

The Extraction of Rare Earth Elements from Appalachian Coarse Coal Refuse through Heap Leaching – (WV 397 Heap Leach Project)

WVWRI Seminar Series February 26, 2026

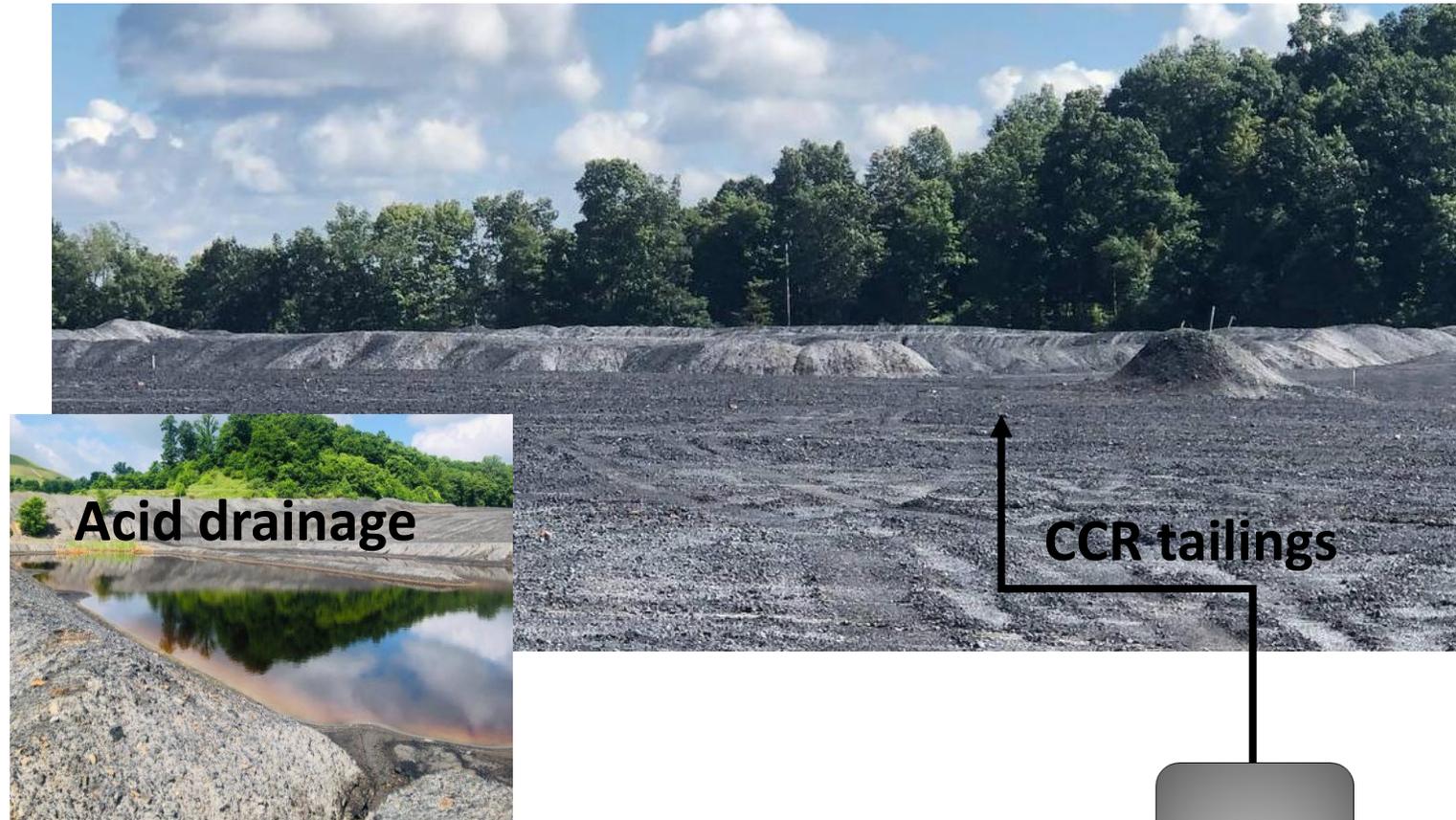
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Background

- Coarse coal refuse (CCR) is the waste material generated during the coal preparation process.
- Previous research has found that the majority of Rare earth elements (REEs) are present in reject streams of coal preparation plants, especially CCR.
- REEs are essential components of many high-tech applications.



Hypothesis

- Pyrite oxidation can be accelerated, REE extraction from CCR can be enhanced, and major metals (Fe, Al) can be removed through the recirculation of AMD.

Main Goal

- Evaluate the performance of heap leaching at bench-scale as a mechanism for the extraction of REEs from CCR in its field conditions.

