

# Assessing weathering in field cell experiments using quantitative mineralogy and sequential leaching

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# Outline

- Objectives
- Waste Rock Classification
- Samples Studied
- Results and Discussion
  - Field Cells
  - Mineralogy
  - Sequential Leaching
- Conclusions

# Objectives

The primary objective of this work was to examine the weathering behavior of carbonate-hosted sulfide waste rock material under neutral and circum-neutral drainage conditions

- Field cell tests
- Mineralogical characterization
- Sequential extraction

# Waste Rock Classification

Presently classified into three categories based on lithology, sulfur and metal contents:

- Class A: high potential for producing undesirable leachate (skarn, intrusive & some hornfels and marble)
- Class B: intermediate potential for producing undesirable leachate (hornfels, marble)
- Class C: low potential for producing undesirable leachate (hornfels, marble)

The results of this study are applicable to the hornfels, marble and limestone lithologies.

# Waste Rock Samples

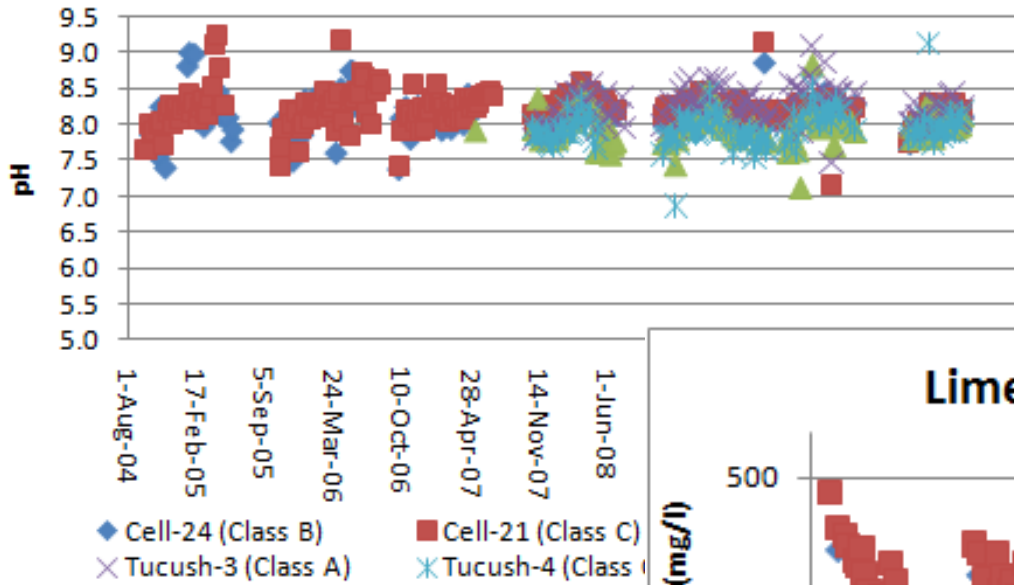
- Hornfels and marble waste rock samples from the Antamina field cell program initiated in 2002
- Samples selected on the basis of observed field cell leaching behavior

Sample ID	Lithology	Class <sup>1</sup>	Observed Field Cell Behavior
Cell-21	Marble	C	High leachate arsenic concentrations
Cell-24	Marble	B	High leachate arsenic concentrations
Tucush-1	Hornfels	B	High leachate concentrations of zinc and copper
Tucush-3	Hornfels	A	Low leachate zinc concentrations
Tucush-4	Limestone	C	High leachate zinc concentrations

