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RETHINKING POTASH MINE TAILINGS AND BRINES AS VALUABLE MATERIALS FOR SITE REMEDIATION AND RECLAMATION

Brandon Stoner, M.Sc. Candidate, G.I.T.
Wonjae Chang, Ph.D., P.Eng.
LuVerne E.W. Hogg, P.Geo.

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Introduction

- **Potash:** Canada is the world's largest producer (30% of global production)

Image Credit: Dr. Wonjae Chang's Lab, University of Saskatchewan

Introduction

- **Potash mining:** Conventional refinement generates substantial volumes of byproducts

Image Credit: Dr. Wonjae Chang's Lab, University of Saskatchewan

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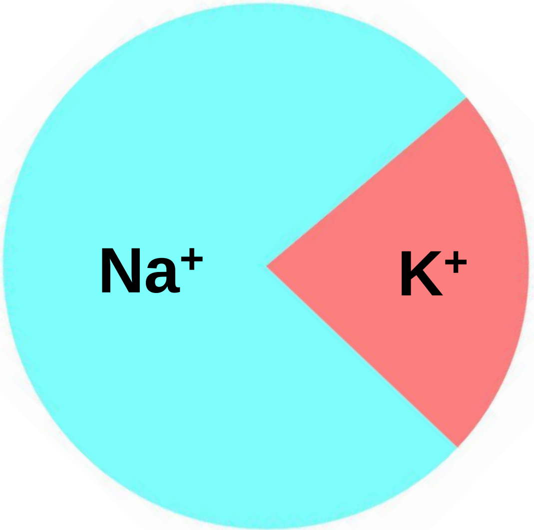
Introduction

Image Credit: Dr. Wonjae Chang's Lab, University of Saskatchewan

- 14-34% of the targeted K remains in potash byproducts (tailings and brines)



Problematic?

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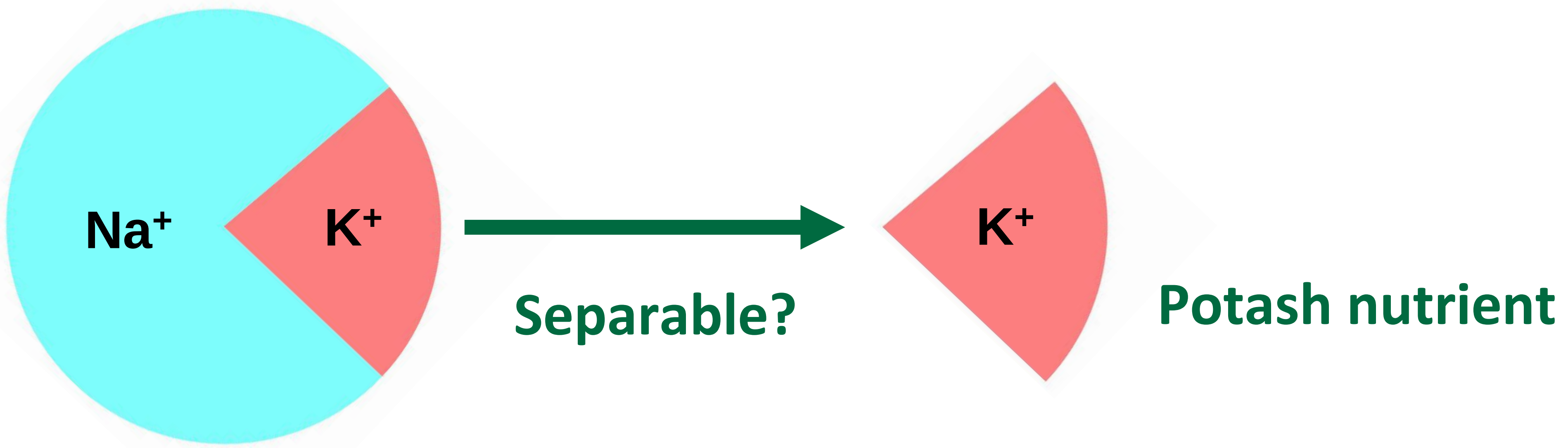
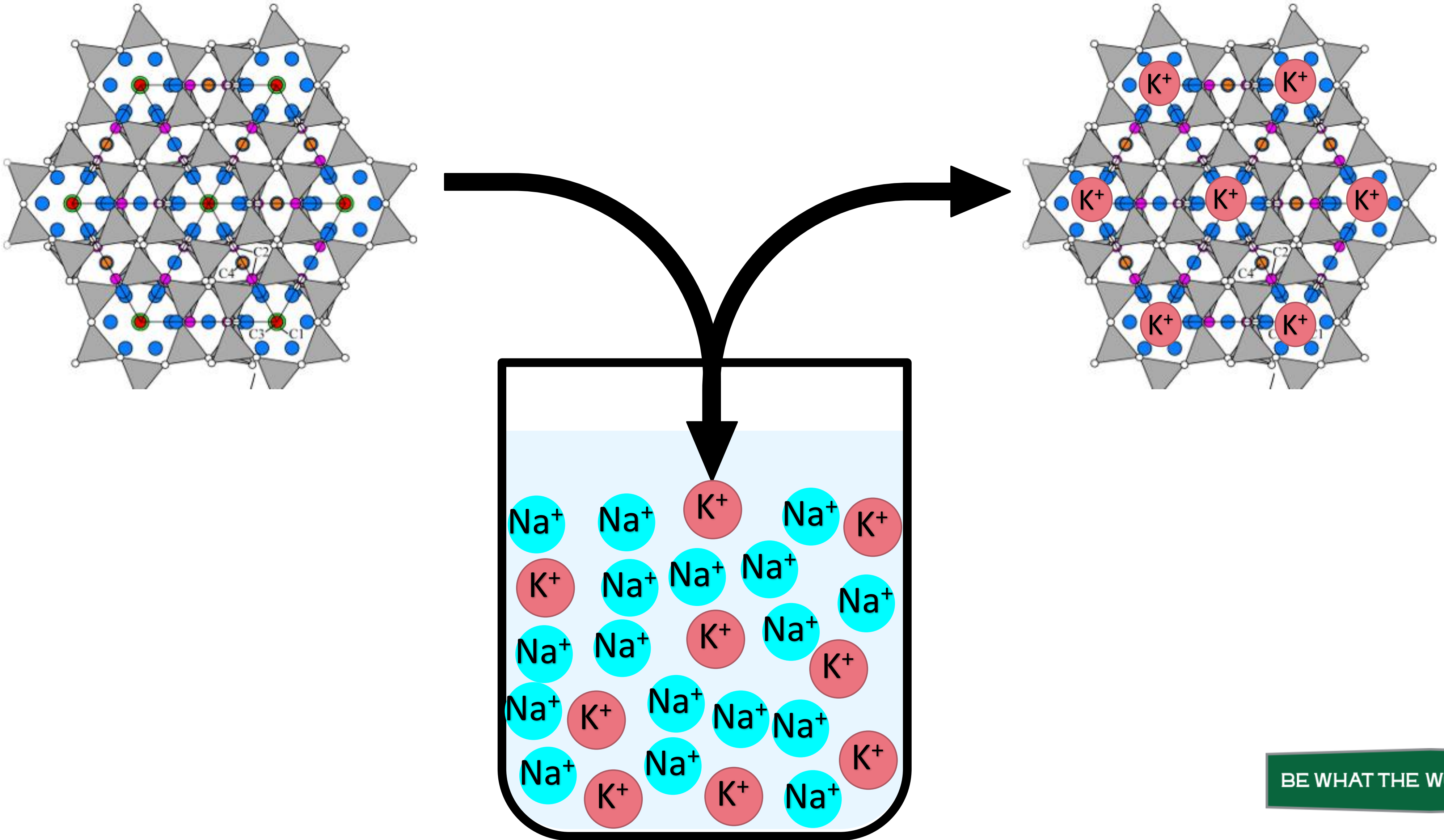
Introduction

