DALHOUSIE UNIVERSITY
Inspiring Minds

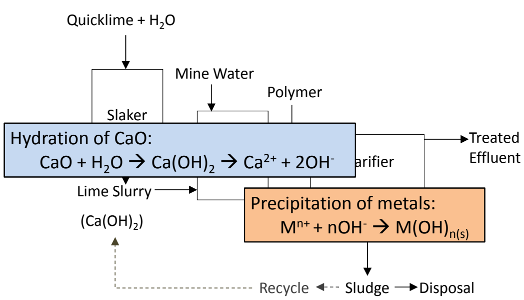
Mine Water Treatment with Cement Kiln Dust (CKD)

Allison Mackie, BEng, MASc Candidate
Department of Civil and Resource Engineering
IMWA 2010, September 6th, 2010

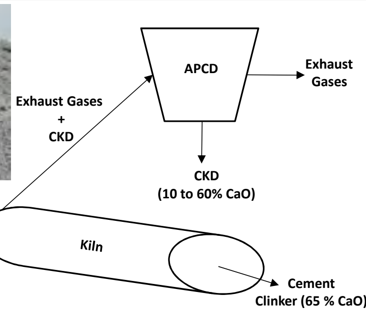
Acid Rock Drainage (ARD)

- Sulphide ores
  - Pyrite, FeS_2
  - Sphalerite, ZnS
- Low pH, high soluble metals
- Generated for decades to centuries

Active Lime Treatment Plant



Cement Kiln Dust (CKD)



CKD as a Lime Substitute

- Lime (CaO)
- Previous studies
  - Effective for target metal removal
    - Dry material
    - Limited CKD samples
    - Synthetic wastewater
- Trace metal concentrations

Objective

- To evaluate the potential of substituting quicklime with CKD in active mine water treatment
  - Acid neutralization
  - Metals precipitation
  - Treated, settled water quality

Materials

Cement Kiln Dust

Sample	Specific Surface Area (m^2/g)	Median Particle Size (μm)	Total Lime (wt %)	Free Lime (wt %)
CKD-A	0.502	8.5	44	15
CKD-B	0.350	15.9	48	9
CKD-C	0.471	20.5	40	5
CKD-F	0.393	21.2	57	37
Quicklime	0.164	32.0	90	87

Materials

Mine water

– lead/zinc mine

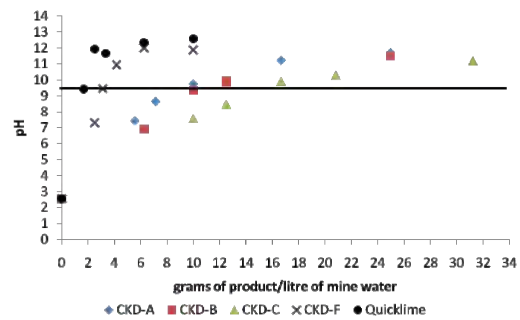
– 3 liquid waste streams

Analyte	Mine Effluent	Discharge Regulation*
pH	2.4 ± 0.1	6.0 – 9.5
TSS (mg/L)	70 ± 50	15
Zinc (mg/L)	122 ± 15	0.5
•Dissolved	115 ± 18	---
Iron (mg/L)	429 ± 78	---
•Dissolved	399 ± 78	---

