Mining Sustainability by Water Treatment, Tailings Repurposing and Slag Recycling

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NAXOS2018 Meeting
Naxos Greece

Butte, Montana

Population 40,000

Close to 2 NP's

Mining Sustainability by Water Treatment, Tailings Repurposing and Slag Recycling

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OUTLINE

Anti-Mining Sentiment

Mining Sustainability

Metallurgical Research

Conclusions

Acknowledgements

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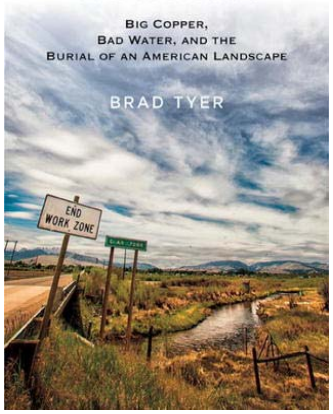
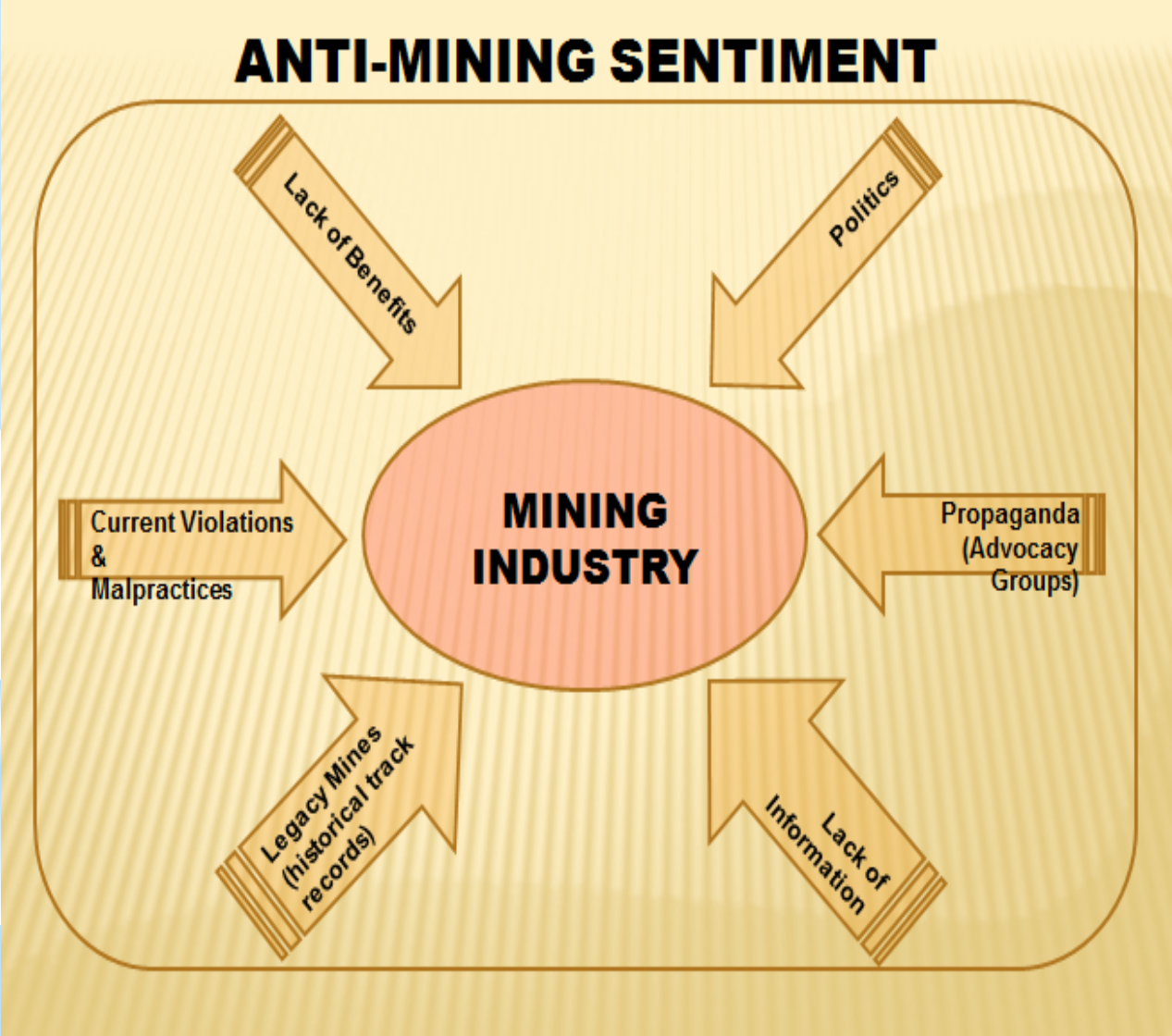
Anti-Mining Sentiment

It's local and global:

East/Midwest
Montana
Nevada
California
Wisconsin
Honduras
Philippines
Nepal
Romania
Peru
Vatican



Anti-Mining Sentiment



The Mining Industry needs more:

- **Accountability**
- **Transparency**
- **Credibility**

In general, there are 6 challenges:

- **Social**
- **Political**
- **Economic**
- **Government**
- **Environment**
- **Health & Safety**

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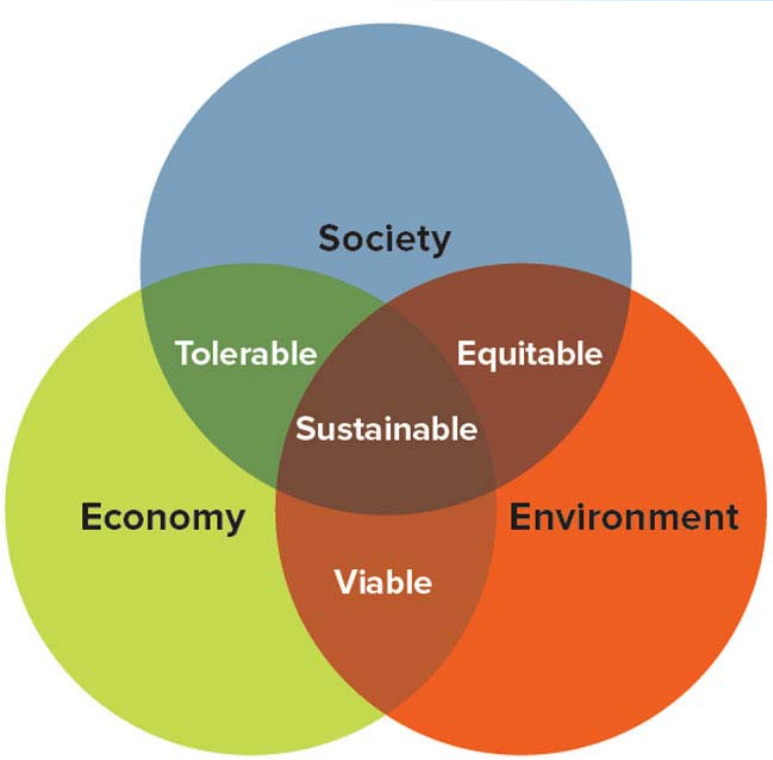
Mining Sustainability