- We rethink potash byproducts as **valuable materials**



We Propose Applying Zeolite to Capture Unextracted K



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What is Zeolite?

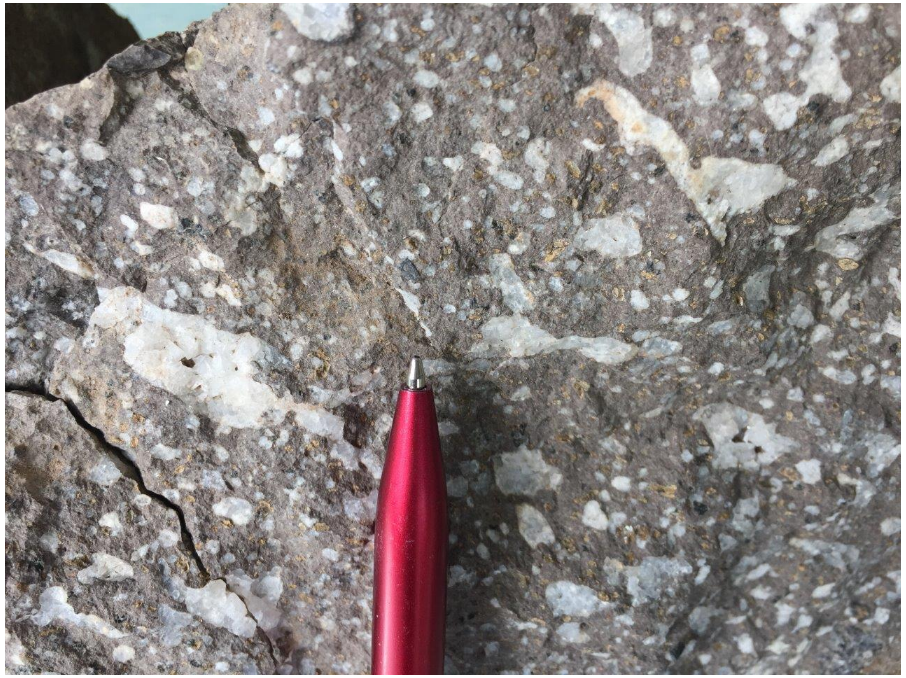

Photo by: ZMM Canada Minerals Corp.