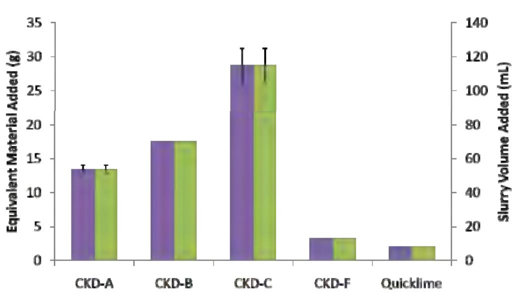
*Metal Mining Effluent Regulations

Methodology

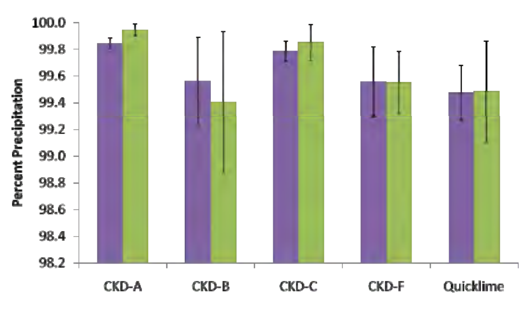
Acid Neutralization Capacity



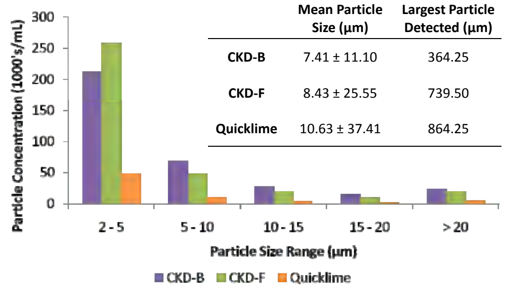
Neutralization



Metals Precipitation

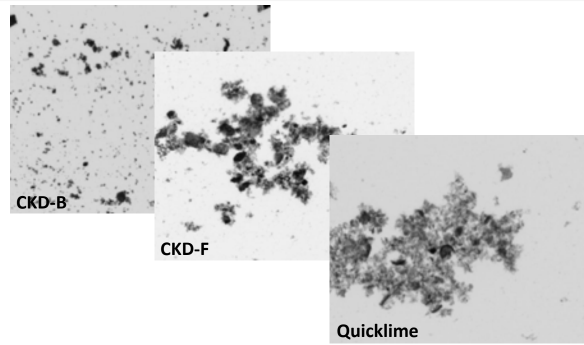


Flocculation

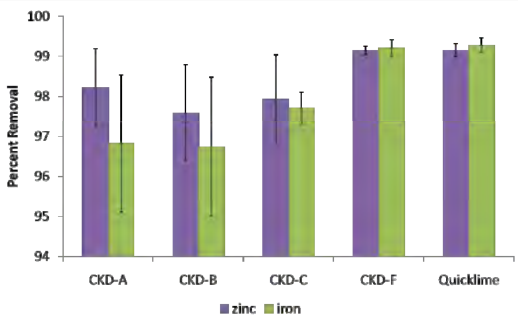


	Mean Particle Size (µm)	Largest Particle Detected (µm)
CKD-B	7.41 ± 11.10	364.25
CKD-F	8.43 ± 25.55	739.50
Quicklime	10.63 ± 37.41	864.25

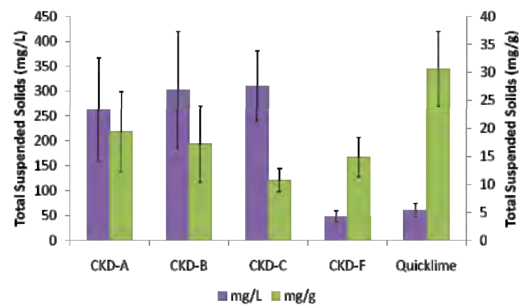
Flocculation



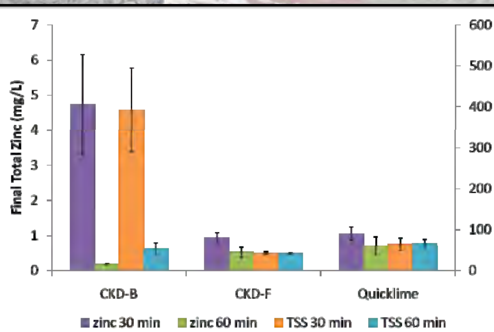
Settled Water Quality



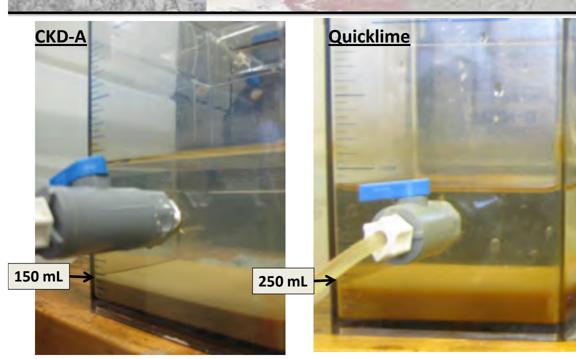
Settled Water Quality



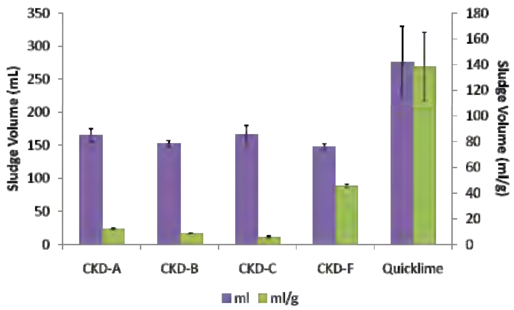
Effect of Settling Time



Settled Water Quality



Settled Water Quality



Conclusions

- CKD is as effective as quicklime in neutralization of acidity and precipitation of soluble metals
- Low free lime CKDs vs. Quicklime:
  - Higher slurry volume required for neutralization
  - Comparable metals precipitation and removal
  - Higher TSS concentrations after settling
  - Lower sludge volume after settling

Conclusions

- CKD-F vs. Quicklime
  - Similar slurry volumes required
  - Comparable metal precipitation and removal
  - Comparable TSS concentrations after settling
  - Lower sludge volume after settling
- Increased settling time
  - Significantly reduced TSS and final total metal concentrations in mine water treated with CKD-B slurry
  - No effect with CKD-F or quicklime

Recommendations

- Sludge characterization (i.e. CST, TCLP)
- Effect of sludge recycle (i.e. HDS)
- Pilot and full scale studies

Acknowledgements

- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Colin Dickson, Cement Association of Canada, Portland Cement Association
- Chris Petrie, Xstrata Zinc
- Heather Daurie, Brian Kennedy, Brian Liekens, Blair Nickerson
- Margaret Walsh PhD, PEng
- CKD Suppliers (LaFarge NA, Holcim, Cemex, Ash Grove Cement)

DALHOUSIE UNIVERSITY
Inspiring Minds

Questions?