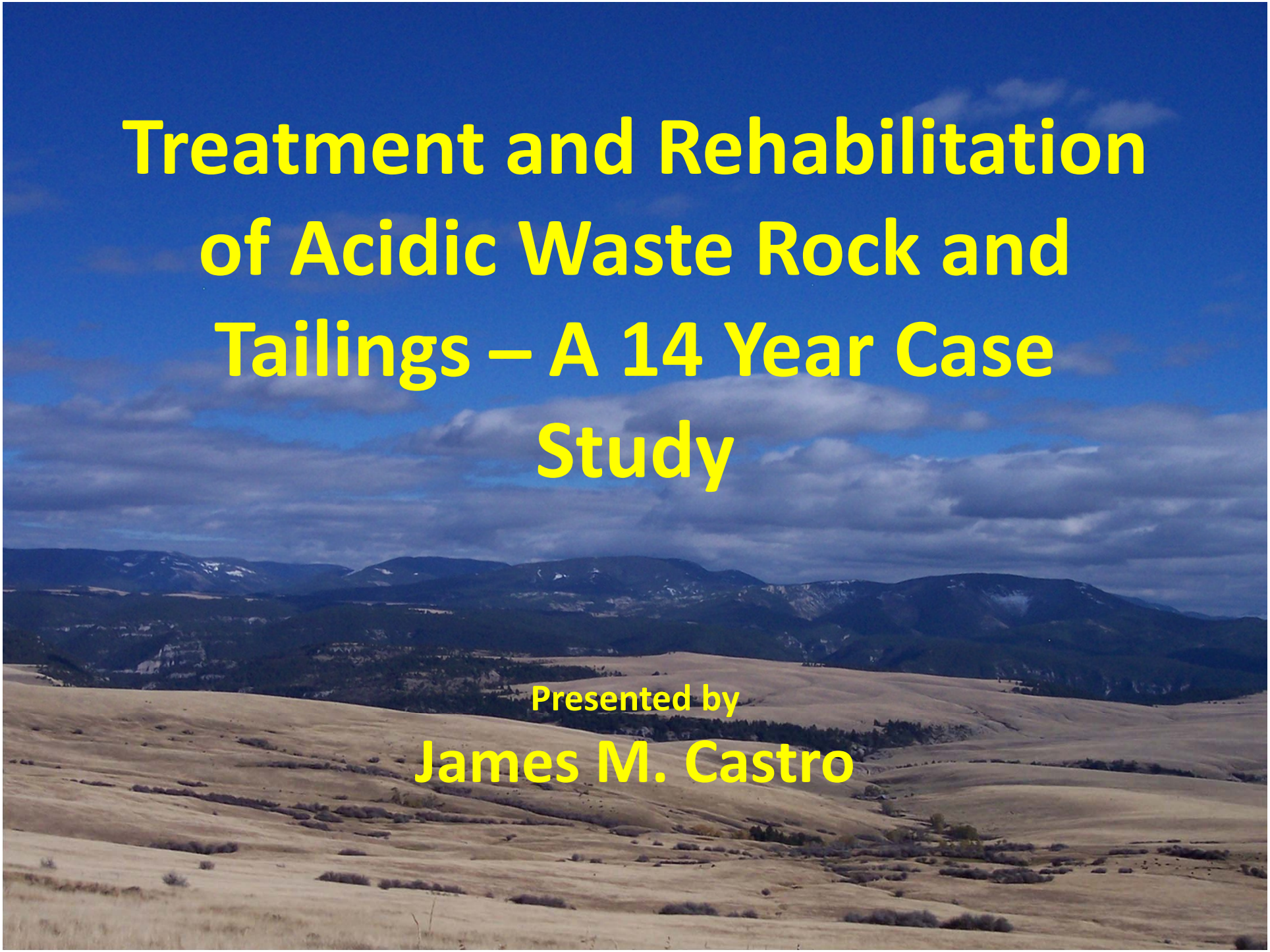


Treatment and Rehabilitation of Acidic Waste Rock and Tailings – A 14 Year Case Study