Heap Leaching/ heap leach pad



<https://www.aquaroyalspring.com/gallery?lightbox=datatem-ld5v6nyq>

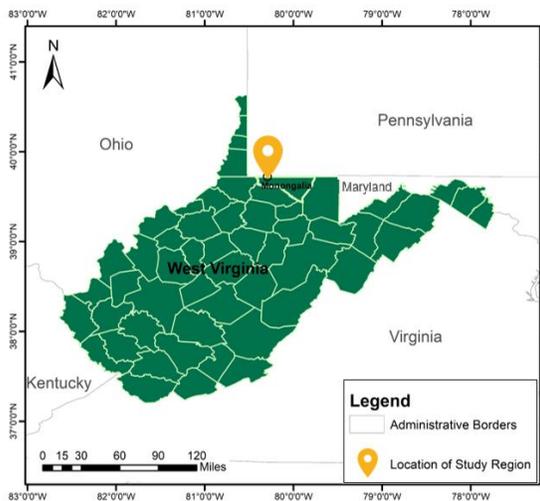


<https://www.xgeomembranes.com/applications/heap-leach-pads>

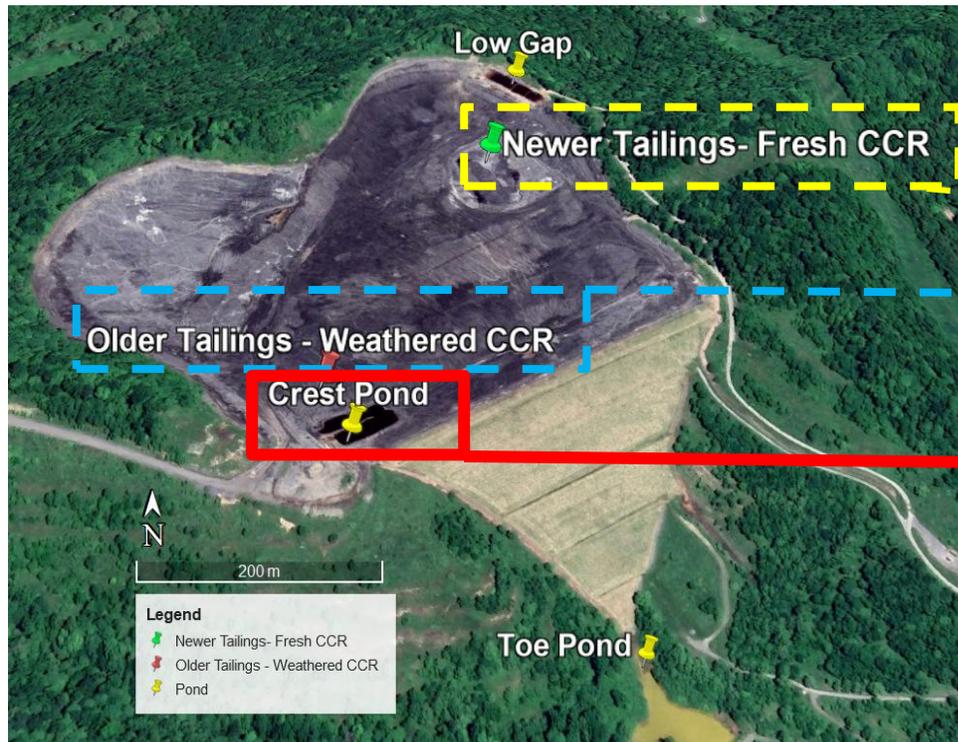


<https://www.netafimusa.com/mining-removed/>

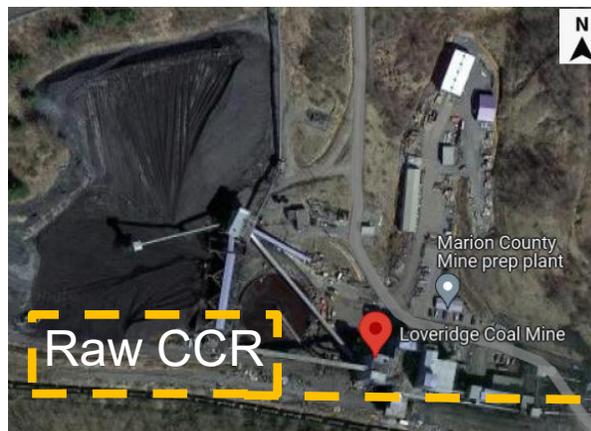
Methods: Sample collection



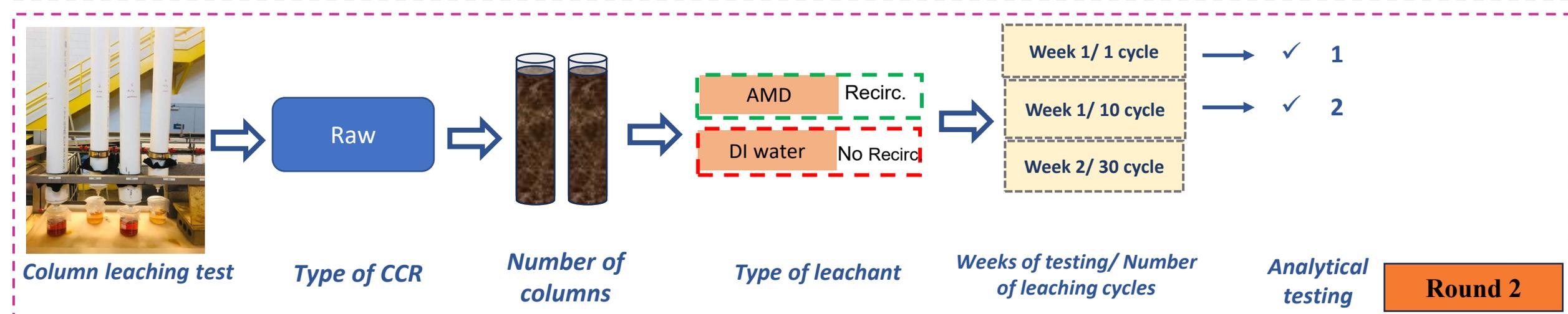
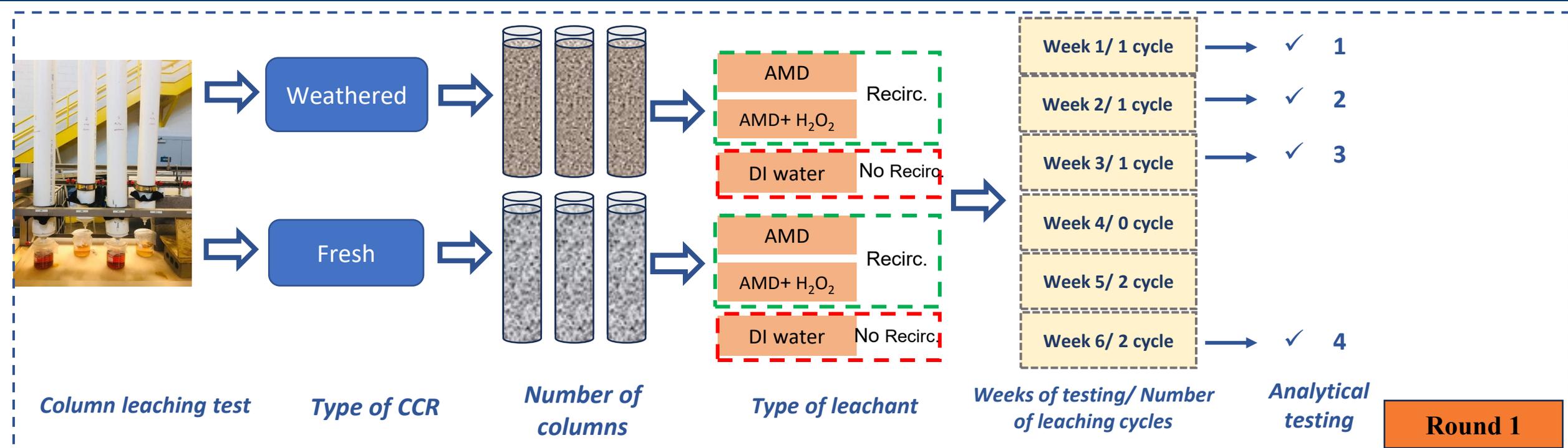
Monongalia County Mine The (also known as "Blacksville Number 2 Coal Mine")



Loveridge Mine in Marion County, WV (Google Maps)