- A group > 60 naturally occurring clay minerals
- Found throughout the world
- Inexpensive to mine and process
- Range of industrial applications: water treatment, catalysis, building materials, agriculture, energy, soil remediation, & medicinal uses

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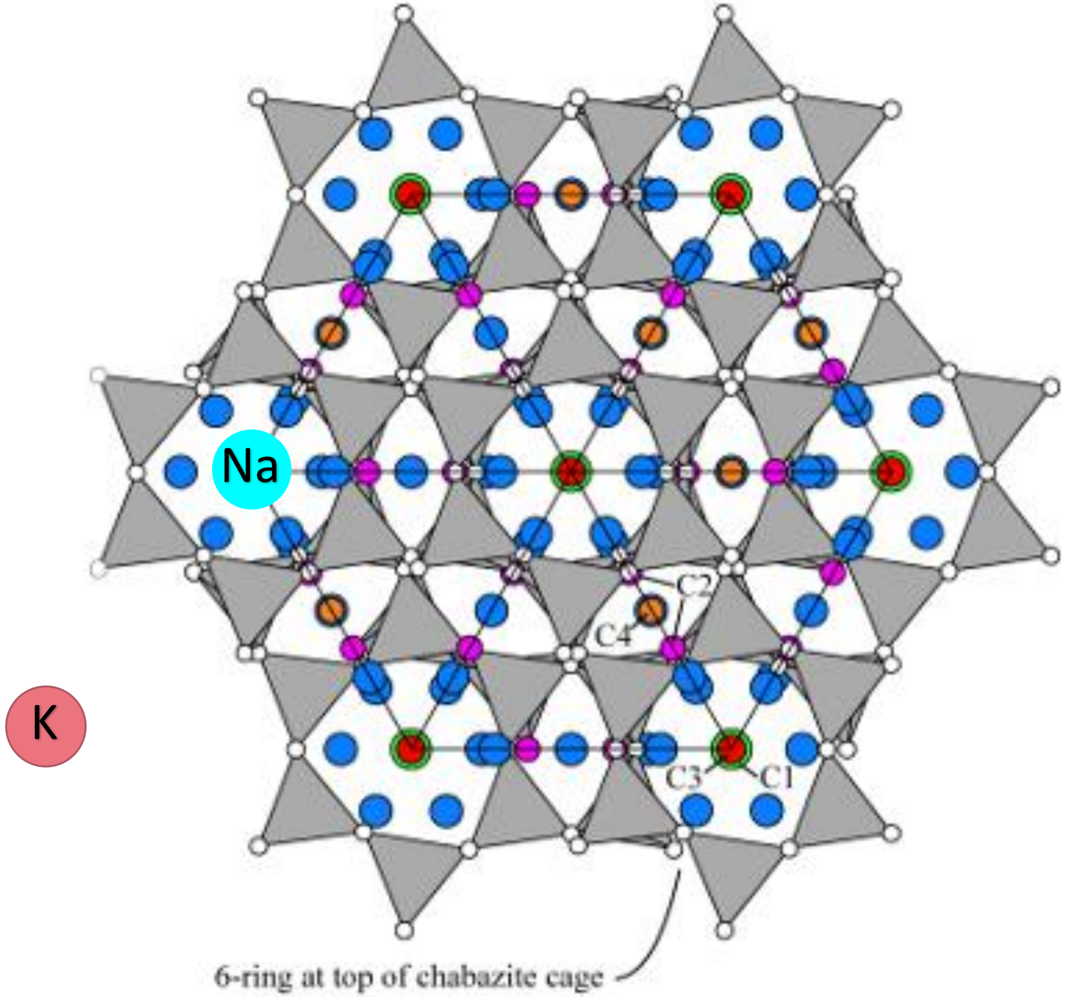
Why Use Zeolite?

- Micro-porous crystal framework
- High cation exchange capacity
- Distinct cation preferences enable selective ion removal
- High water retention
- High specific surface area

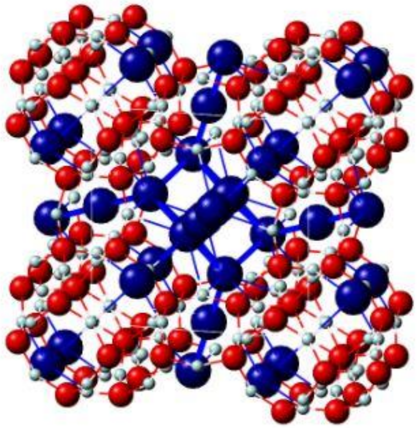
Chabazite Microporous Framework

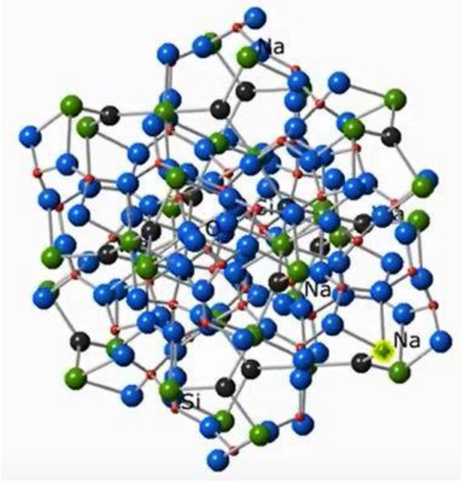


Source: International Zeolite Association

Zeolite Used in this Study

- ZMM® provided samples from new zeolite deposits from B.C.