Presented by

James M. Castro

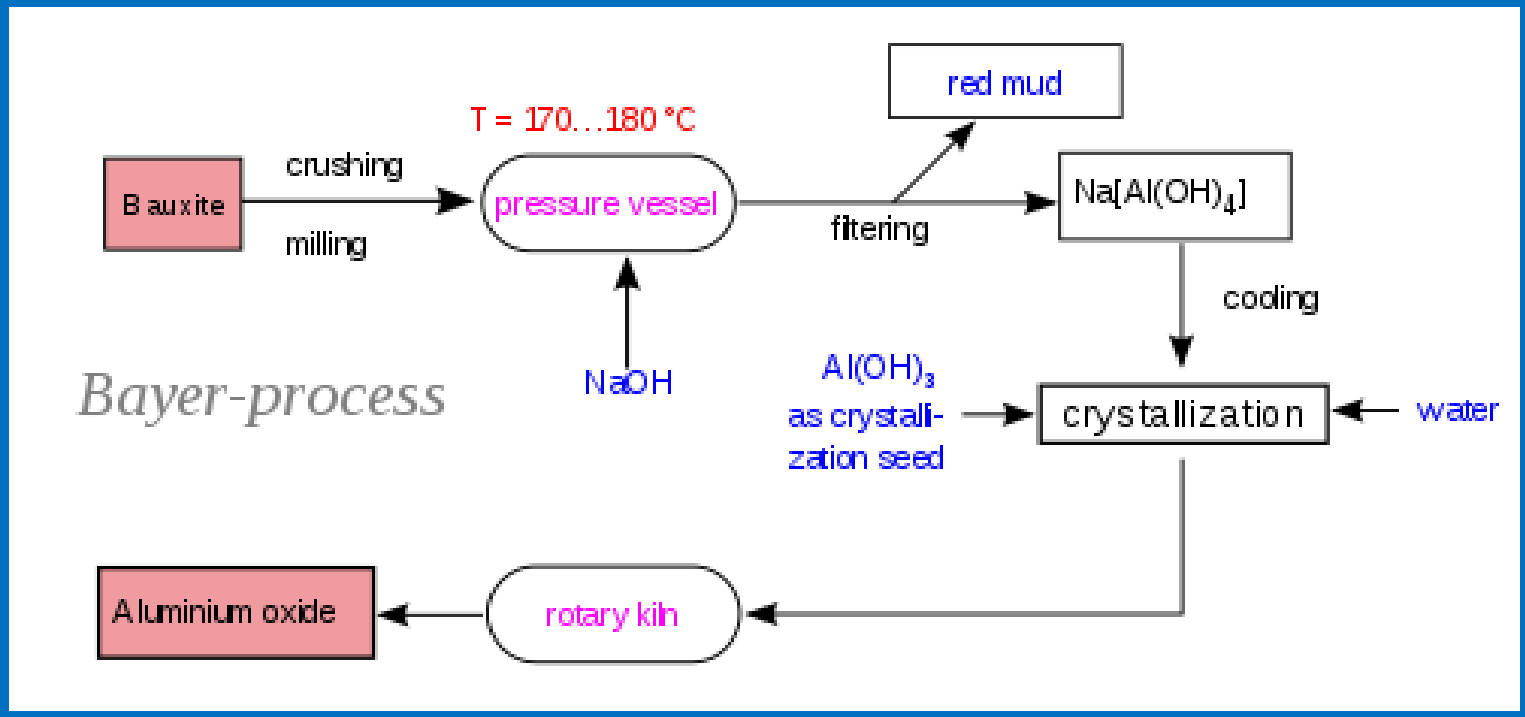

Original Paper:
L. Fergusson, D. Blair, and T. Scutts. Treatment and Rehabilitation of Acidic Waste Rock and Tailings – A 14 Year Case Study. Proceedings, Life of Mine 2014 Conference, Brisbane, 16-18 July 2014.

Common Problems at Precious and Base Metal Mines with Sulfide Ores:

- Acid rock drainage
- Neutral metal leaching

A possible solution to these problems originated as a waste product in the aluminum industry.

Bauxite is refined using the Bayer Process



Red Mud Properties

- pH ~ 13
- Gelatinous, high water content; hard to drain.
- Hard to reclaim the ponds.
- Depending on source of bauxite, may contain heavy metals in addition to Fe.
- Few industrial applications.

Queensland Alumina Red Mud Handling

- As a fresh water conservation measure, the red mud is piped to the pond in a slurry with seawater.
- The pond is also flushed with tidewater every day.
- As a result the red mud at QAL is neutralized by seawater.

Virotec International

- Seawater-neutralized red mud was commercialized by Virotec.
- The company was formerly known as Mount Carrington Mines.
- The trademark for the seawater-neutralized red mud products is Bauxsol ™

Properties of Bauxsol

- Moderate pH
  - Saturated paste pH ≈ 10
  - 1:5 soil reaction pH ≈ 8.6
- Metal binding capacity almost 1500 mg/kg
- Alkalinity is primarily solid (e.g., carbonates)
- Acid neutralizing capacity = 4-7 mol/kg @ pH 7