Lab Work



Lab Work: Column leaching-test setup

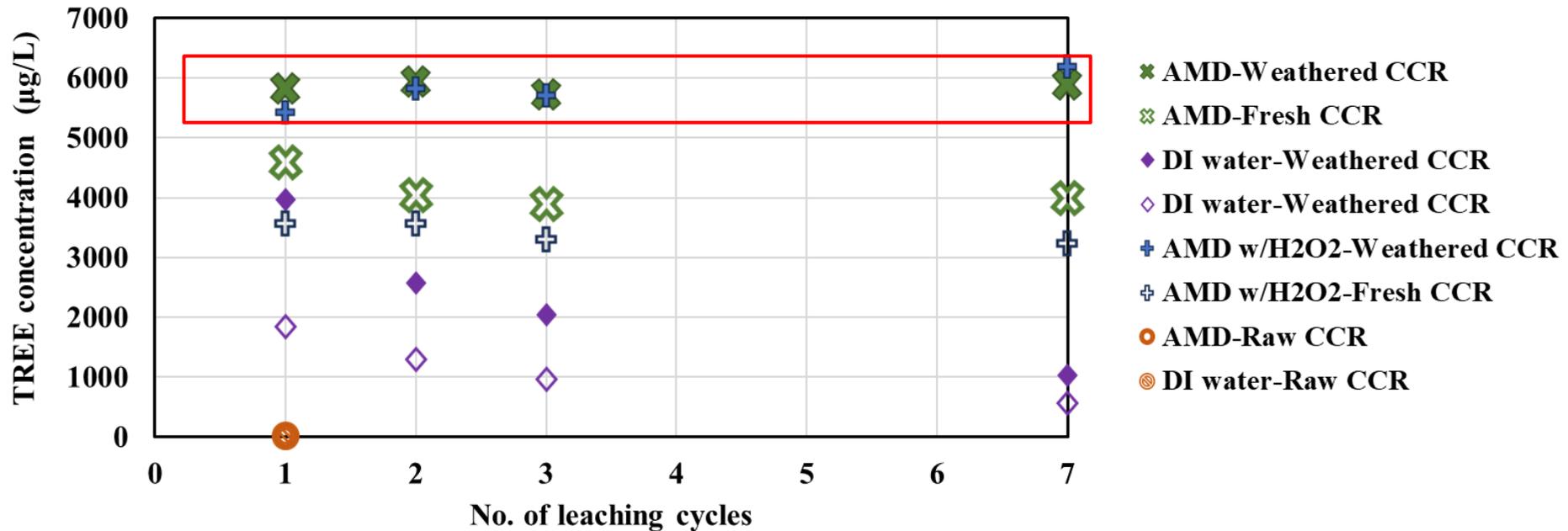


Key findings: Column Leaching Test

- Best results – Weathered CCR with AMD as the leaching solution

Column	Paste pH
Weathered	4
Fresh	3
raw	9

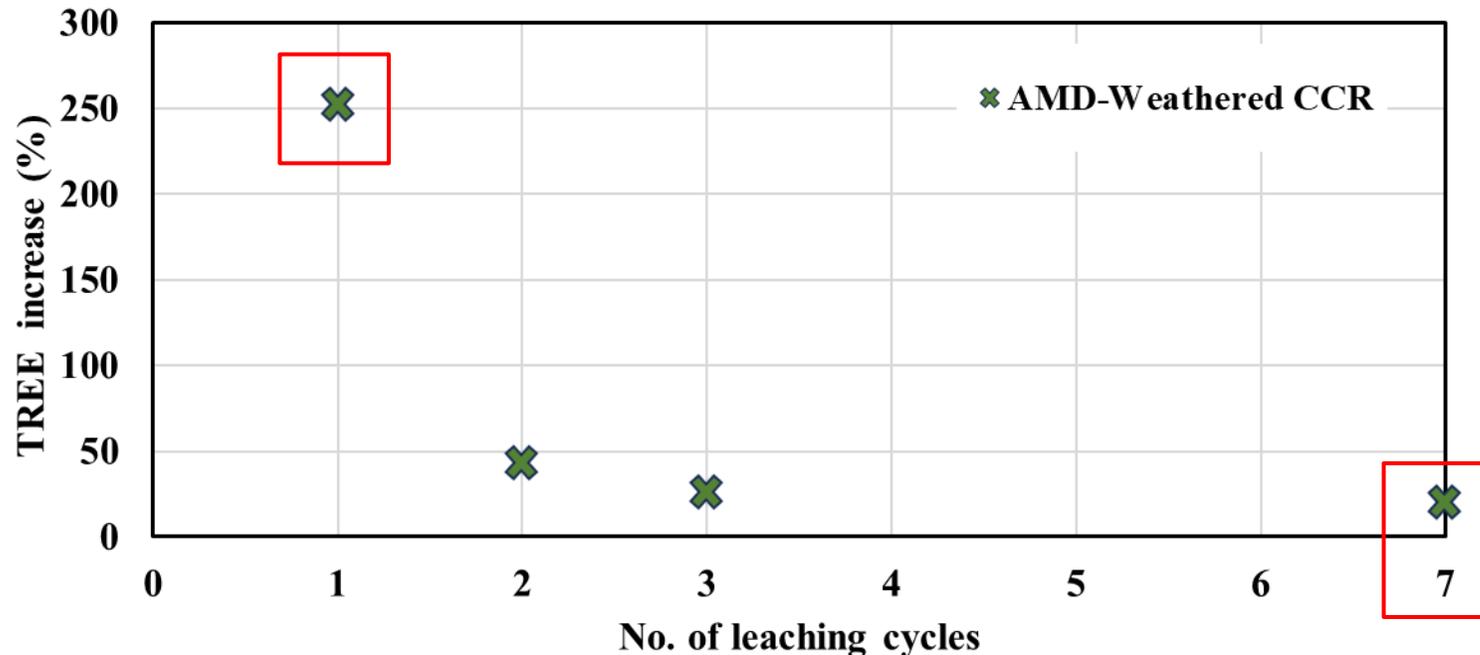
Geotechnical Properties	CCR		
	Raw	Fresh	Weathered
Initial Moisture Content (%) - Oven dried	7.0	14.4	17.6
