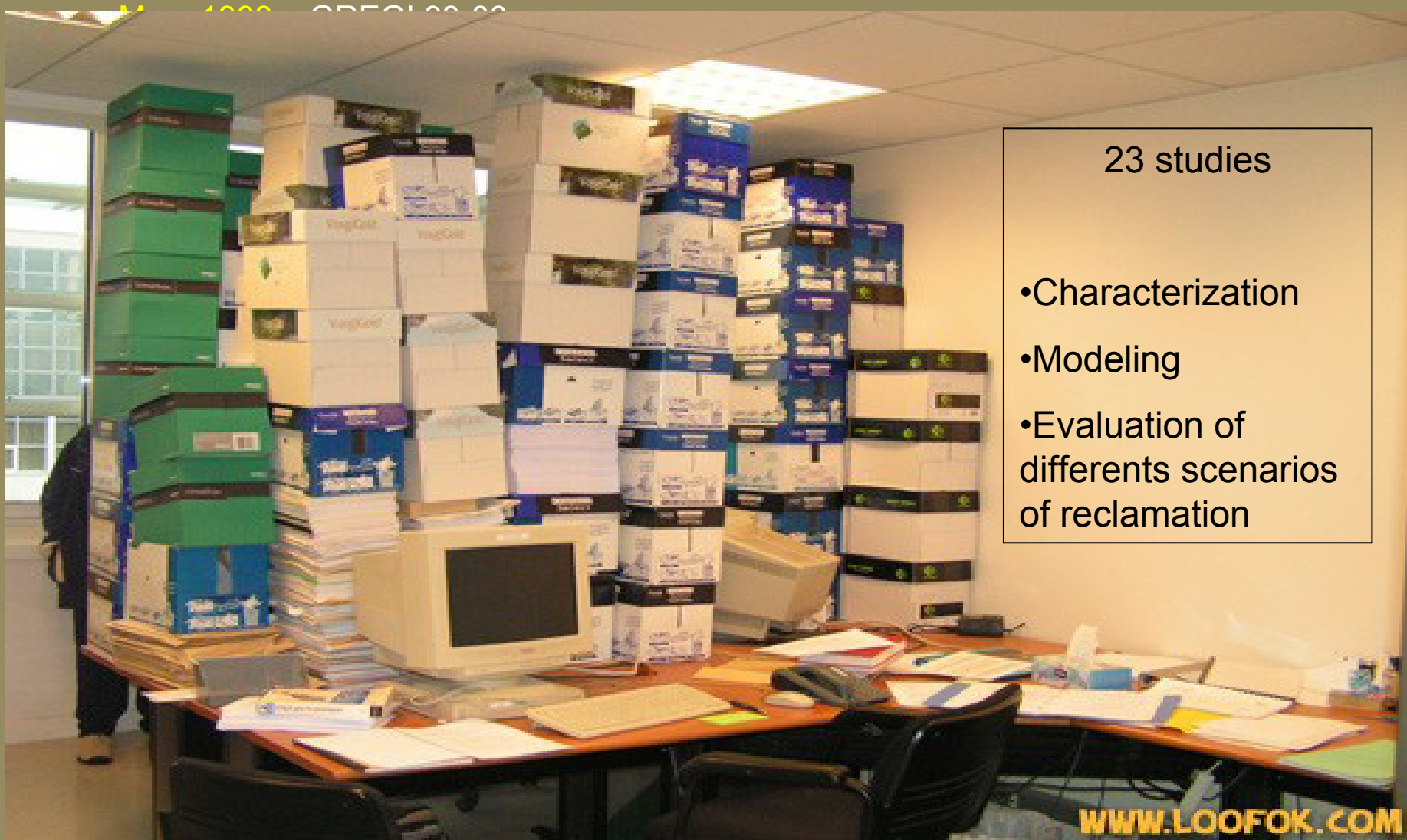
South waste rock pile

- Built from 1983 to 1988
- Close to the open pits, in an area that sloped down towards Bousquet river
- 30 M tons of PGA rocks
- Reaches 30 m high
- Received the waste rocks from the main pit, minor quantity of overburden and less reactive waste rocks from the west pit