Suggests the need to minimize:

- Water consumption
- Energy consumption
- Land disturbance
- Waste production



and the criticality to conduct:

- Soil, water and air treatment
- Mine closure
- Land reclamation

Current needs met; future generations uncompromised

- Environmental stewardship
- Social responsibility
- Integrated economy

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METALLURGICAL RESEARCH

- Artisanal Mining (Example: Peru)
- Water (Cyanide, As/Se, ARD, Remediation)
- Slag (ARD Treatment, Recycling)
- Tailings (Lunar Soil, Resource Recovery)
- Energy Reduction (Electrowinning)
- Spent Materials (SPL Waste Minimization)
- Process Development (Au Thiosulfate, REEs)

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Water
(Natural Remediation)

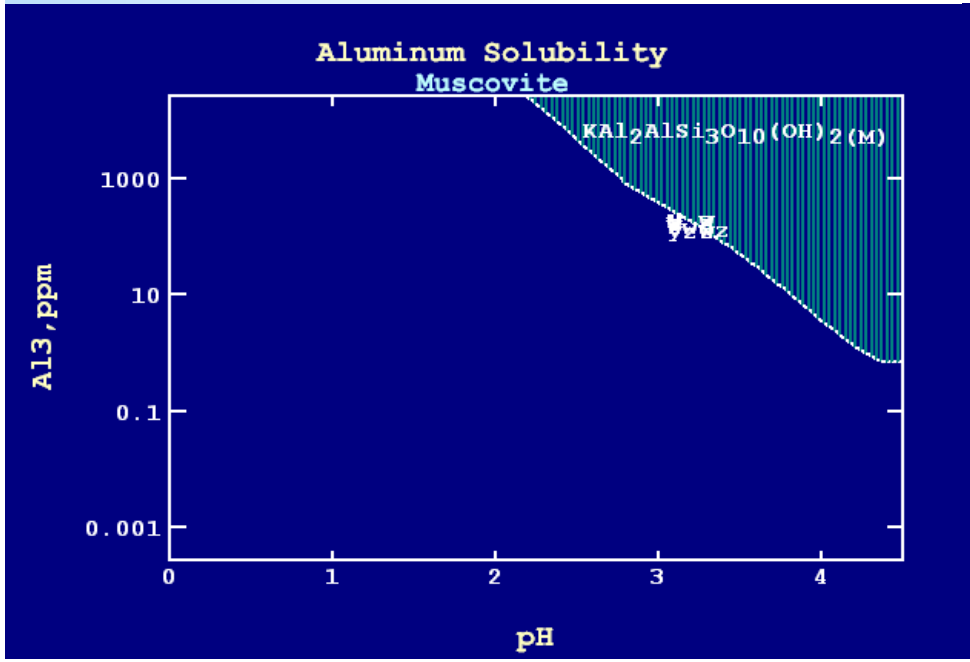
Modeling BPLW

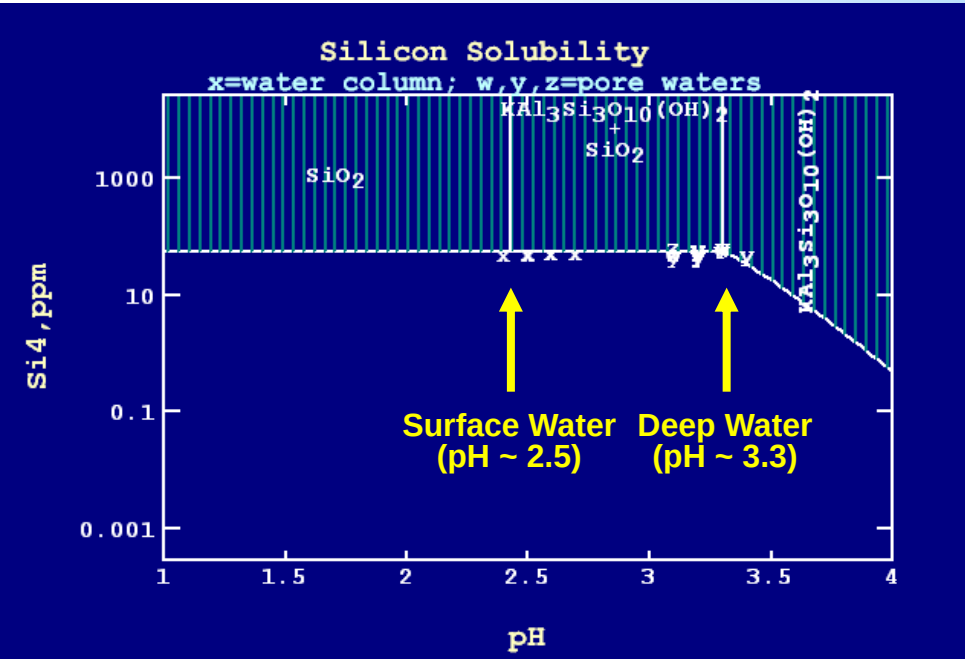
(Deep Water, Pore Water and Sediment)