Initial Moisture Content (%) – air dried	5.4	11.3	13.1
D10 (mm)	2.0	0.7	0.7
D30 (mm)	5.0	3.0	2.5
D50 (mm)	8.1	6.0	4.8
D60 (mm)	12.0	8.1	6.0



Key findings: Column Leaching Test

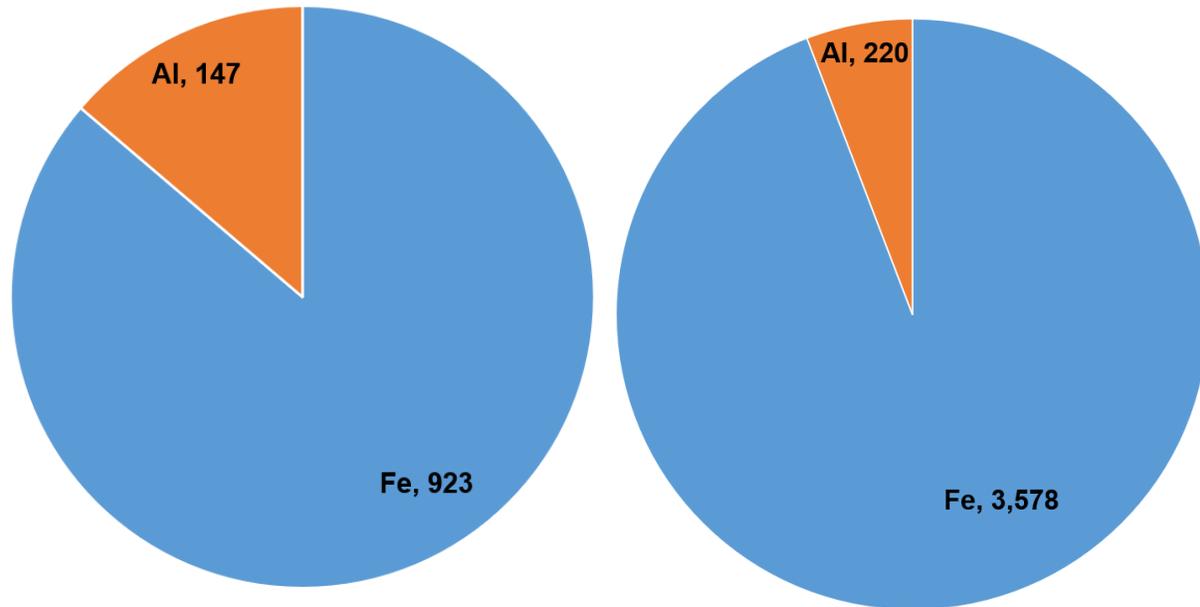
- Most leaching occurs in the first leaching cycle
- Multiple leaching cycles did not promote REE extraction.