- **Septembre 1992** – P. Gélinas – Monitoring of AMD in a waste rock dump
- **Novembre 1992** – GREG 92-19 – Monitoring et modélisation du DMA des haldes de stériles – Doyon – Phase II
- **Décembre 1992** – Met-Chem Pellemon – Solution permanente au processus d'acidification par colmattage imperméabilisant

South waste rock pile studies

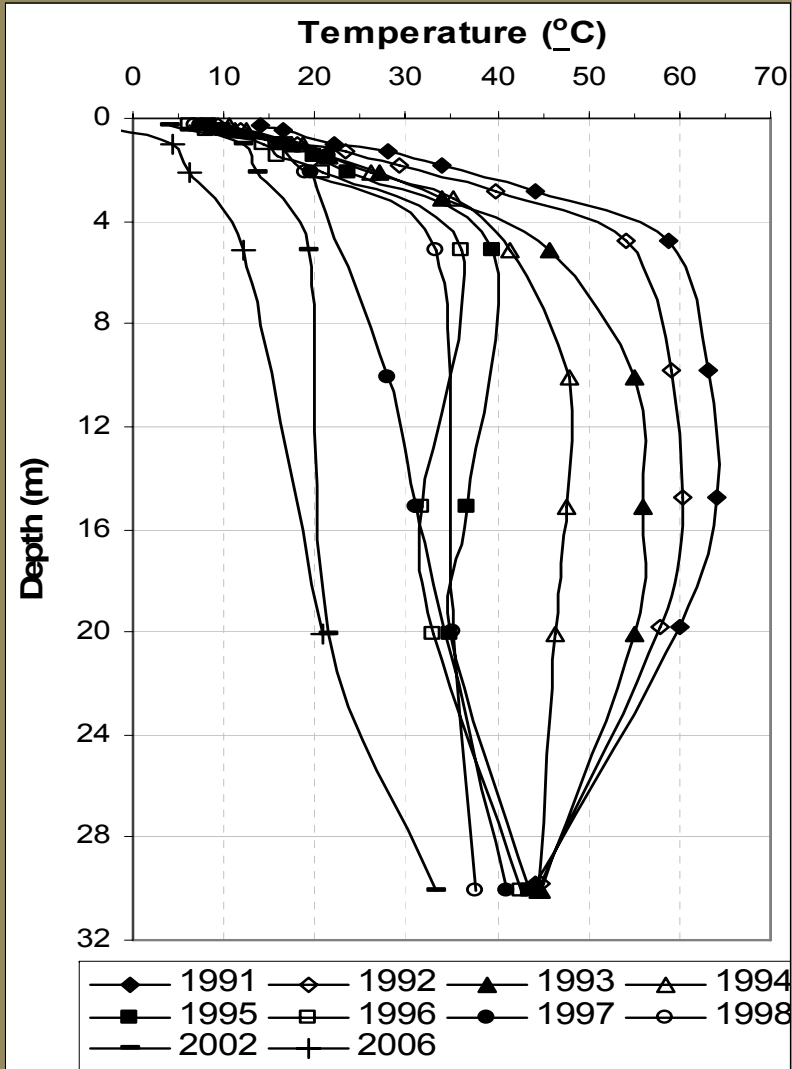


23 studies

- Characterization
- Modeling
- Evaluation of different scenarios of reclamation

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South Waste Dump Internal Temperatures



65 °C



Closure scenarios studied

For the South waste rock pile :