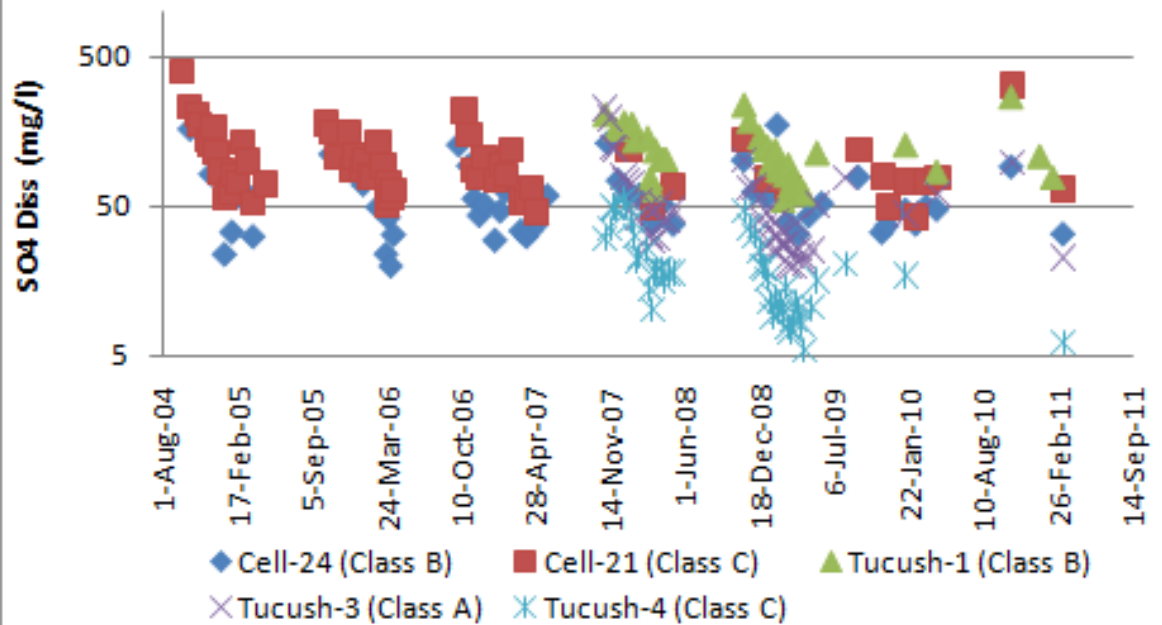
<sup>1</sup>by Antamina geology

# Field Cells

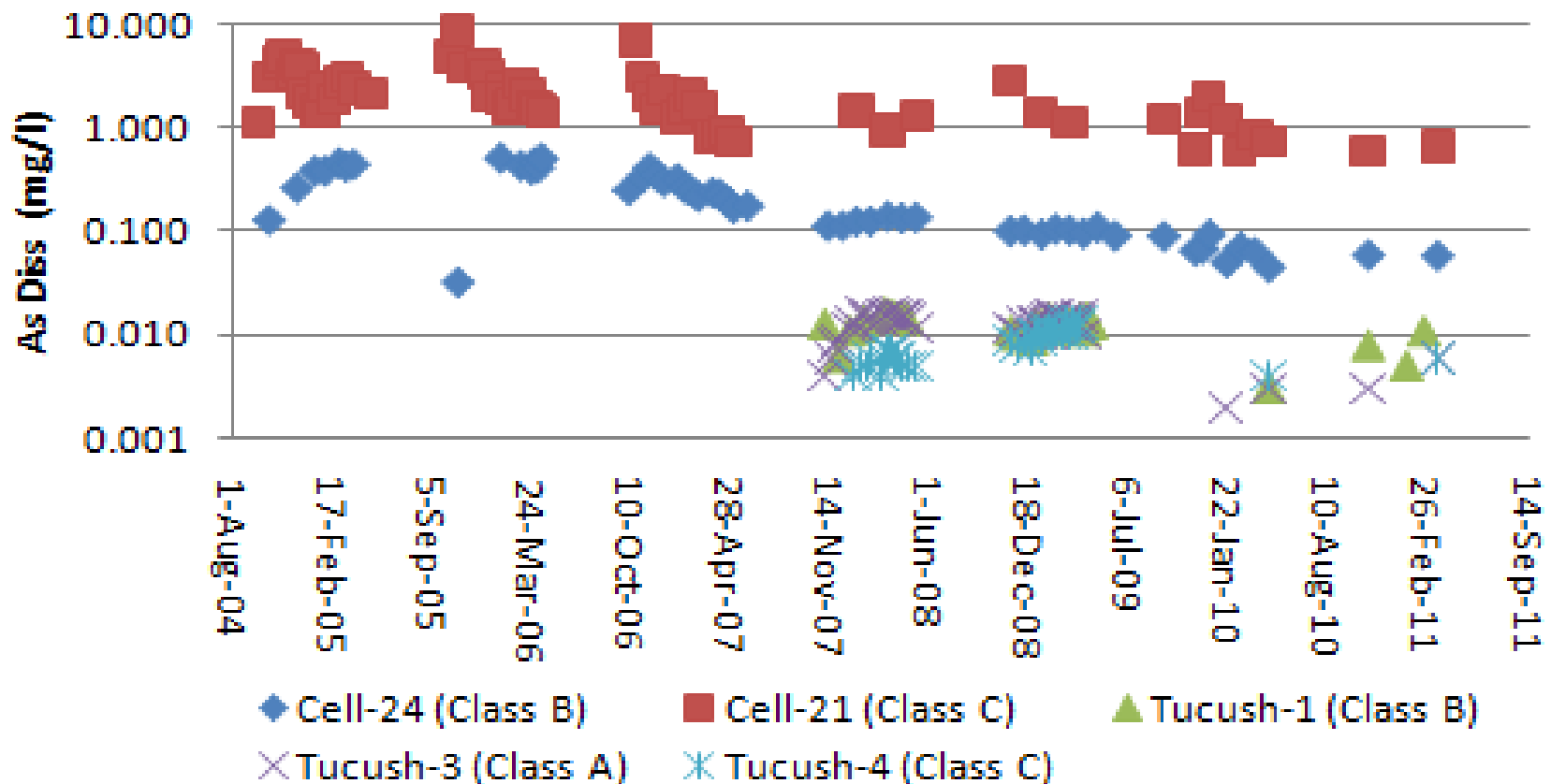
## Limestone, Hornfels and Marble



## Limestone, Hornfels