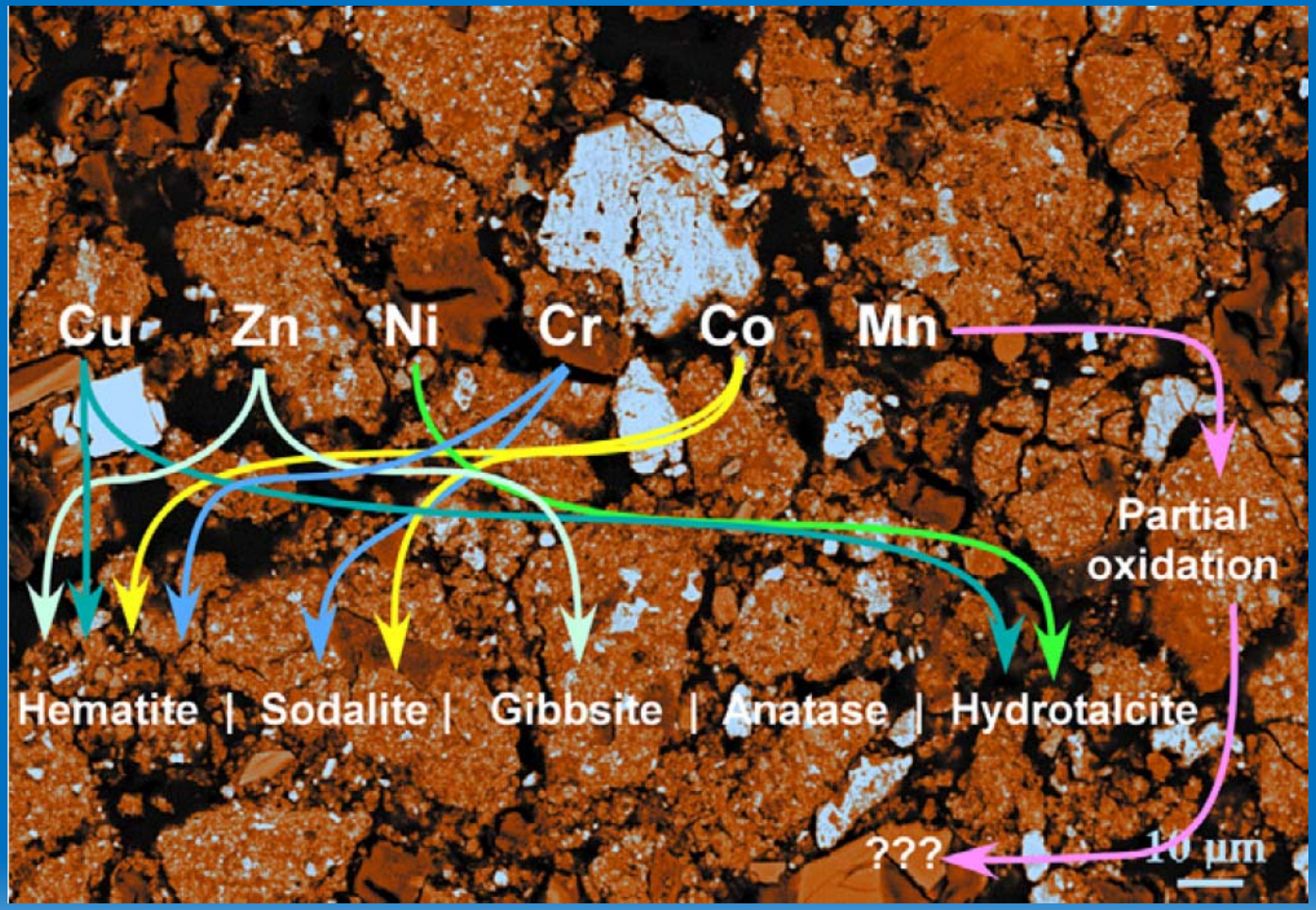
Major Minerals in Bauxsol

- Hematite (Fe_2O_3)
- Boehmite (γ-AlOOH)
- Gibbsite ($Al(OH)_3$)
- Sodalite ($Na_8Al_6Si_6O_{24}Cl_2$)
- Quartz (SiO_2)
- Cancrinite ($Na_6Ca_2Al_6Si_6O_{24}(CO_3)_2$)
- Hydrotalcite [$Mg_6Al_2(CO_3)(OH)_{16}\cdot 4H_2O$]

Minor Minerals in Bauxsol

- Meixnerite [$Mg_6Al_2(OH)_{18}\cdot 4H_2O$]
- Anatase [TiO_2]
- Aragonite, calcite [$CaCO_3$]
- Brucite [$Mg(OH)_2$]
- Diaspore [α-AlOOH]
- Ferrihydrite [$(FeOOH)_5(H_2O)_2$]
- Gypsum [$CaSO_4\cdot 2H_2O$]
- p-Aluminohydrocalcite [$CaAl_2(CO_3)_2(OH)_4\cdot 3H_2O$]
- Low-solubility trace minerals

Binding of Specific Metals



Mount Carrington Mine

- Au + Ag mine at Drake, N.S.W.
- Country rock contained subeconomic levels of Cu, Zn, and Pb.
- Waste rock was highly acid-generating.
- Drainage water from waste piles contained significant Cd, Cu, Zn, and Pb.
- Mine was closed in 1990.

Location of Mount Carrington Mine

Mount Carrington Mine Study (2000-2013): 3 Programs

1. Rehabilitation in 4 acidic waste rock areas
2. A second acidic waste rock study: variations of treatment with 5 subplots
3. Tailings beach treatment

Program #1:

3 different intervention strategies over 14 years.