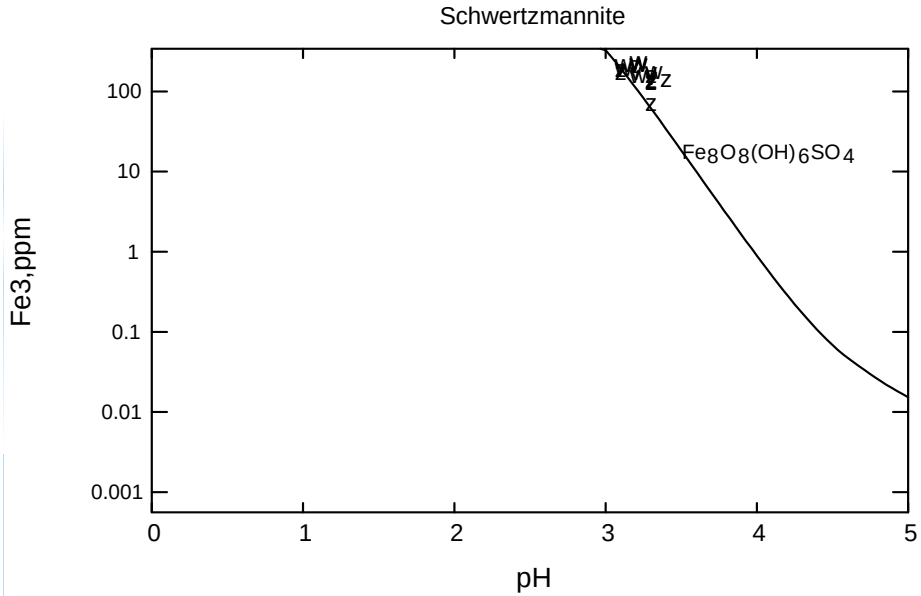
Siphon/Filter Off Deep/Pore Water

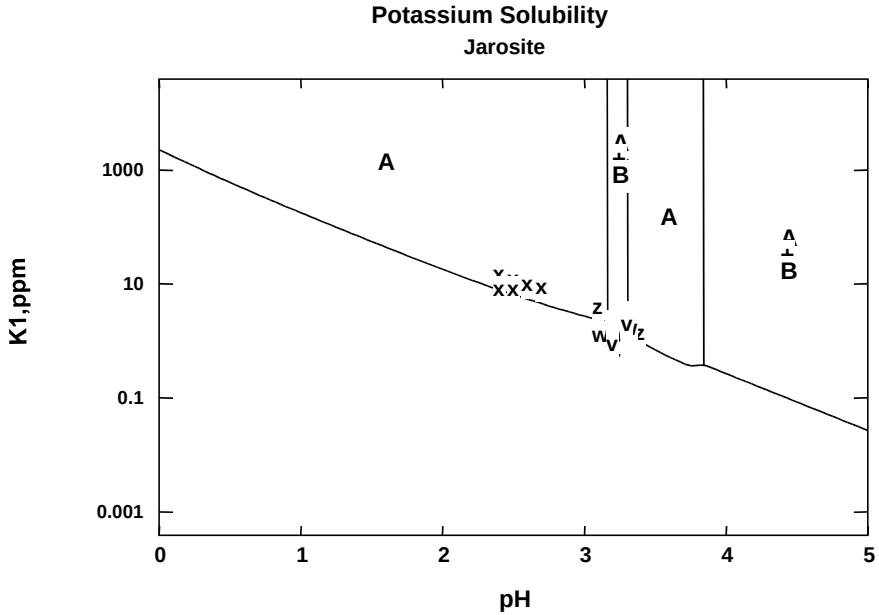
Analyze the Water & Solid Contents

Chemical Control by Mineral Solubility

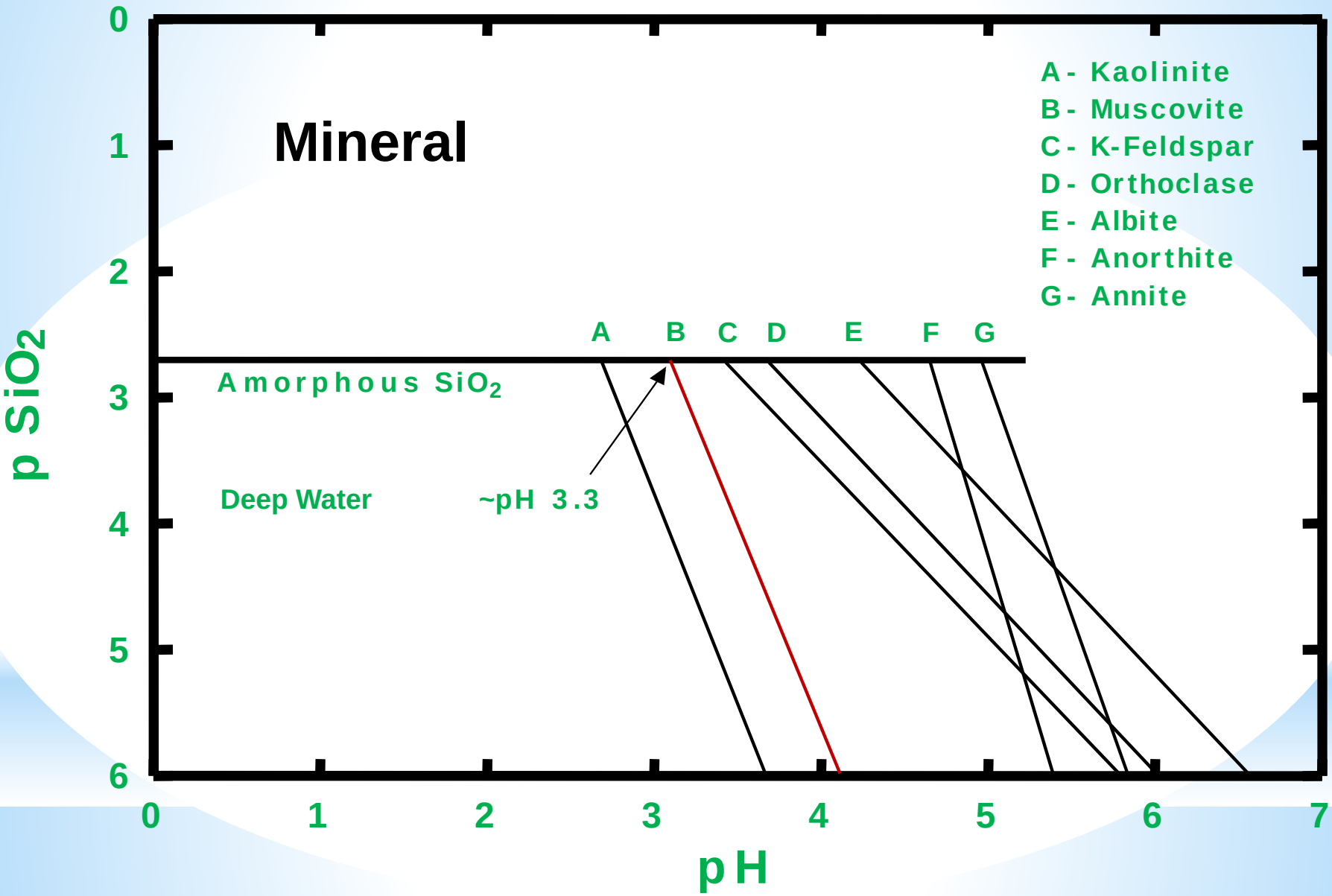






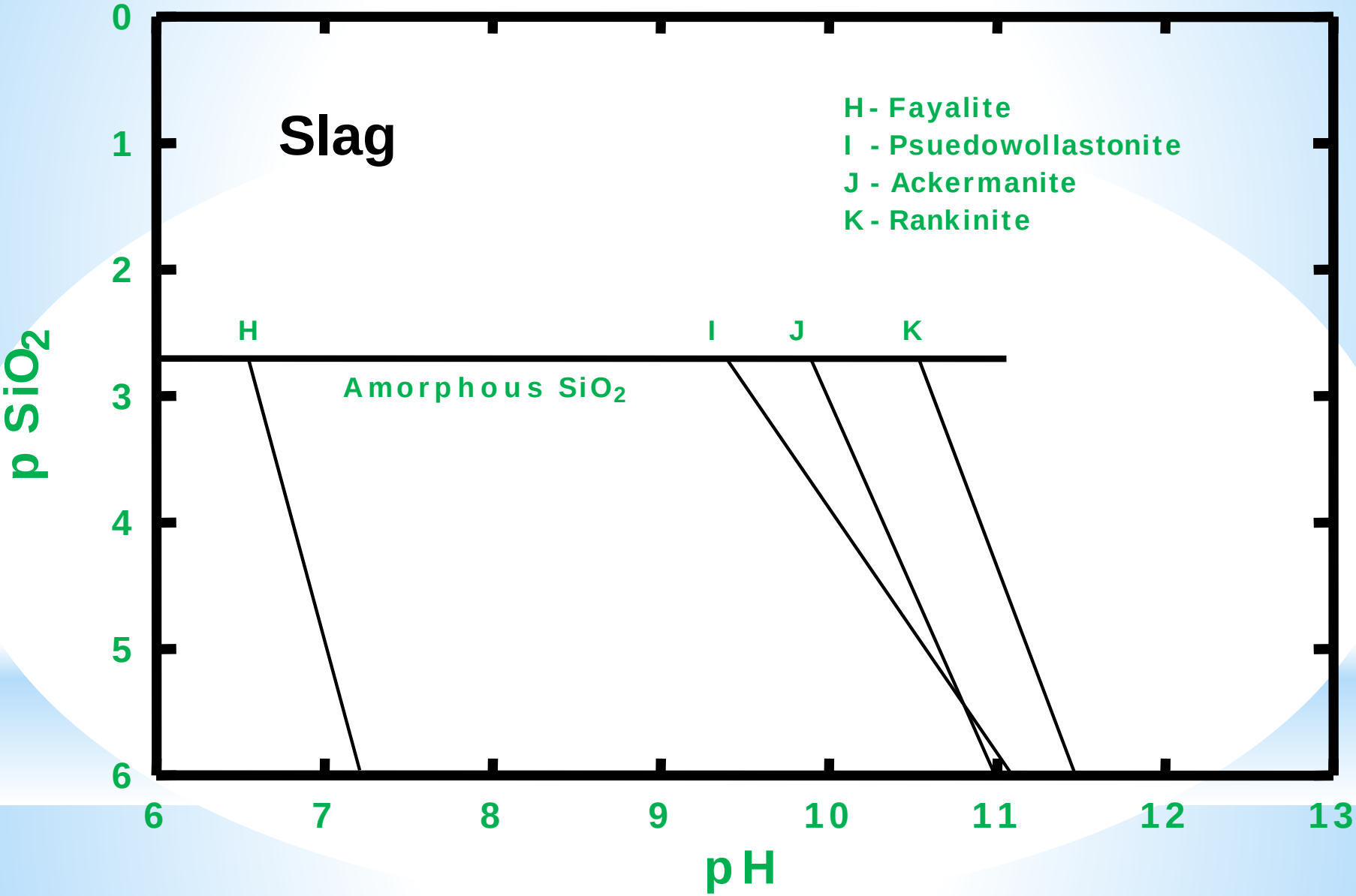


Chemical Control by Mineral Solubility



Slag
(ARD Treatment)

What if the silicate mineral was slag?



Silicate Slags (in Montana)