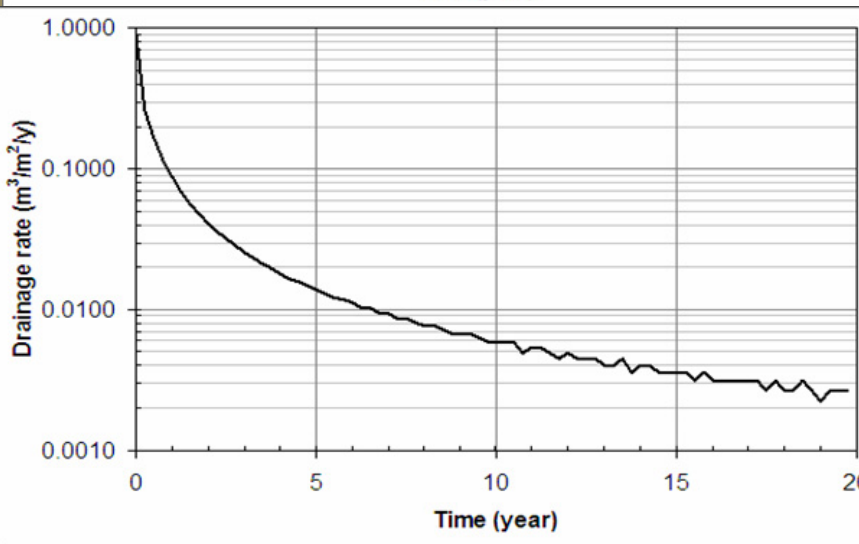
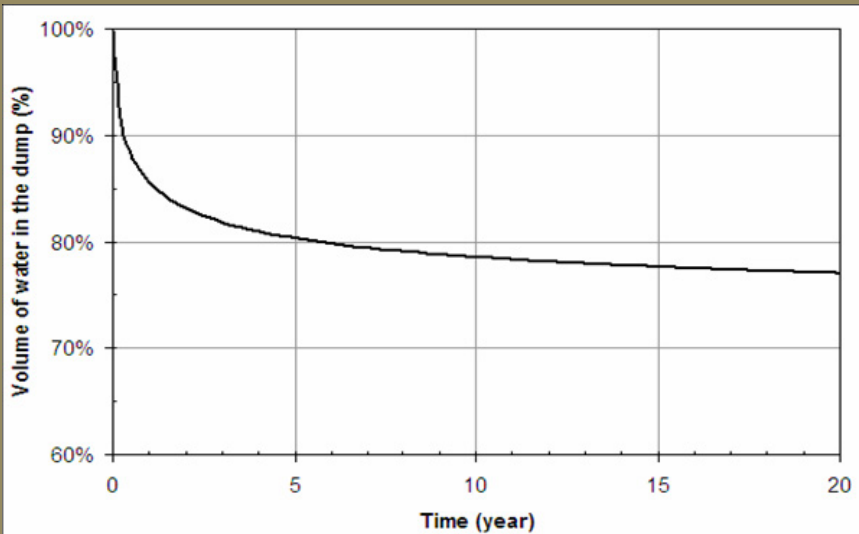
- Move all the rocks in the pit
- Do nothing
- Glacial till cover
- Sludge incorporation cover
- Multilayer cover
- Synthetic liner

Options that needs more study :

- HDPE liner everywhere, in the steepers, on the flat area?
- Paste rock cover?



Drainage of the dump after covering - Preliminary Simulation



We learn that the dump can lose:

- 10% of its initial volume after 3 months;
- 17% after 2 years;
- 20 % after 5 years;
- closer to 20 years, the loss represents 23 % of initial volume
- the rate of drainage is very high at the beginning
- (0.94m³/m²/yr) after 3 months.
- 0.0027 m³/m²/ after 20 years,
- Most of the leachate will remain in the dump in residual form, retained by capillarity.