1. Untreated control
2. Waste rock + $CaCO_3$ + biosolids
3. A standard capping treatment (semipermeable clay + topsoil cover)
4. Mixture of waste rock + Terra B (Bauxsol)

Program #1

- Each plot 50 m X 35 m.
- Particle size distribution in each plot ranged from fine clay to boulders (≤ 1 m diameter).
- Areas 2 & 4 mixed with treatment (5% v/v) to 1 ft depth.
- Area #3 capped with 1 ft clay + topsoil.

Program #1

- All 4 areas were planted immediately after treatment in 2000 with native tree species (Grey ironbark and golden wattle)
- Tree growth (density and height) monitored by research team.

Eucalyptus paniculata (grey ironbark)

Acacia fimbriata (golden wattle)

Program #2

- On an acidic waste rock dump ~ 1 mile SE of Program #1
- One control + 4 treatments
- Each plot 25 m X 25 m
- Grey ironbark and narrow-leaf green ironbark planted in 2000.

Program #2

1. Control
2. 8% Terra B
3. 8% Terra B + 2% biosolids
4. 12% Terra B + 3% biosolids
5. 2% biosolids only

Program #2

All 5 areas monitored for

- Soil pH
- Metal concs (Al, Mn, Fe, Zn, Cu, Ca, K, Mg, and Na as %) in leaves compared with *E. paniculata* growing in undisturbed Australian woodlands.
- Tree growth.

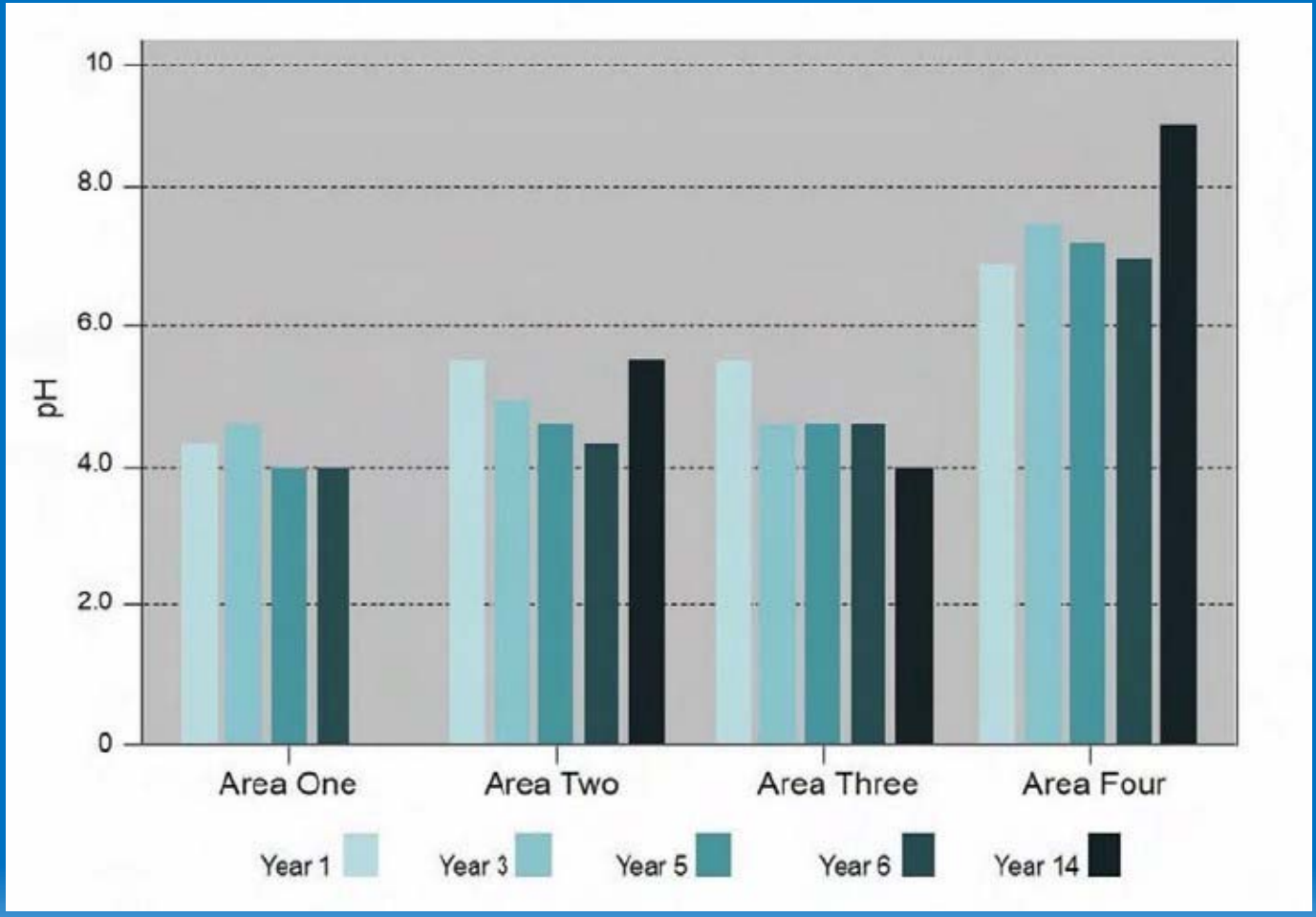
Eucalyptus crebra
(Narrow-leafed green ironbark)