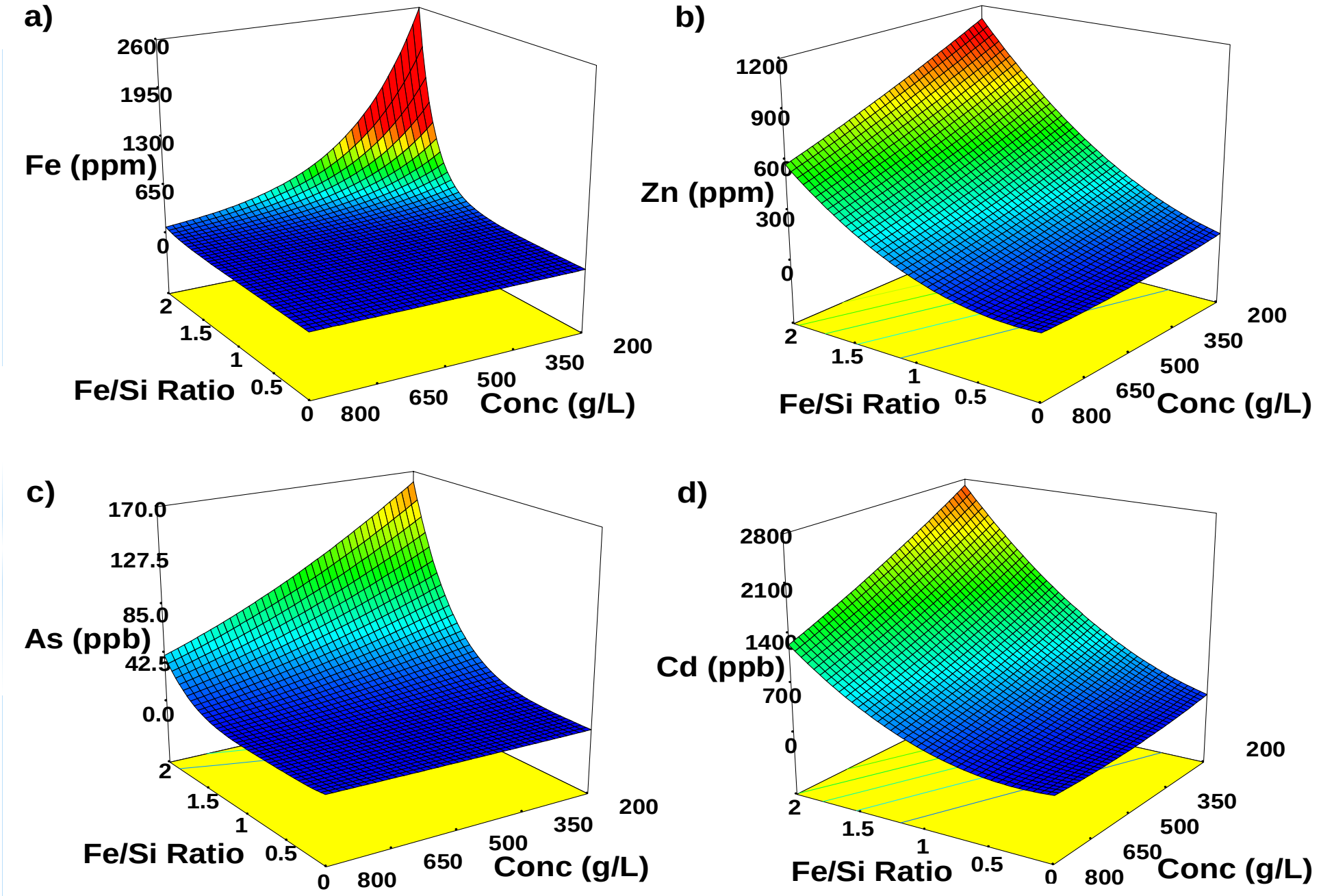
Source of Silicate (and lime)

- Act as pH-Buffers (replace lime)

Available everywhere (active and inactive smelters)

- Rhone Poulenc - Pseudowallastonite, $CaSiO_3$
- ASARCO - Olivine-type, $CaFeSiO_4$
- ARCO - Fayalite, Fe_2SiO_4

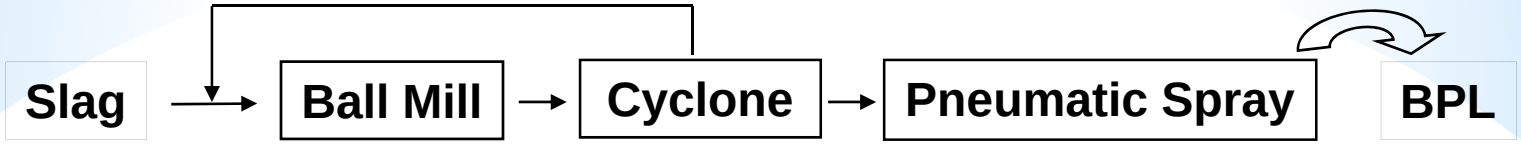
Slag	Ca (%)	Fe (%)	Si (%)	Fe/Si
Rhone Poulenc	30.3	0.4	19.0	~ 0
ASARCO	14.0	22.6	22.7	~ 1
ARCO	2.6	30.9	15.8	~ 2