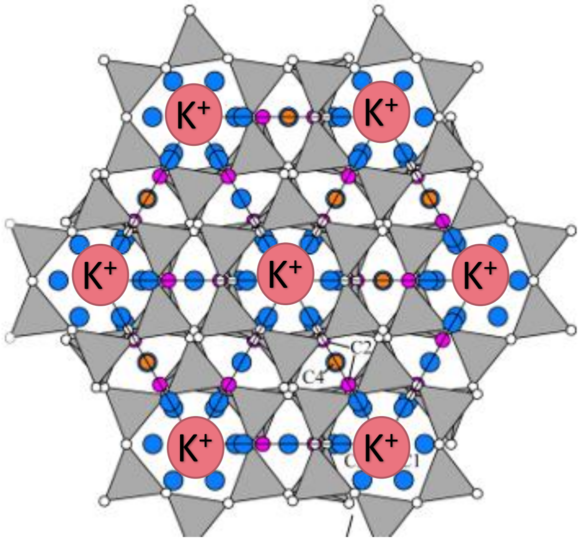


Juniper Zeolite Assemblage
(Chabazite, Heulandite, Phillipsite)

TransCanada Zeolite Deposit
(Analcime)

Photos by: ZMM Canada Minerals Corp.

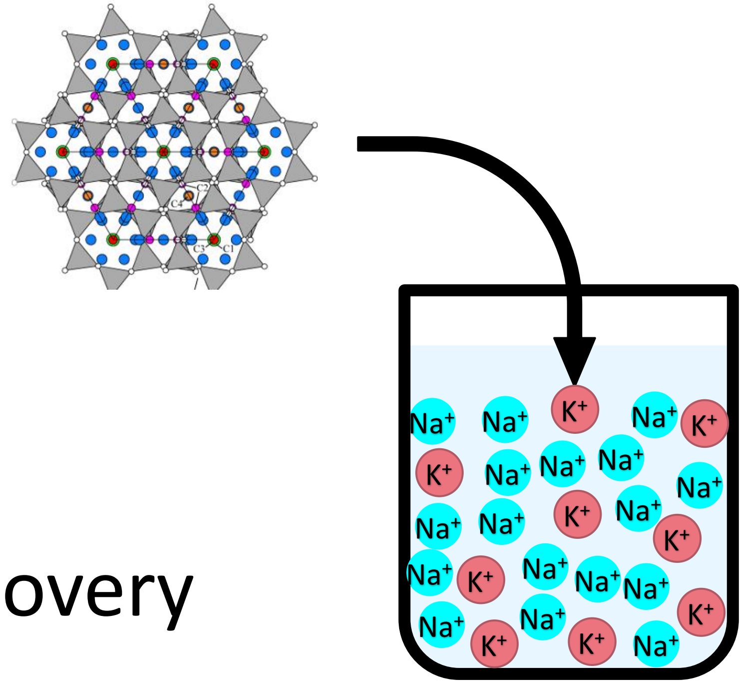
How is K-form Zeolite Valuable?



K-form Zeolite

- Soil amendment
  - Bioremediation of PHC-impacted soils
- Revegetation
  - Mine closure cover soil
  - Landfill cover soil
  - Fertilizer component

Research Objectives:



1. Select the best zeolite for K-recovery
2. Optimize parameters to maximize K-recovery
3. Evaluate K-form zeolite biocompatibility and determine its suitability as a soil amendment