Program #3
Tailings beach treatment

- Exposed tailings beach treated in 2001 with Terra B
- 3% (v/v) of Terra B added to tailings (1 ft depth)
- 100 m X 100 m area treated

Results

Program #1 Soil pH



Program #1
Total Actual Acidity (mmol/kg)

	Control	$CaCO_3$ + biosolids	Clay + topsoil	Bauxsol
2000 (before treatment)	87	87	87	87
2013	--	45	24	0

Program #1
Total Potential Acidity (%)
(Peroxide Method)

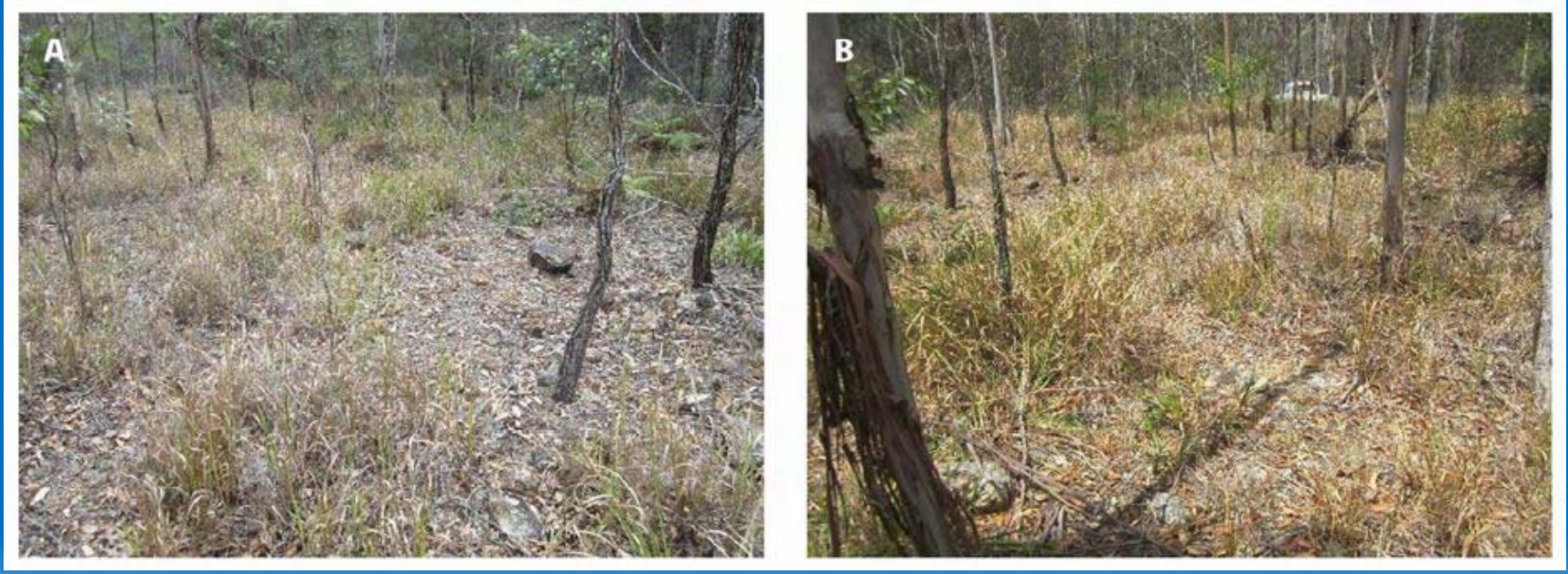
	Control	CaCO3 + biosolids	Clay + topsoil	Bauxsol
2000 (before treatment)	0.7	0.7	0.7	0.7
2013	--	0.18	0.68	0.08

Program #1
Tree growth in Area 1 (control)