and Marble

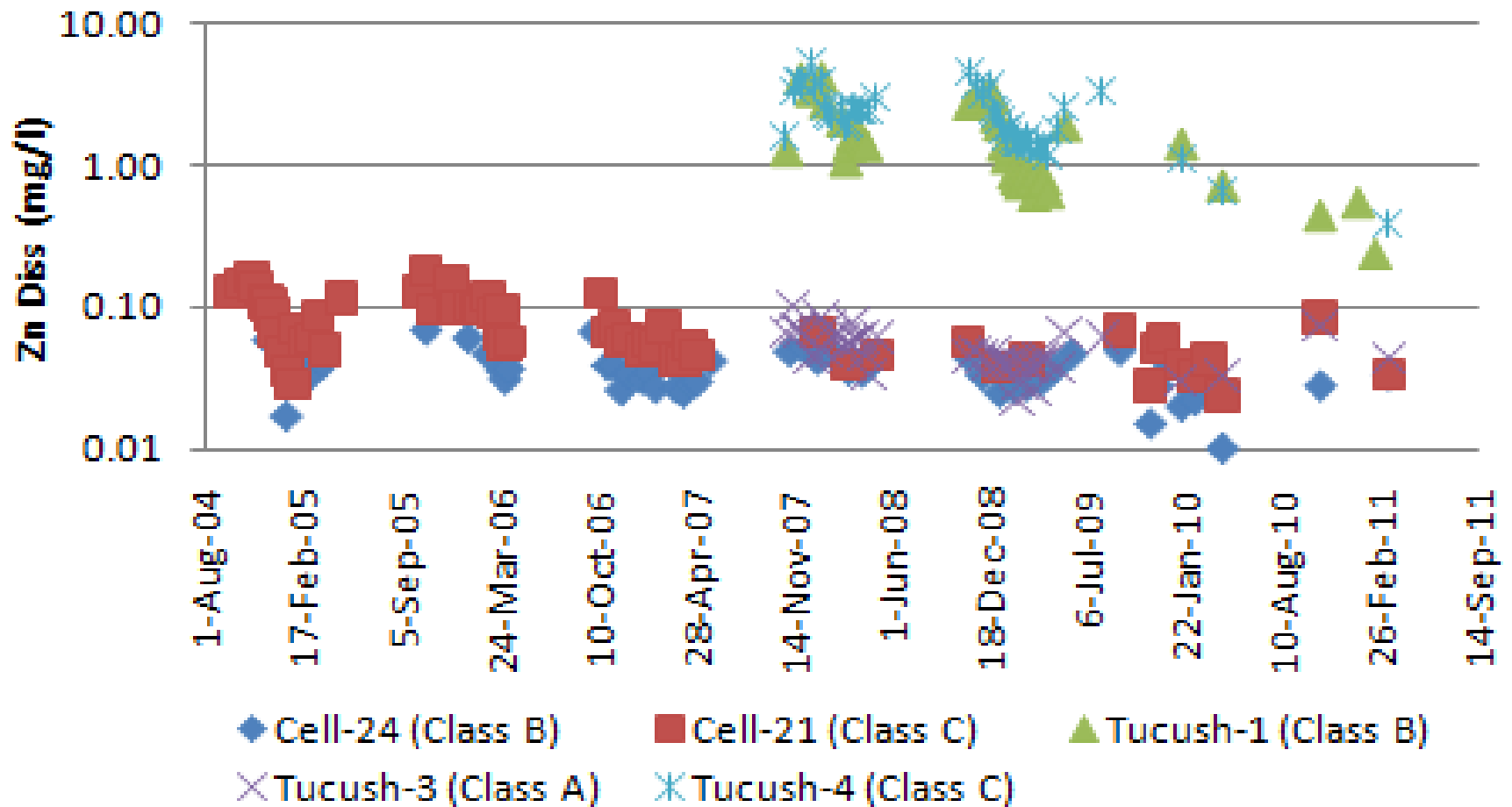


## Limestone, Hornfels and Marble





# Limestone, Hornfels and Marble



# Mineralogy

Sample ID	Cell-21						SUM
$\mu\text{m}$	Liberated (%)	Sulfide (%)	Carbonate (%)	Silicate (%)	Other (%)	Ternary (%)	
<b>+50800</b>	18.62	1.38	6.87	71.01	0.01	2.12	100.01
<b>-12700</b>	30.12	1.78	20.14	35.64	0.33	11.98	99.99