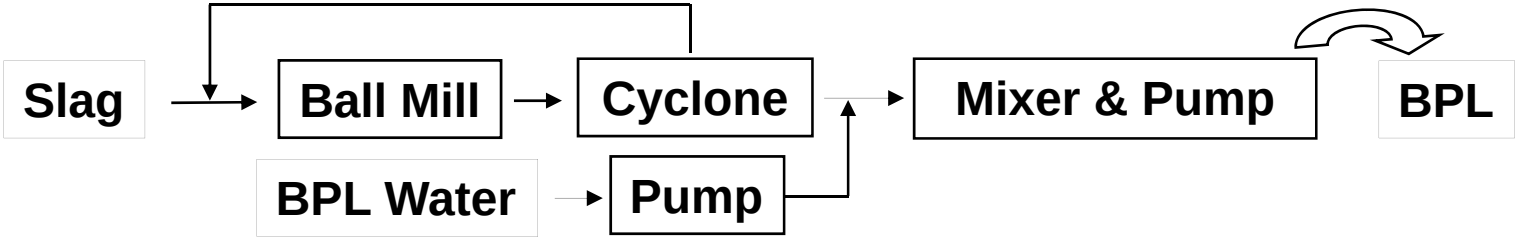


Slag Remediates!

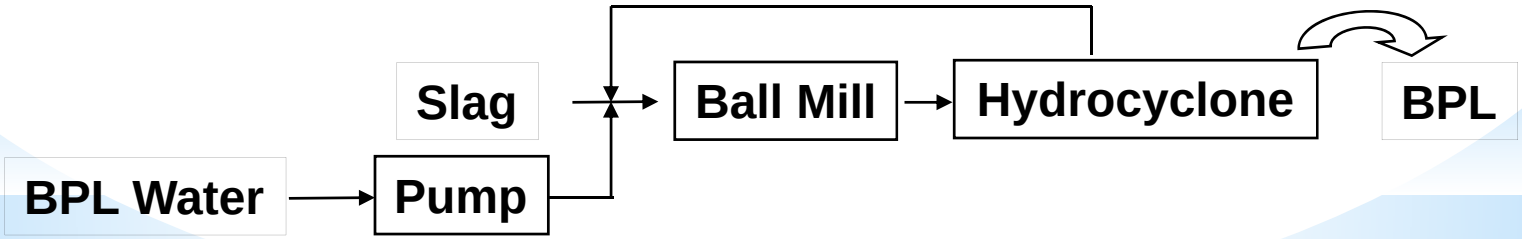
Conceptual Flowsheet Designs

Dry Grinding

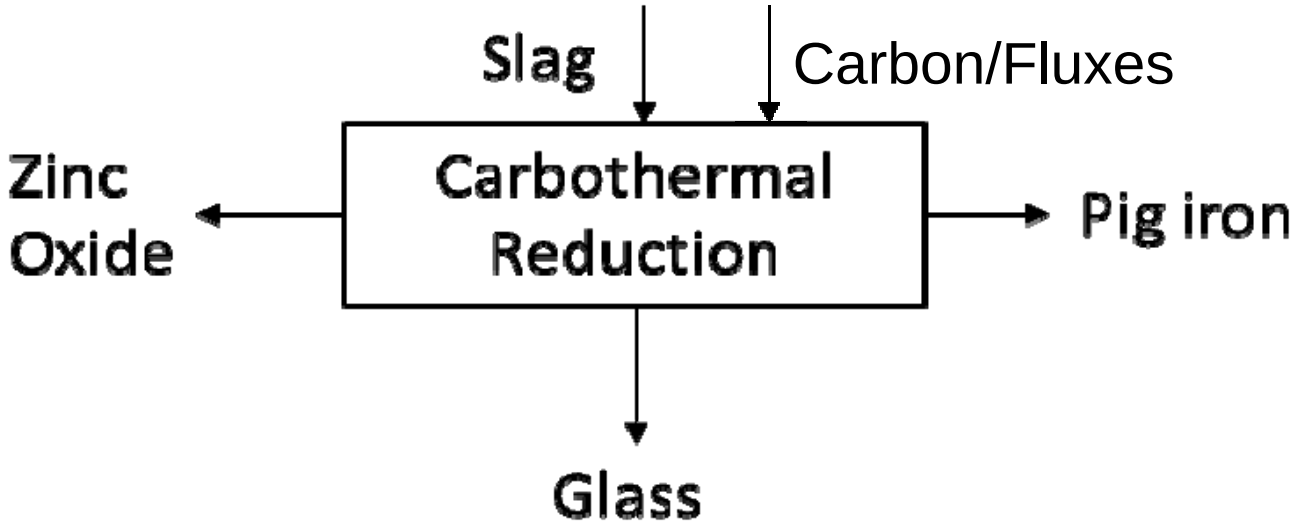




Wet Grinding



Slag
(Recycling)