The first leaching cycle is a flushing of surface REE compounds that have been made available by previous weathering and oxidation



Results: Column Leaching Test

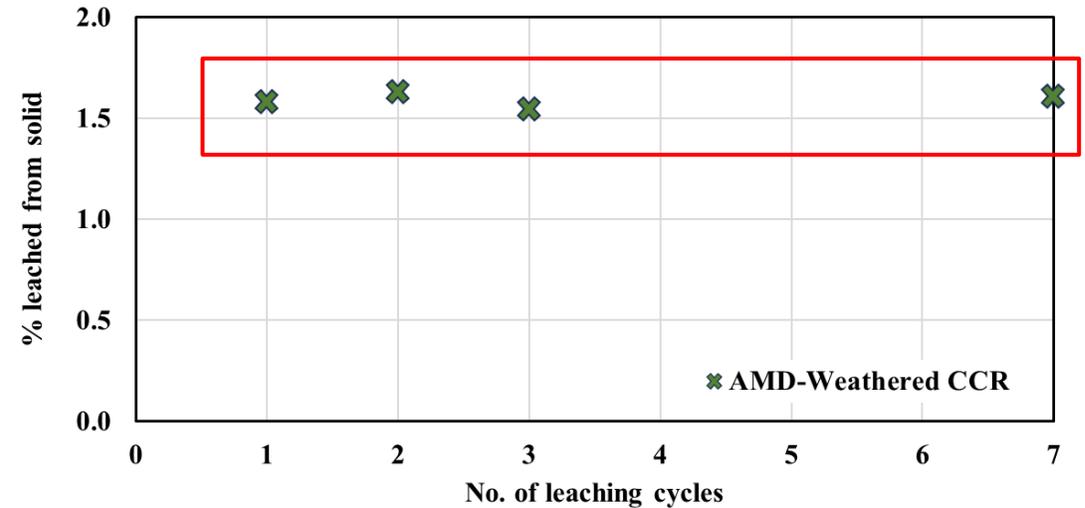
- The highest percentage of TREE leached from solids was approximately 1.7%.
- Similarly to TREE, TMM (Fe, Al) followed the same trends.



Before Leaching

After Leaching

Column AMD-Weathered CCR



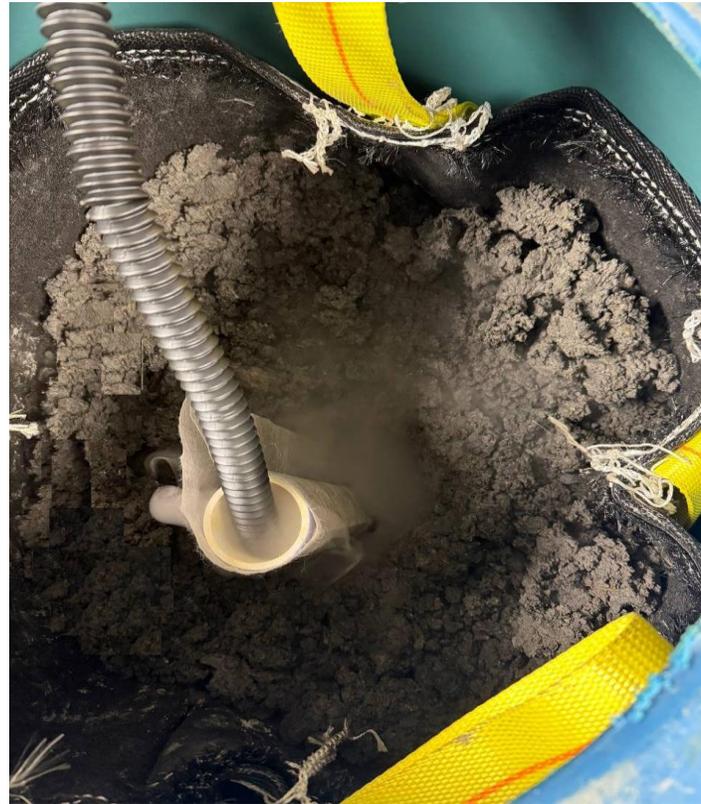
Lab Work

Type of CCR	Number of drums	Type of leachant	Name of drum	Leaching cycles	Lab samples
Weathered	2	Recirc. AMD	Drum 1 and Drum 2	Week 1/ 1 cycle	→ 1
				Week 2/ 1 cycle	→ 1
				Week 3/ 1 cycle	→ 1
Extended drying period of 4 months					
Weathered	1	Recirc. AMD	Drum 1	1 cycle	→ 1
				2 weeks of air drying	
				1 cycle	→ 1
Weathered	1	Recirc. AMD	Drum 2	1 cycle	→ 1
				2 weeks of sealed humidified air	
				1 cycle	→ 1