**Arsenic minerals (%) locked in binary or higher for Cell-21**

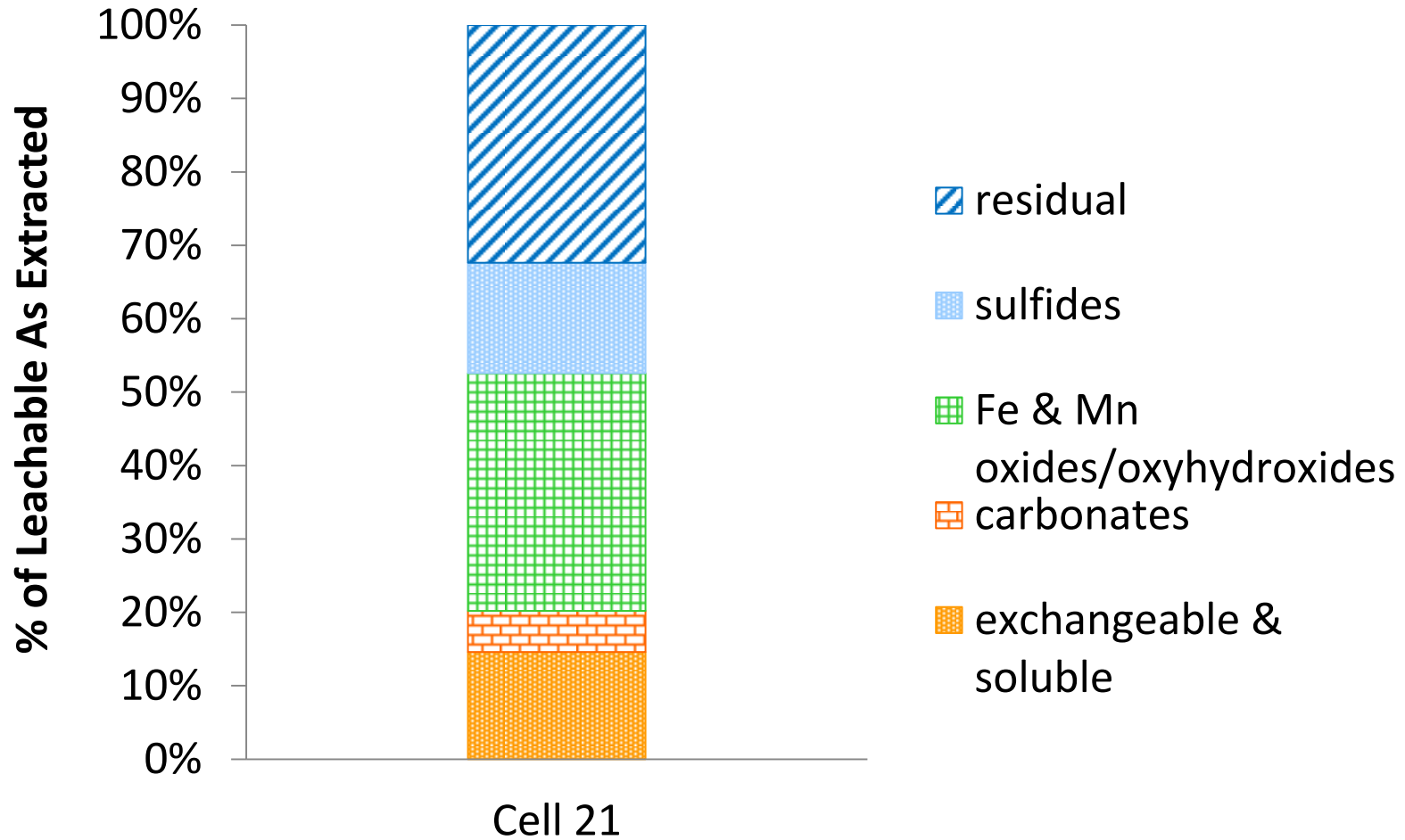
Sample ID	Tucush-3						SUM
	Liberated (%)	Sulfide (%)	Carbonate (%)	Silicate (%)	Other (%)	Ternary (%)	
25400	10.18	0.08	0.77	6.66	0.15	2.75	20.59
4800	12.12	0.23	2.91	13.62	0.01	2.35	31.24
1200	4.54	0.14	0.24	0.45	0.00	0.22	5.59
600	4.20	0.49	0.71	3.03	0.00	1.61	10.04
297	5.34	0.16	0.26	1.07	0.01	1.44	8.28
105	4.23	0.45	0.26	1.16	0.08	0.99	7.17
53	2.86	0.22	0.18	0.54	0.02	0.66	4.48
53 Dup	2.62	0.36	0.24	0.70	0.10	0.82	4.84
-53	6.61	0.23	0.23	0.33	0.05	0.31	7.76
SUM	52.70	2.36	5.80	27.56	0.42	11.15	99.99