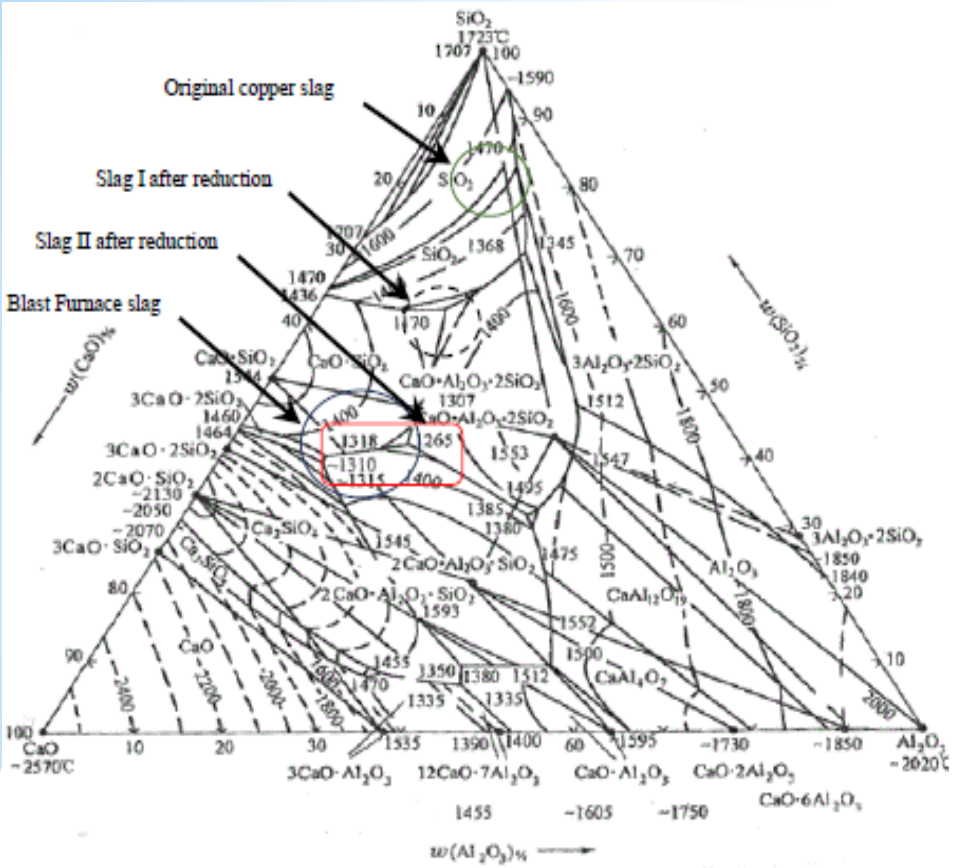


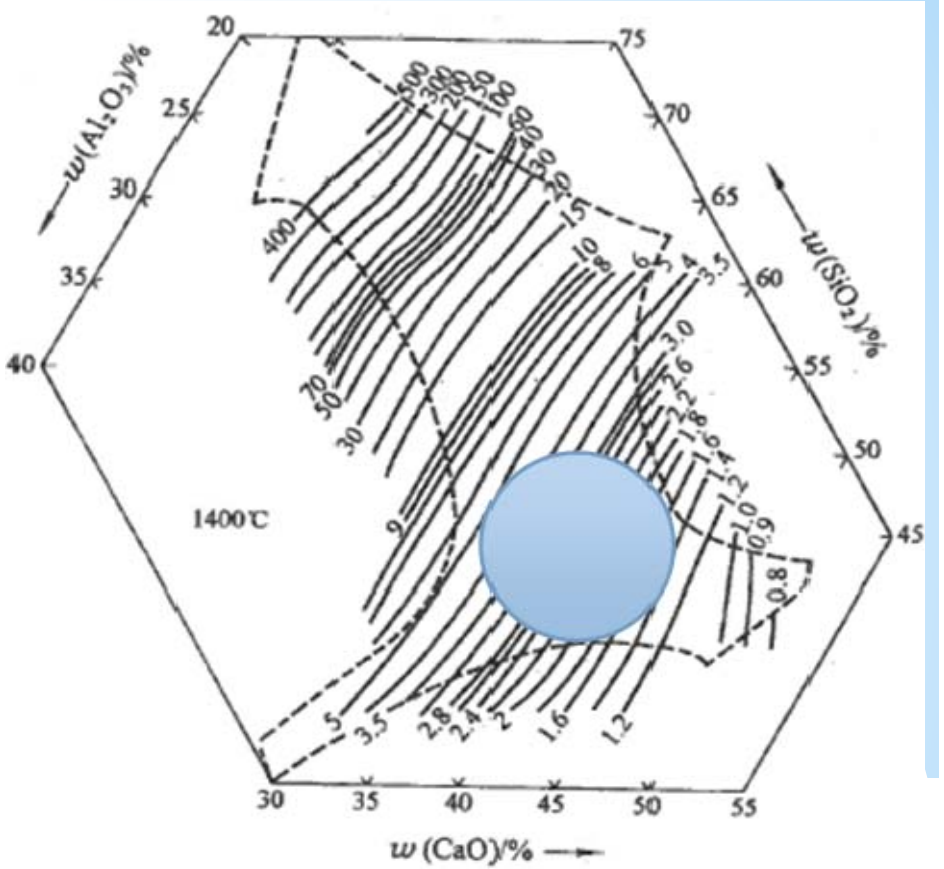
Variables

Temperature Time Carbon Amount Slag Site Flux Addition

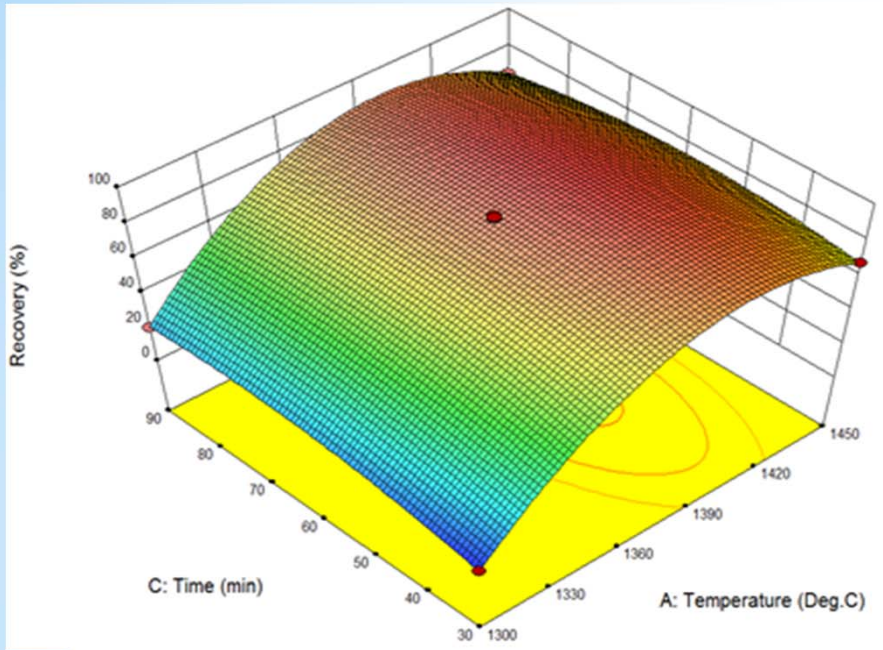
Responses

Iron Recovery Glass Hardness Glass Density

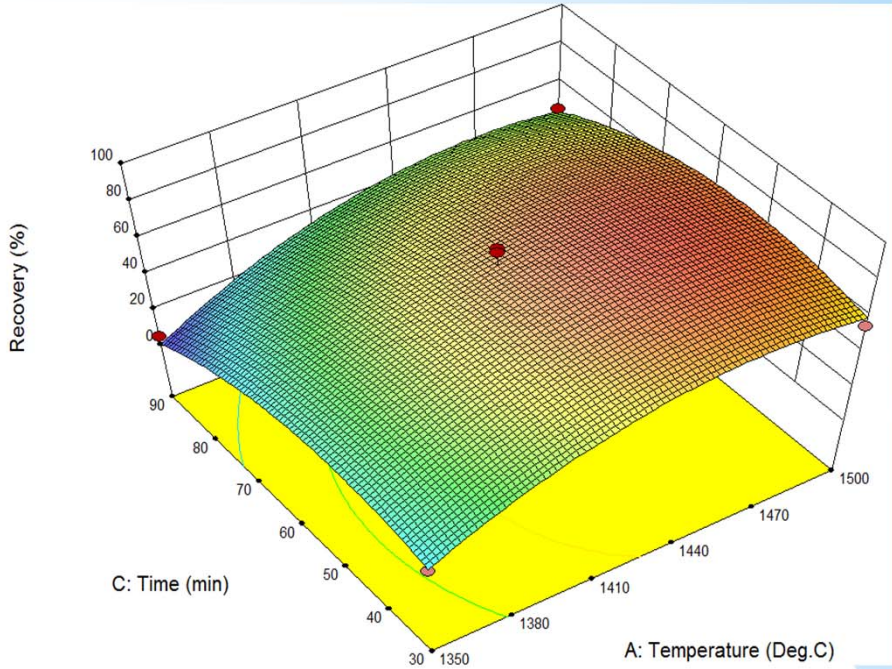




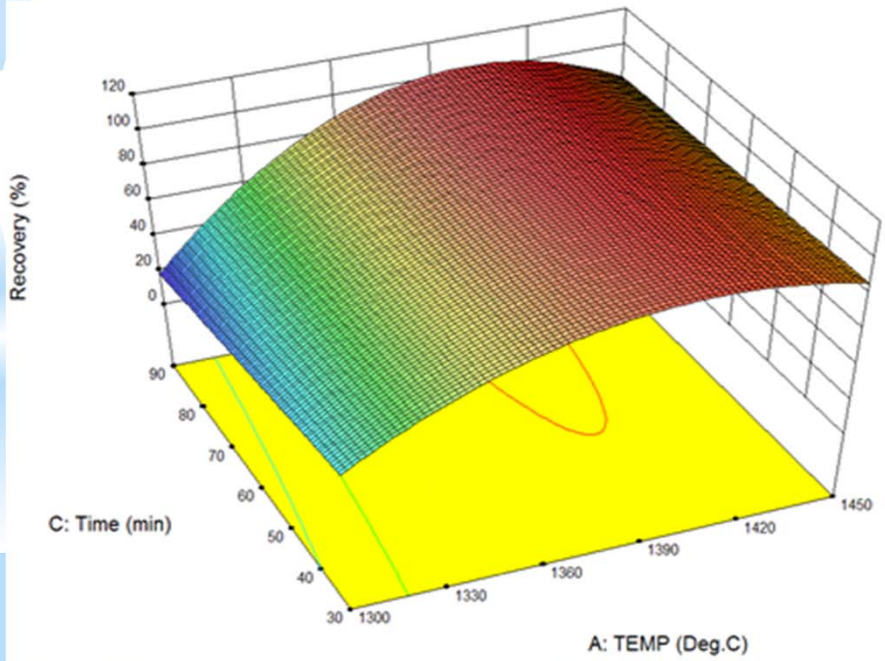
ANACONDA SLAG			
Glass One	**Temp (°C)**	**Carbon(g)**	**Time(min)**
	1410	12.5	73.7