2000 2013

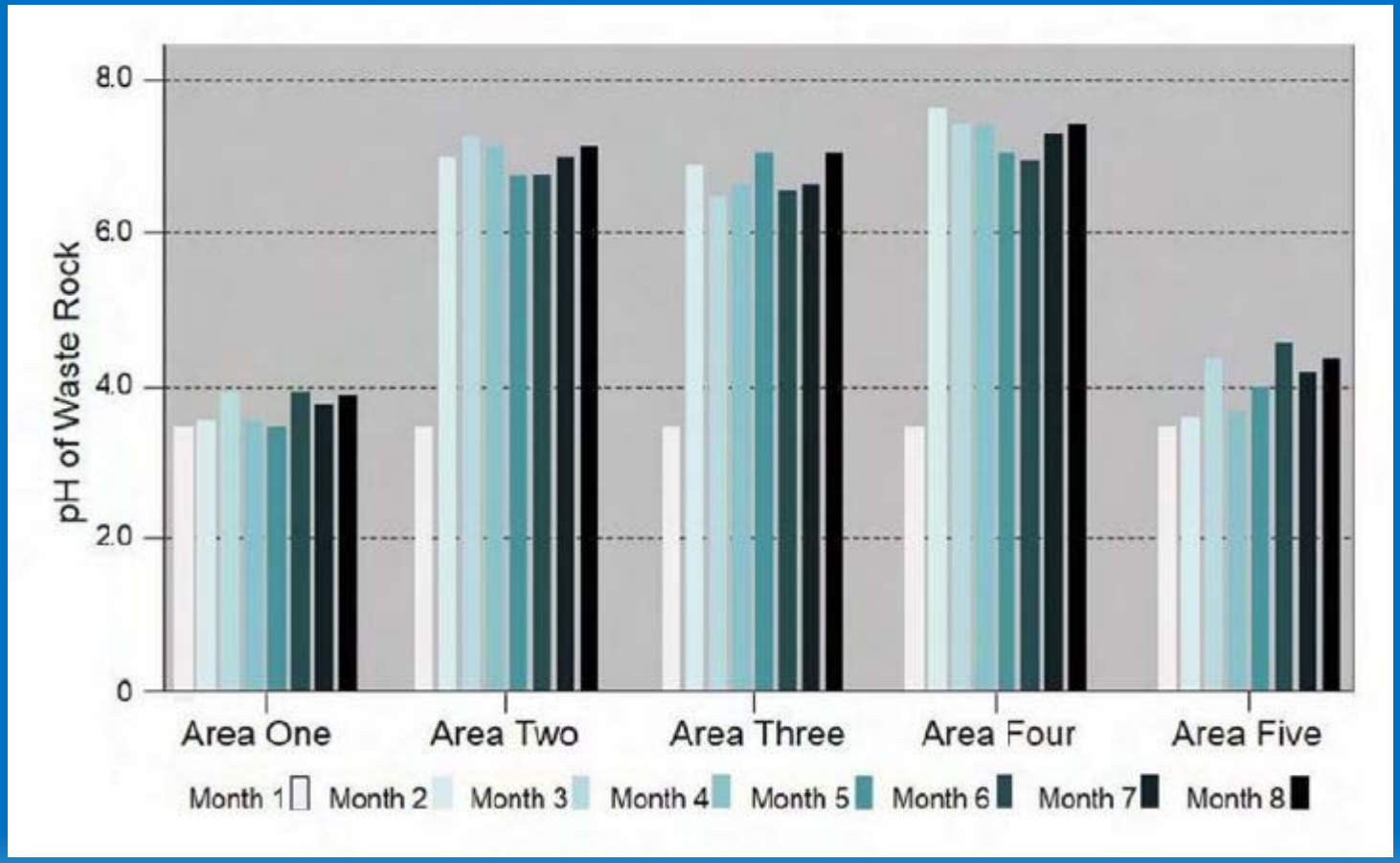
Program #1
Tree growth in Area 2 in 2013
(limestone + biosolids)

Program #1
Tree growth in Area 3 in 2013
(Clay/Topsoil Cap)