Phase #1

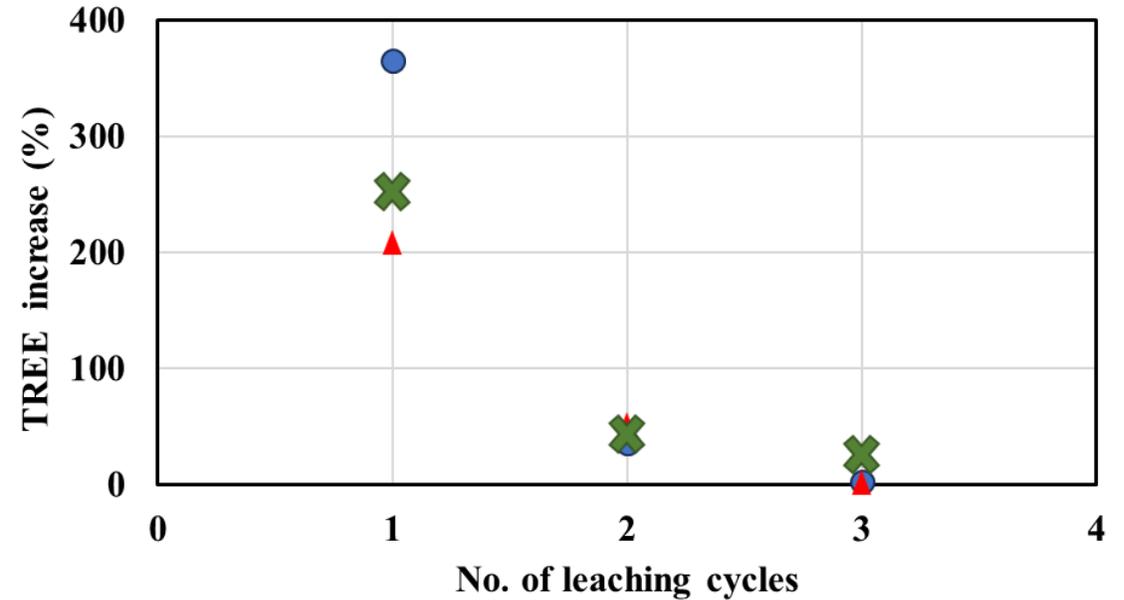
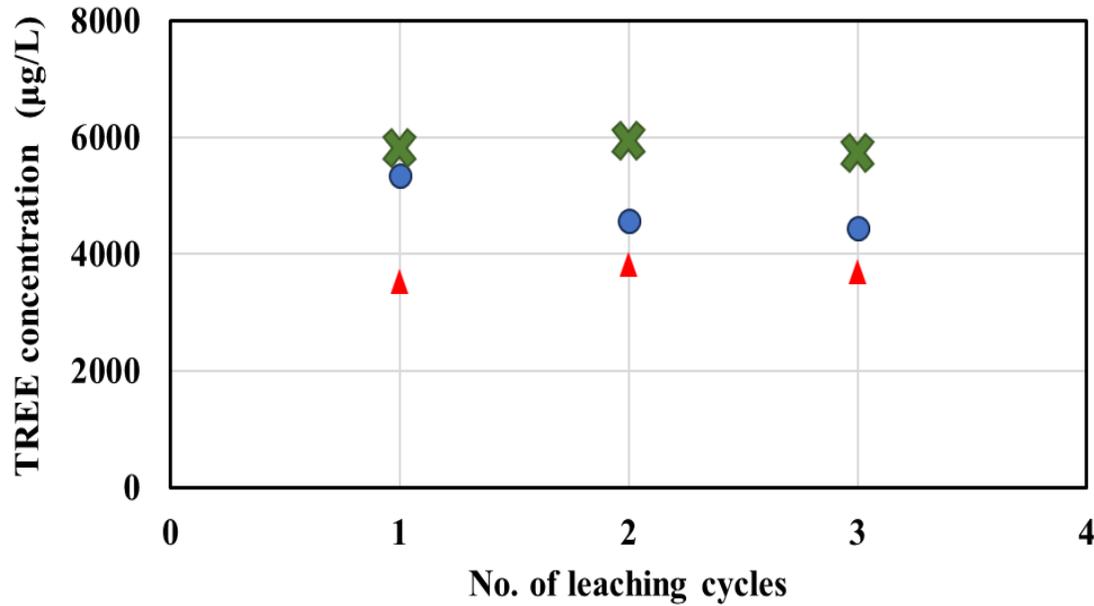
Phase #2