**Zinc minerals (%) locked in binary or higher for Tucush-3**

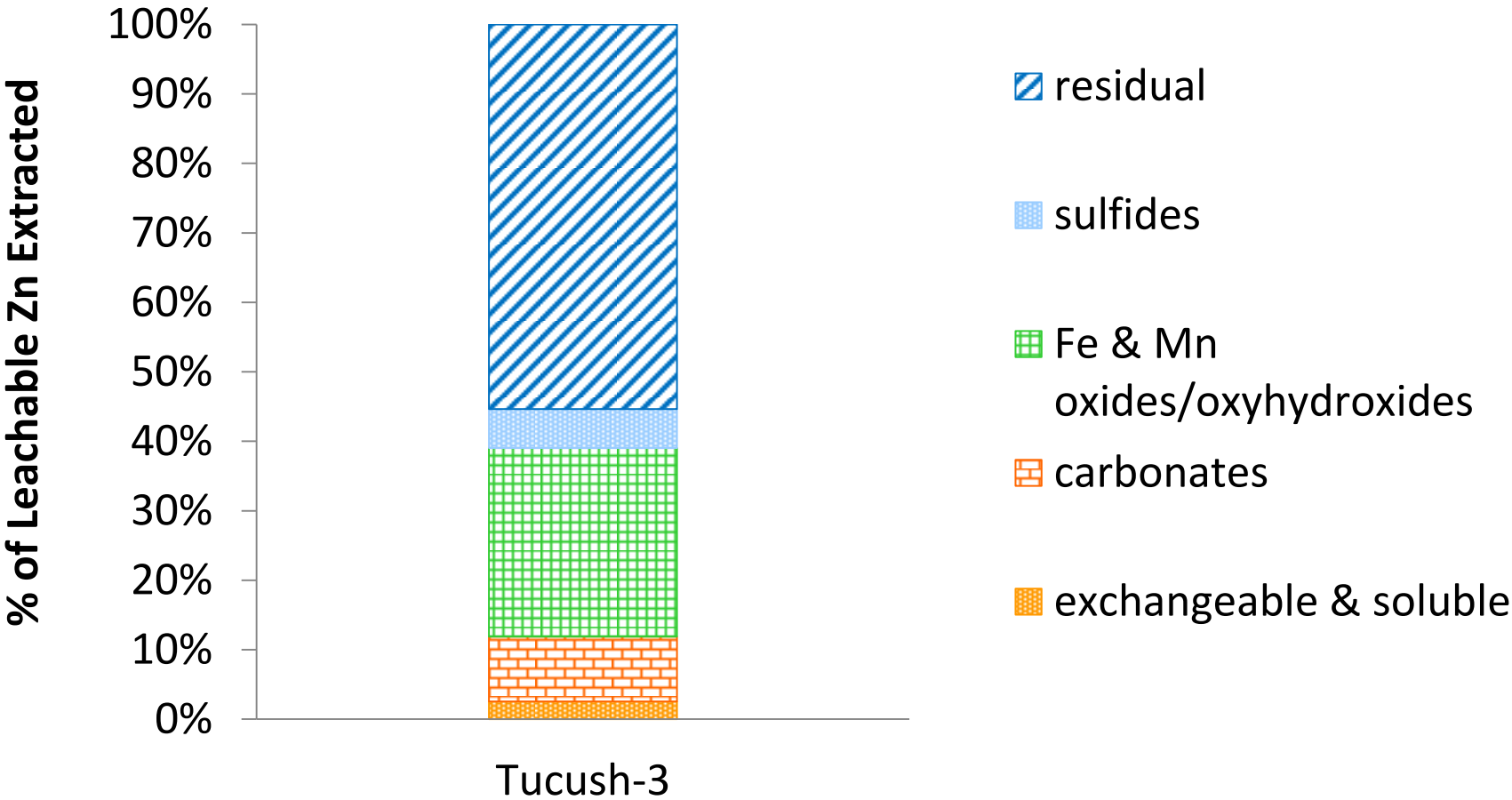
# Sequential Leaching

Sample ID	Cell 21		Tucush-3	
Extraction Step	[As] mg/L	%As	[Zn] mg/L	%Zn
L1	0.13	14.60	0.35	2.55
L2	0.05	5.61	1.28	9.34
L3	0.30	32.38	3.72	27.13
L4	0.14	15.04	0.77	5.62
L5	0.30	32.38	7.59	55.36
Sum	0.91	100.00	13.71	100.00
% Extraction	1.6		0.5	

# Arsenic Extraction



# Zinc Extraction



# Conclusions

- field cell tests provide a good indication of long-term leaching behavior for As and Zn
- classification criteria can be improved with the inclusion of additional data, such as sequential and MLA, but such test work needs to be adapted to an operational environment
- mineralogical data can be used to explain results obtained from both the field cells and sequential extraction
- sequential extraction tests are helpful in determining solid phase metal source and providing an indication of weathering behavior

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Thank you!