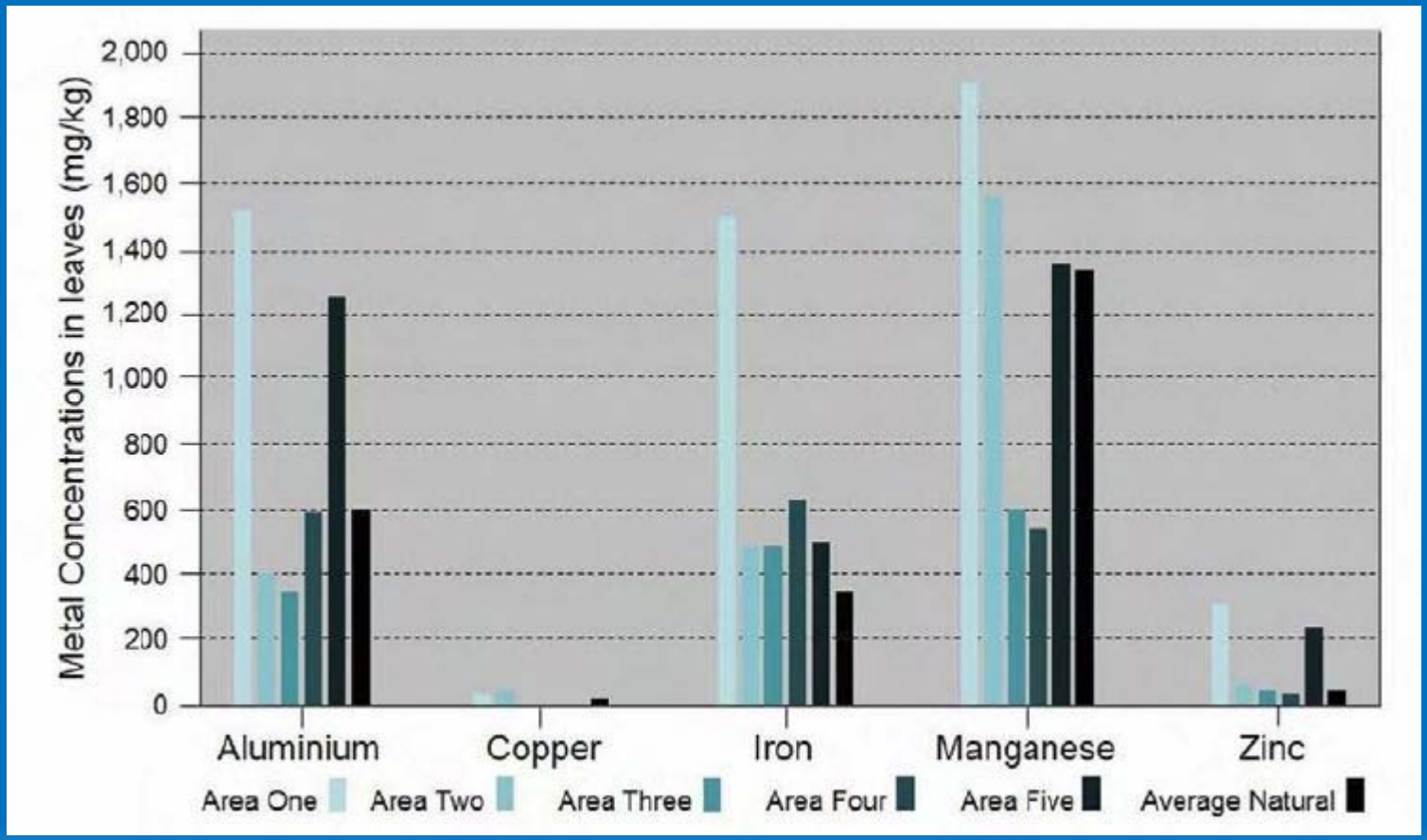


Program #1
Tree growth in Area #4 in 2013 (Bauxsol)

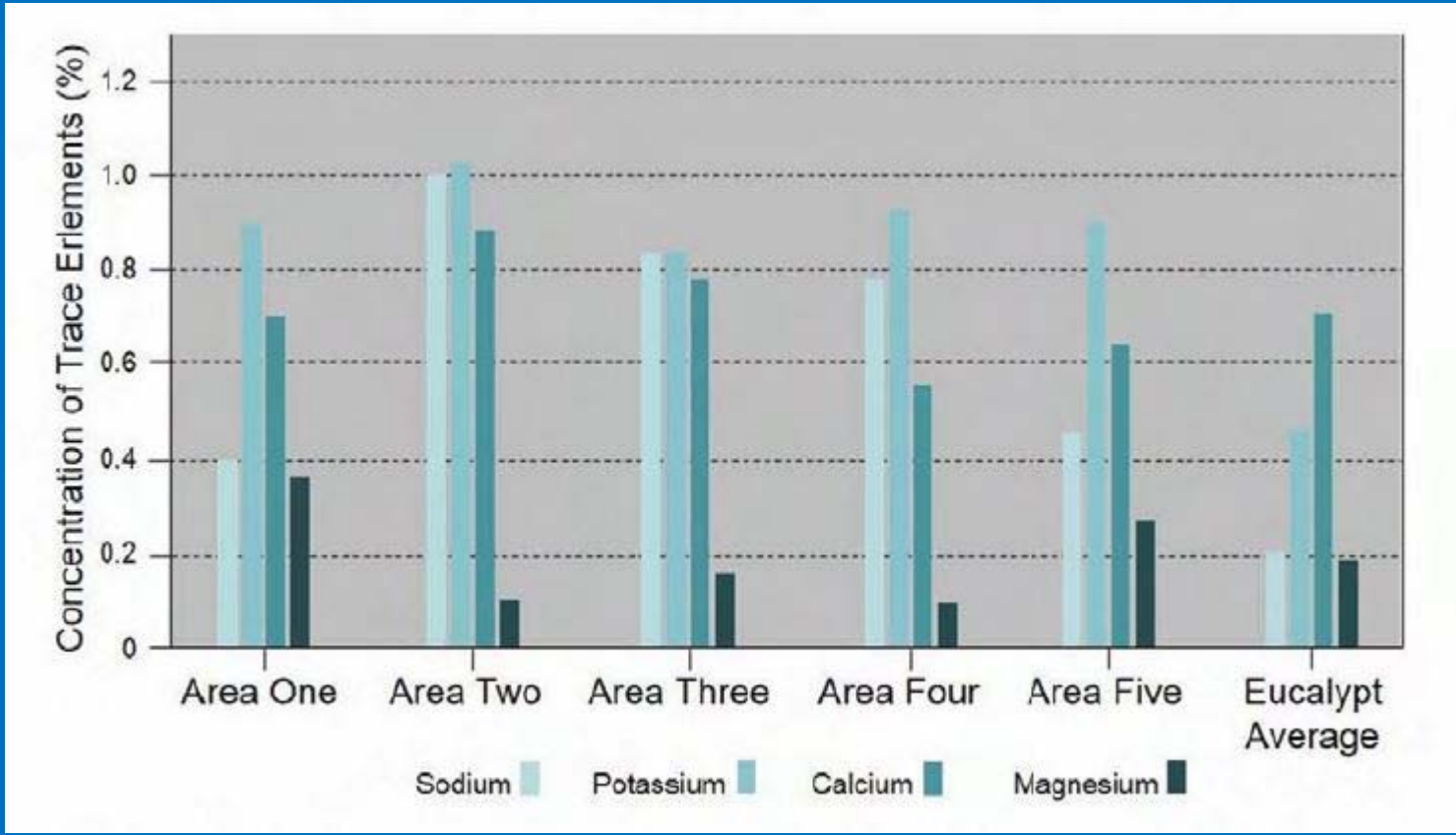
Program #2
Soil pH over an 8 month period