Tailings Ponds reclamation

Water Cover for the ponds 2 and 3

177 HA



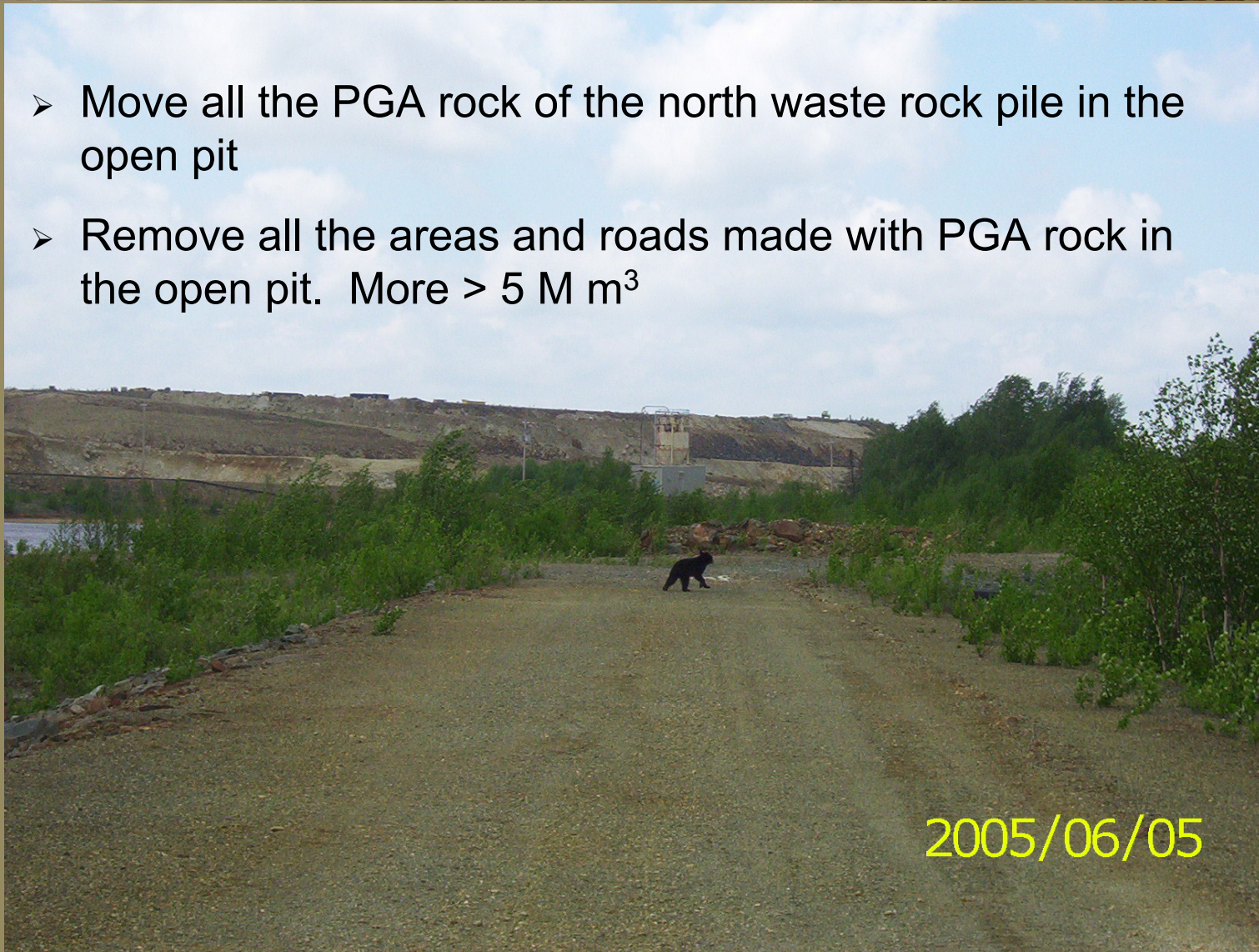
Tailings Ponds reclamation

Multilayer cover for the pond 1
experimented cells were constructed this summer



Reclamation

- Move all the PGA rock of the north waste rock pile in the open pit
- Remove all the areas and roads made with PGA rock in the open pit. More > 5 M m³



Sustainability

Futur : Westwood





La mine Doyon, été 1999



Questions





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