Lab Work: Drum leaching-test setup



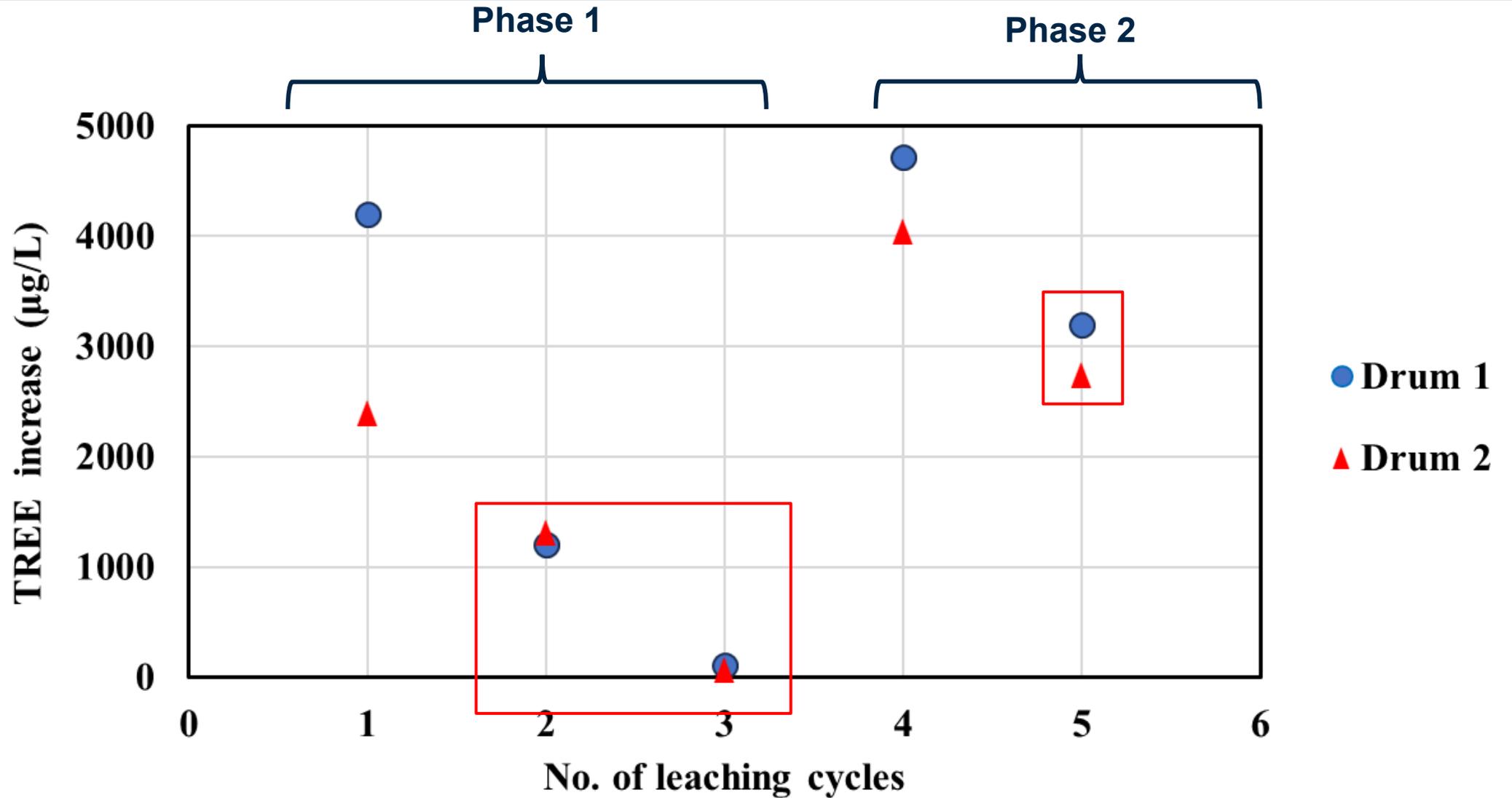
Results: Drum Leaching Test – Phase 1

- Confirmed results of column tests

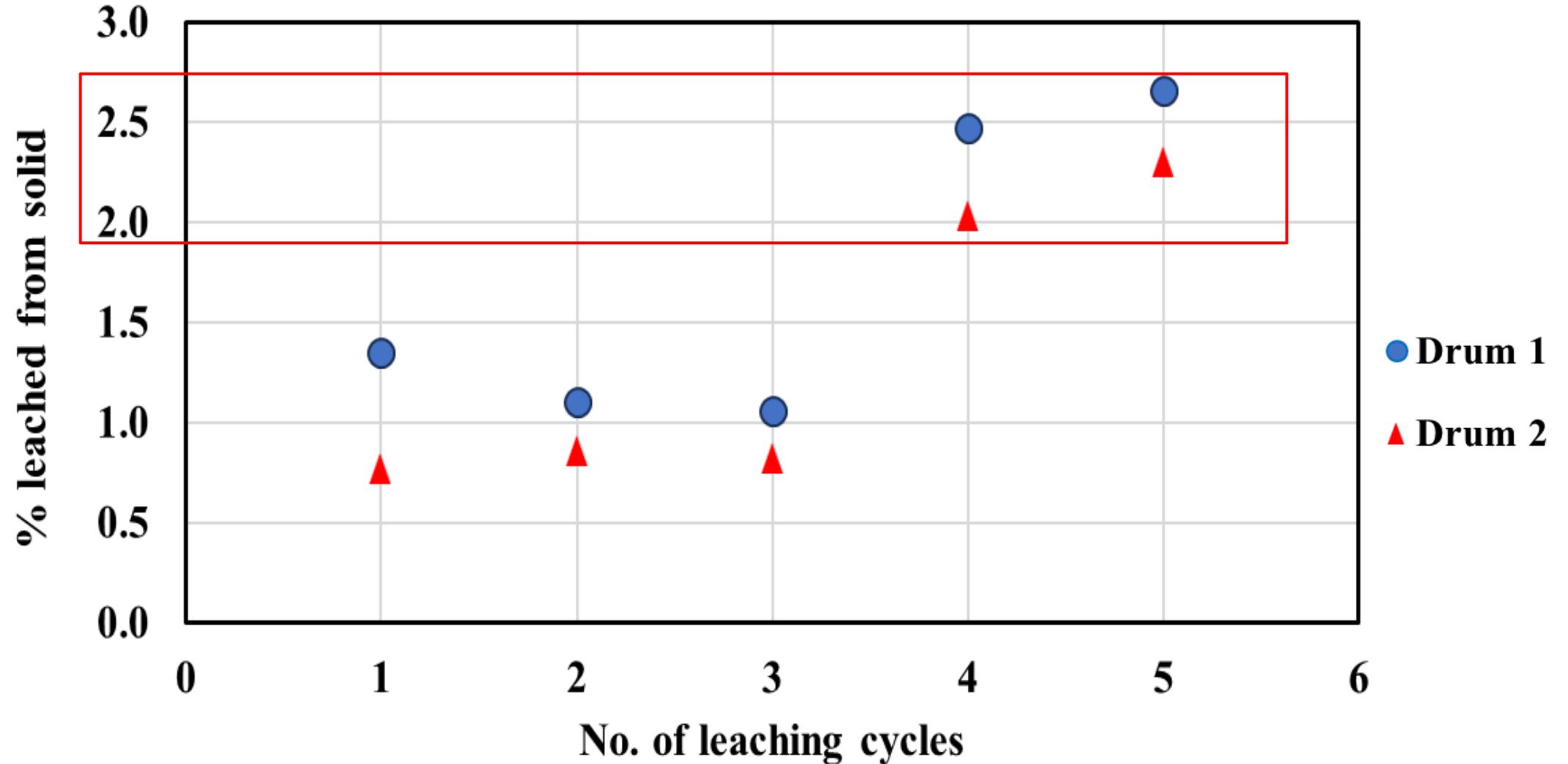


- Drum 1
- ▲ Drum 2
- ✕ Column 1 (AMD-Weathered CCR)

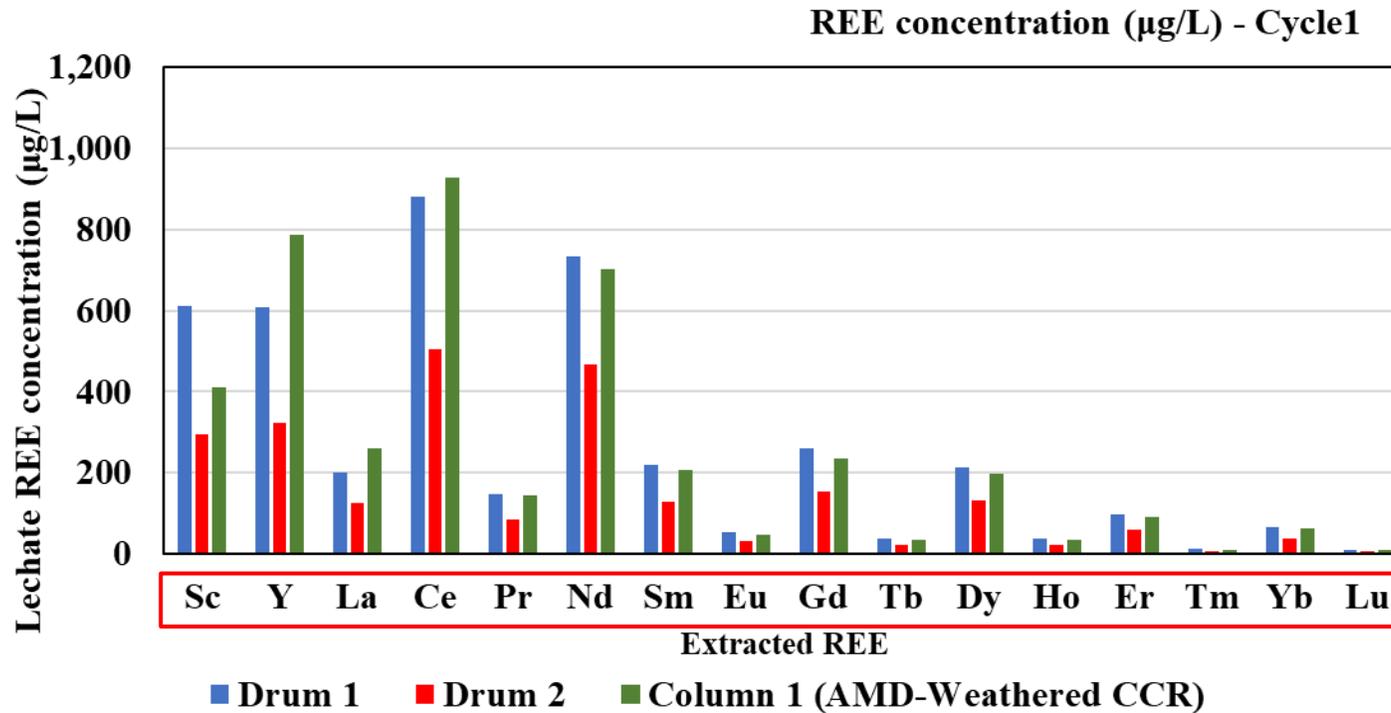
Results: Drum Leaching Test – Phase 2



Results: Drum Leaching Test – Phase 2



Individual REE Concentrations



✓ Cerium (Ce), neodymium (Nd), scandium (Sc), and yttrium (Y) were the most abundant REEs in weathered CCR.

General Conclusions

- Weathered CCR and AMD as a leaching solution gave the best results in terms of REE extraction from CCR.
- Extended drying periods may allow for additional pyrite oxidation and REE compounds accumulation at the surface of the solid refuse.

Next Step

- Evaluate shorter drying periods of 2 months.

Acknowledgements



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THANK YOU