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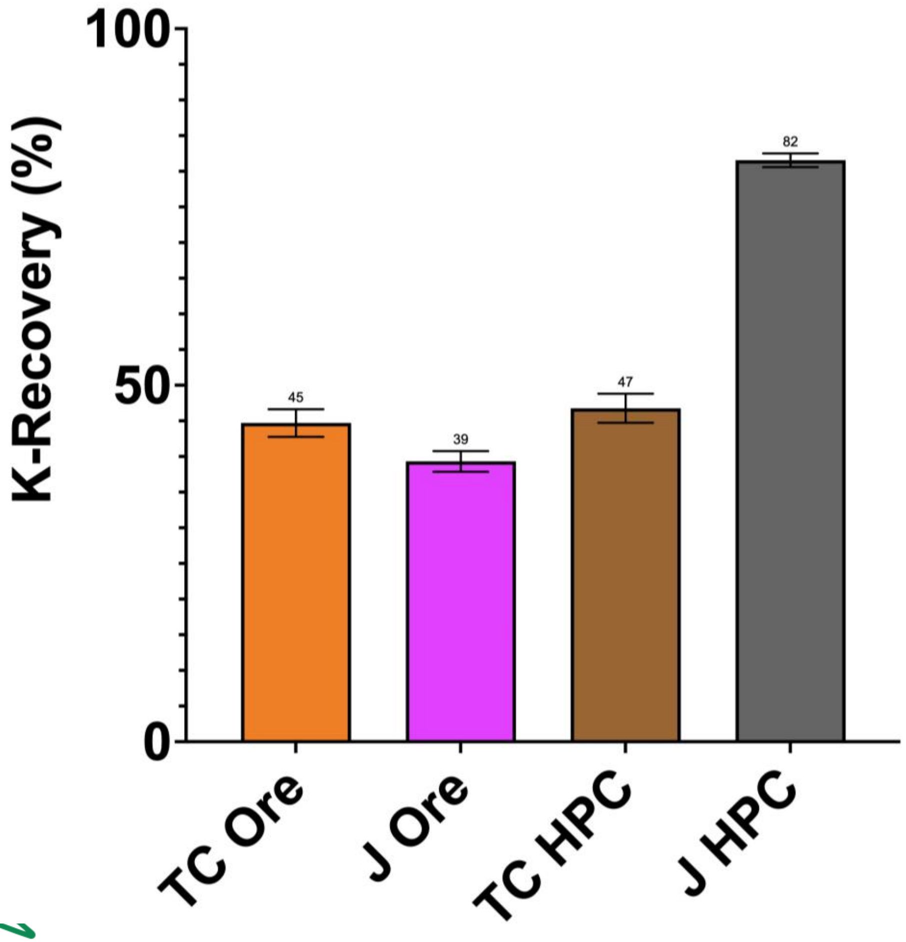
Objective 1: Select the Best Zeolite for K-recovery



Batch Experiment

- Mixed zeolite + $KCl_{(aq)}$
- Quantified K^+ ions removed from solution

$$Recovery\ (\%) = \left(1 - \left(\frac{C_{final}}{C_{initial}}\right)\right) \times 100\ (\%)$$

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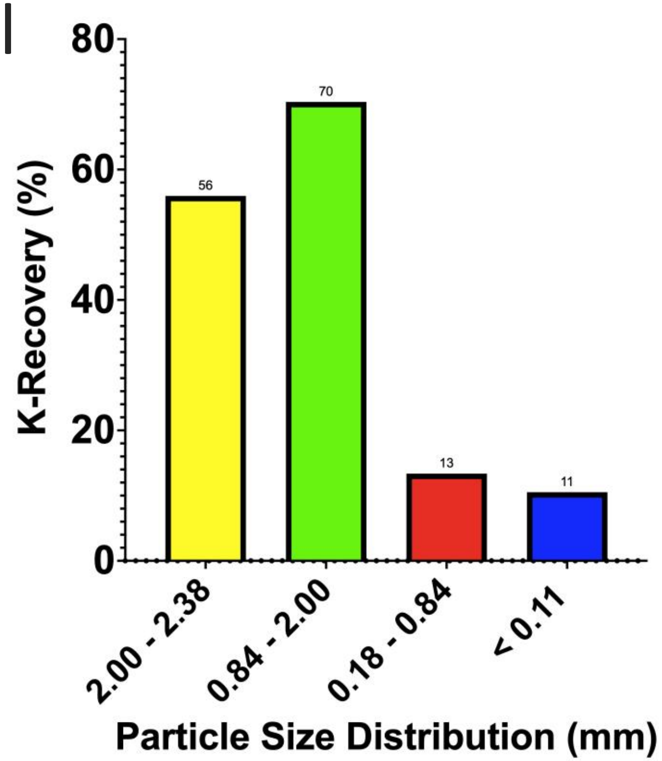
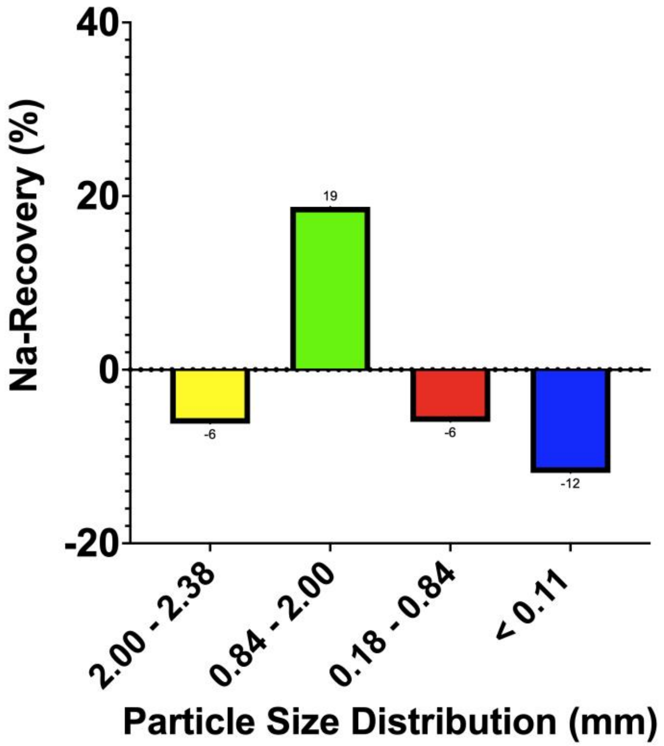
Objective 2: Optimizing Parameters – Grain Size