	Recovery(%)	Hardness(VH)	Specific density(g/cc)
	92.23	646.9	2.71
Glass Two	**Temp (°C)**	**Carbon(g)**	**Time(min)**
	1500	15	67.5
	Recovery(%)	Hardness(VH)	Specific density(g/cc)
	66.89	692.1	2.92



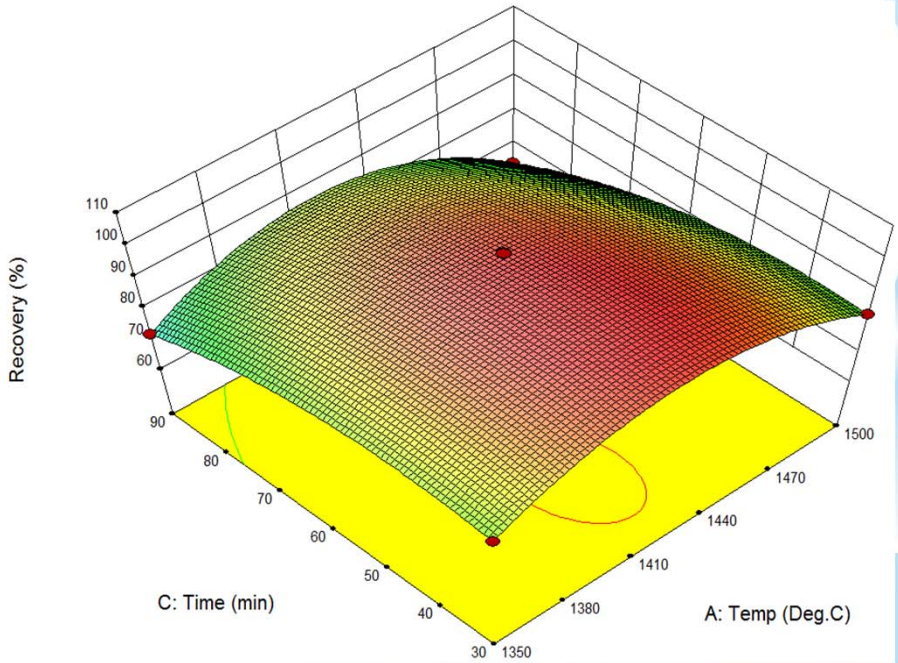
Anaconda Glass One



Anaconda Glass Two



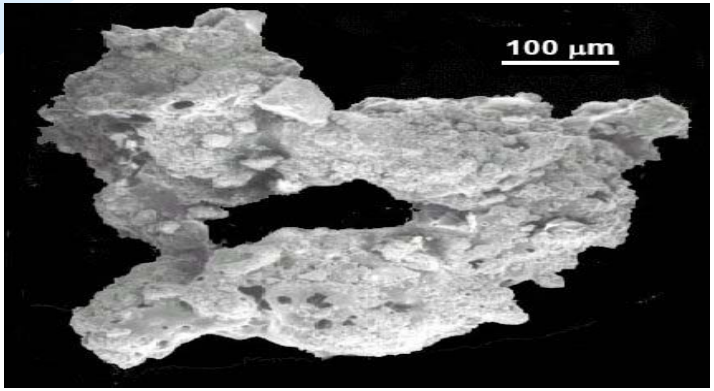
Freeport Glass One



Freeport Glass Two

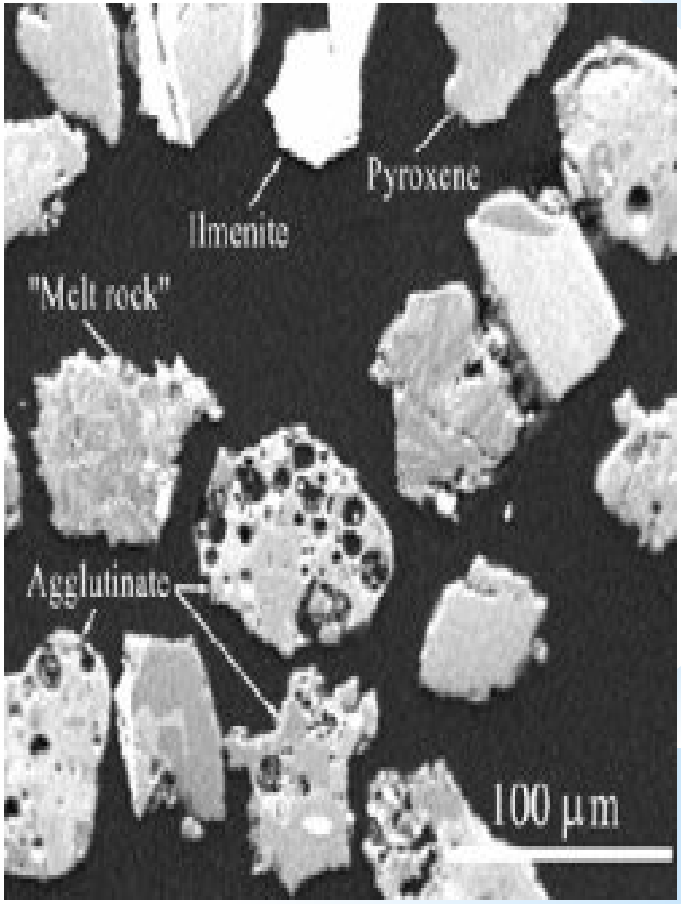
Tailings
(Lunar Soil)