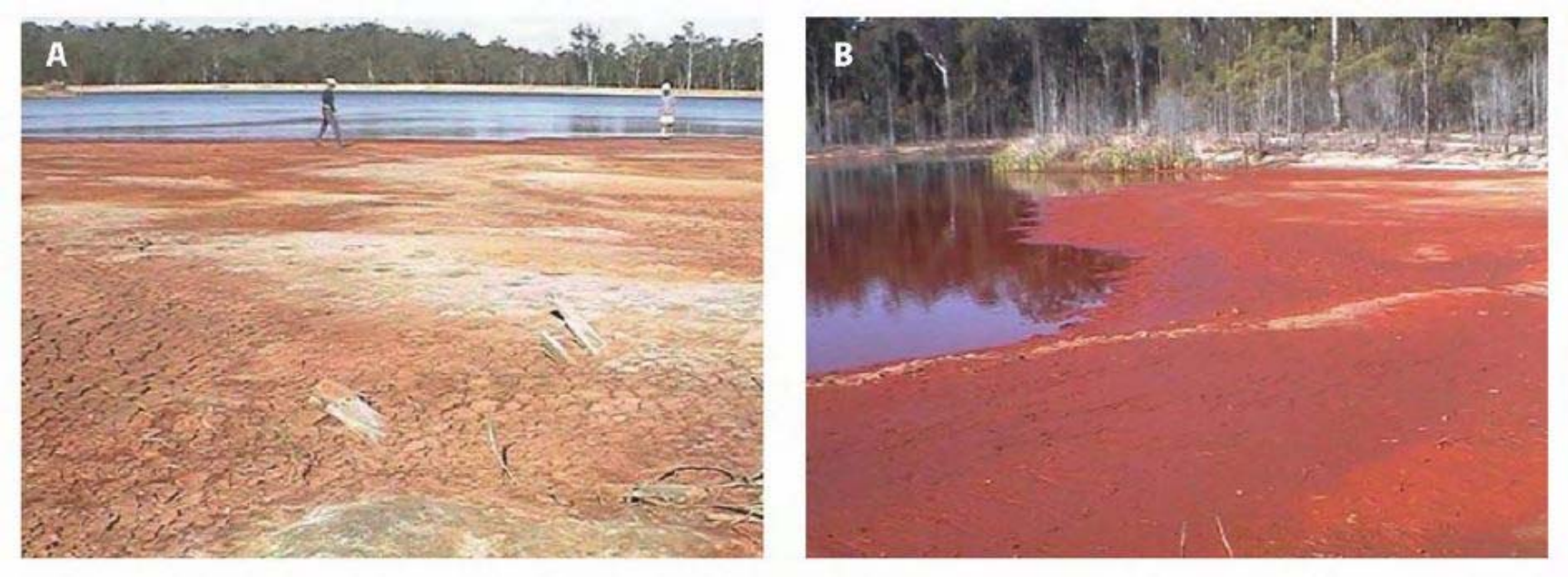
Program #2
Al & Heavy Metals in Leaves at 2 Years



Program #2
Major Metals in Leaves at 2 Years



Program #3
Tailings Beach before Treatment



Program #3
Tailings Beach in 2013

Program #3
Colonizing of Tailings Beach, 2013

Shrub (bottlebrush)

Spotted python

Conclusions

- Bauxsol (Terra B) was effective at promoting reclamation of acidic waste rock as indicated by soil pH, tree growth, and reduced heavy metal uptake by trees.
- Limestone, biosolids, and clay-topsoil cap were much less effective
- A single application of Bauxsol in the upper foot of an acidic tailings beach promoted plant growth and colonization.

For further information

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Virotec Global Solutions

http://virotec.com/


Questions?