Upscaling Batch-Mixing

- Potash brine dilutes and mechanical mixer
- Larger grains yielded superior K-adsorption
- Simultaneous Na-desorption
  - Zeolite preference for K over Na





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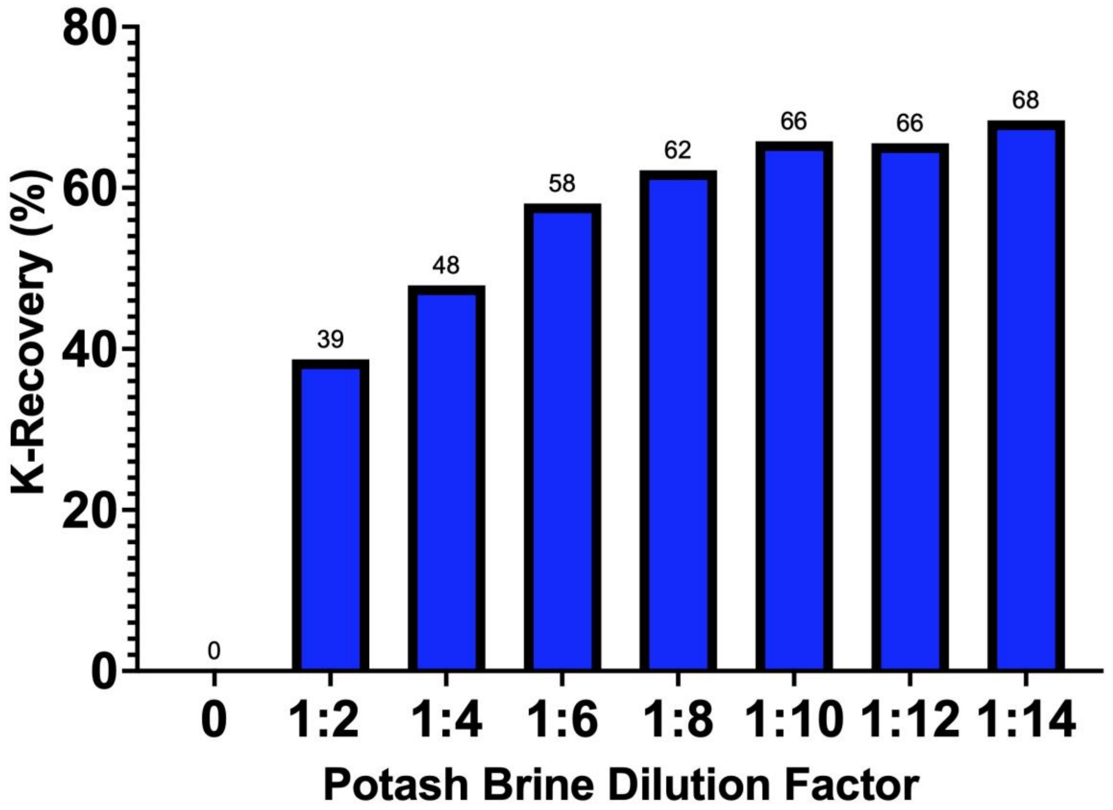
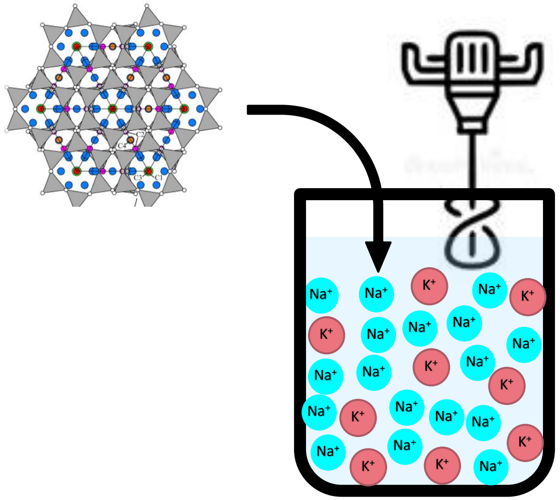
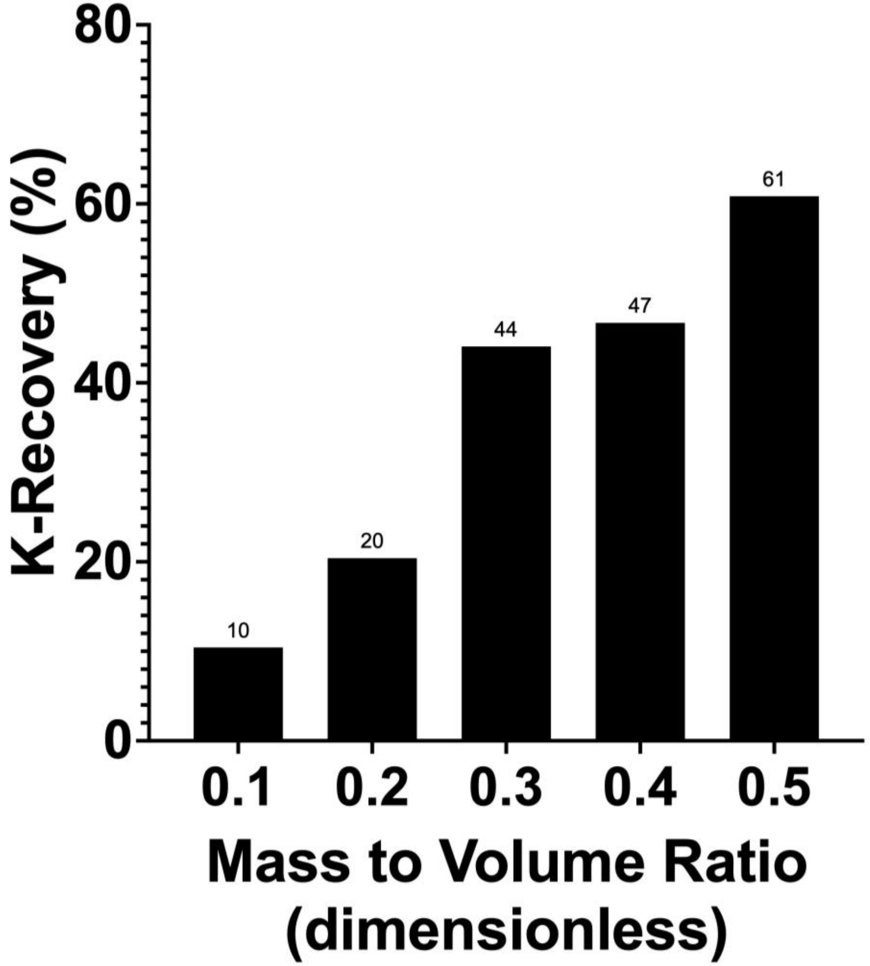
Objective 2: Optimizing Parameters – Dilution