Fine Powder



Broken Rock

Lunar Regolith



NASA Flowsheet - Road Norite (SMC Tails)

Road Norite

↓

Crush to -600 µm

↓

Screen at 75 µm

↓ -600 /+75 µm

RE Belt Separator

→ Paramagnetic Material

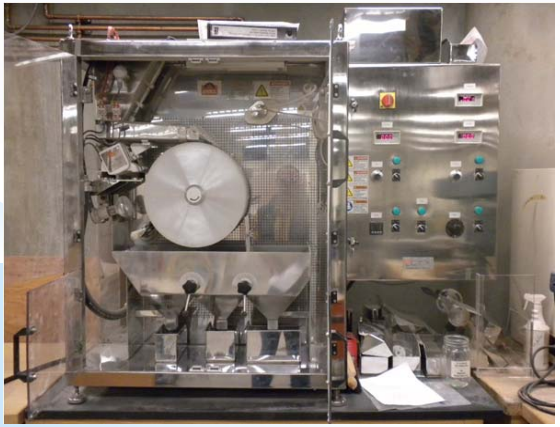
→ Nonmagnetic Material

Paramagnetic Material → Electrostatic Separator → Tails

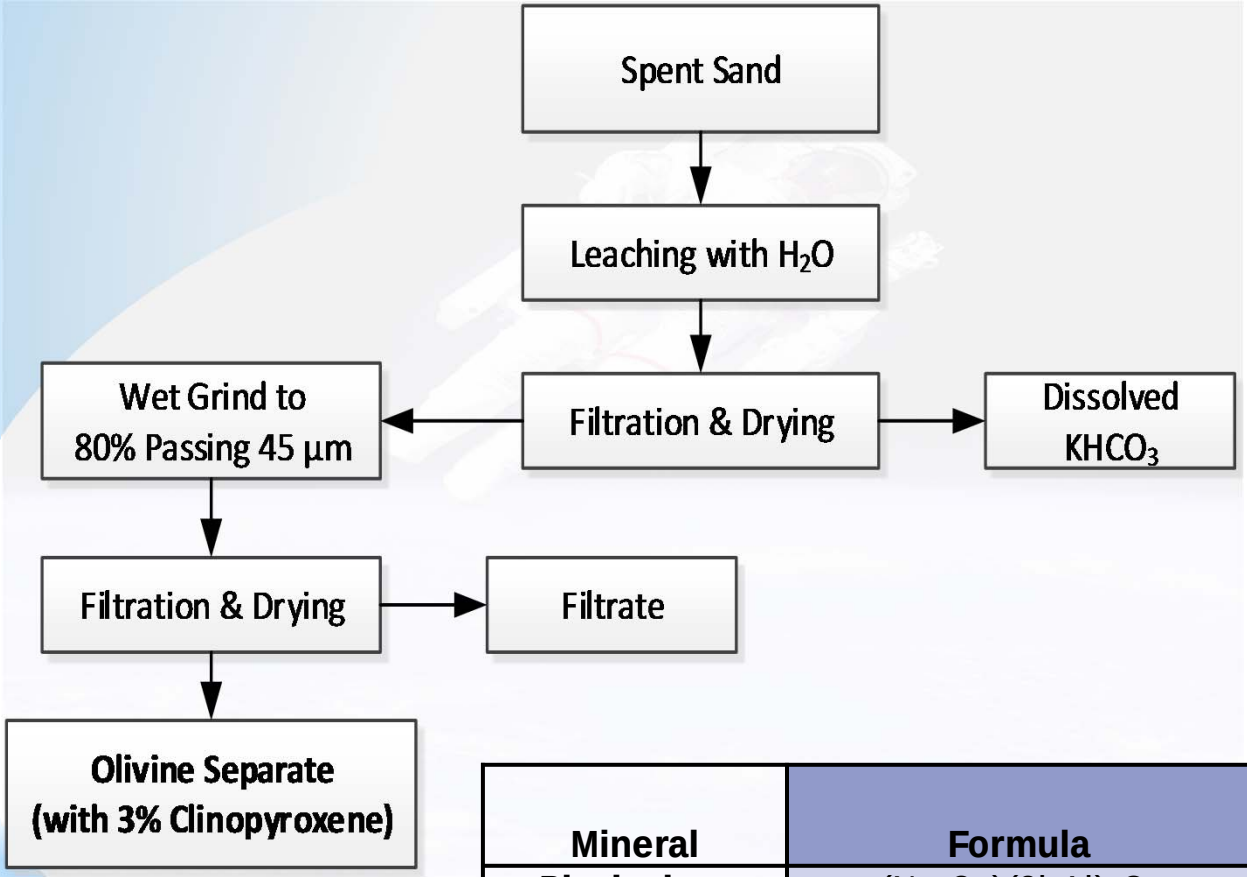
Electrostatic Separator → **Pyroxene Separate**

Nonmagnetic Material → Wet Grind to 80% Passing 45 µm → Flotation (Collector) → **Plagioclase Separate**

Flotation (Collector) → Hydrated Silicates



NASA Flowsheet - Spent Sand (Casting)



Mineral	Formula	Lunar Soil	Calculated Wt. %	NASA XRD
Plagioclase	$(Na,Ca)(Si,Al)_4O_8$	75	75.01	79
Orthopyroxene	$(Mg,Fe,Ca)(Mg,Fe,Al)Si_2O_6$	10	11.09	12
Clinopyroxene	$(Ca,Na)(Mg,Fe)(Si,Al)_2O_6$	5	3.31	1
Olivine	$(Mg,Fe)_2SiO_4$	10	9.99	8

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CONCLUSIONS

Minerals and metals are pillars of society

Minimal dependence on foreign supply

Importing commodities = exporting pollution

Environmental Stewardship is mandatory

The Mining Industry is becoming Socially Responsible

Sustainability will lead to an Integrated Economy

More innovative research on resources is needed!

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ACKNOWLEDGEMENTS

Metallurgical & Materials Engineering Department

All of the mining friends and companies that have supported us through the years

Undergraduate and graduate students who did the research, including my daughters

Collaborators and faculty who made it possible

GO PACK GO!


24
ACKERS
PINK
Jarrett Bush
#24
Take Picture w/ us?
Celebrating our
Today on Sept
GO PACK GO!
Goal: SB in N'rleans!