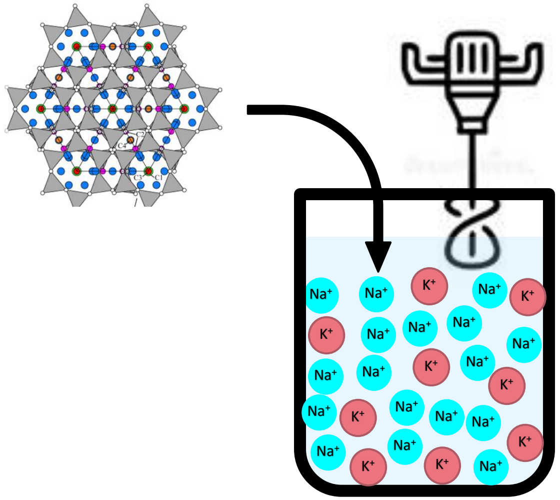




Controlling Dilution Factor (DF)

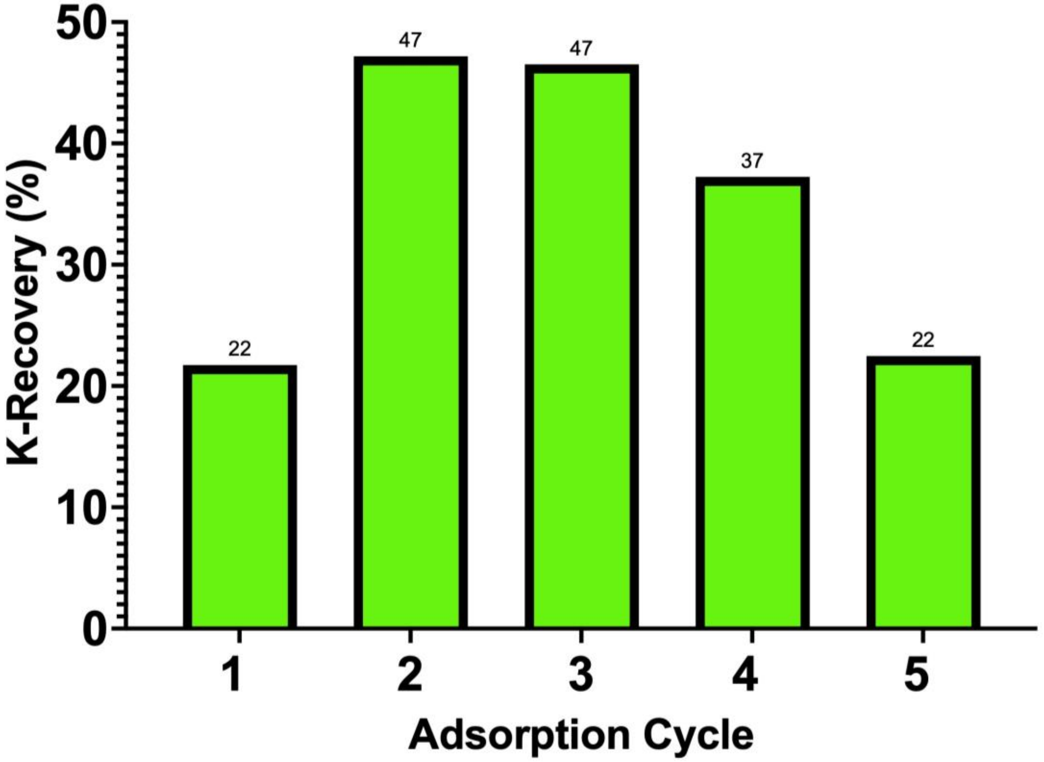
Objective 2: Optimizing Parameters – Mass to Volume

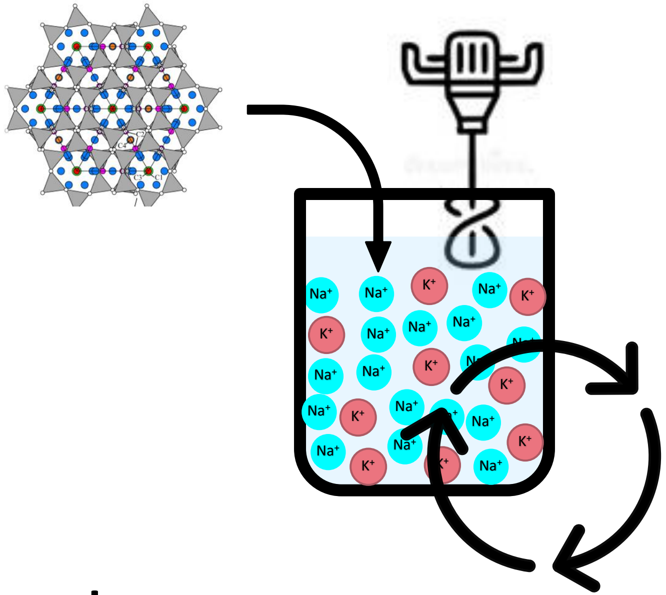




Controlling Mass to Volume (m/V)
(zeolite/brine)

Objective 2: Optimizing Parameters – Polycyclic Adsorption





Multiple cycles

- **Synthetic brine from granular Potash tailings water**
- **Reusing zeolite + brine**

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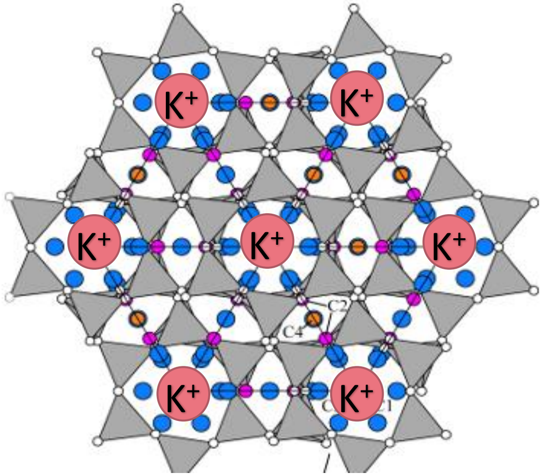
Creating an Oilfield Bioremediation Agent from Recycled K-form Zeolite



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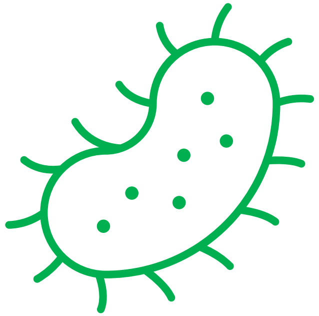

Indigenous PHC-degrading soil bacteria

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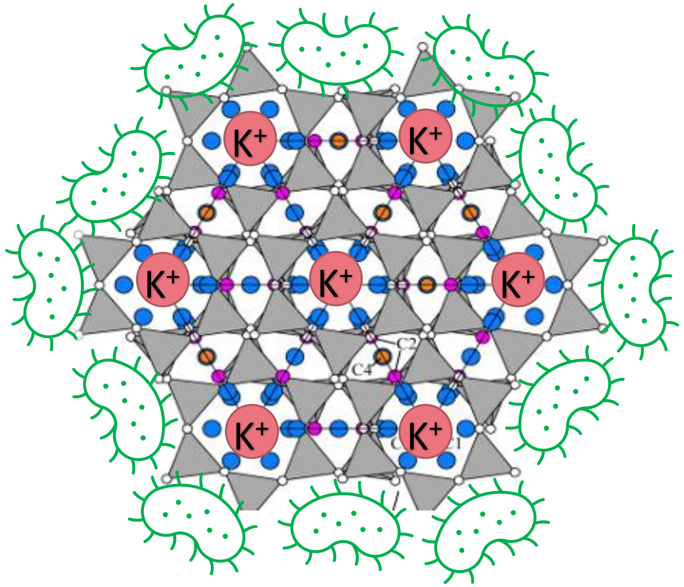

K-ZeoBioSphere

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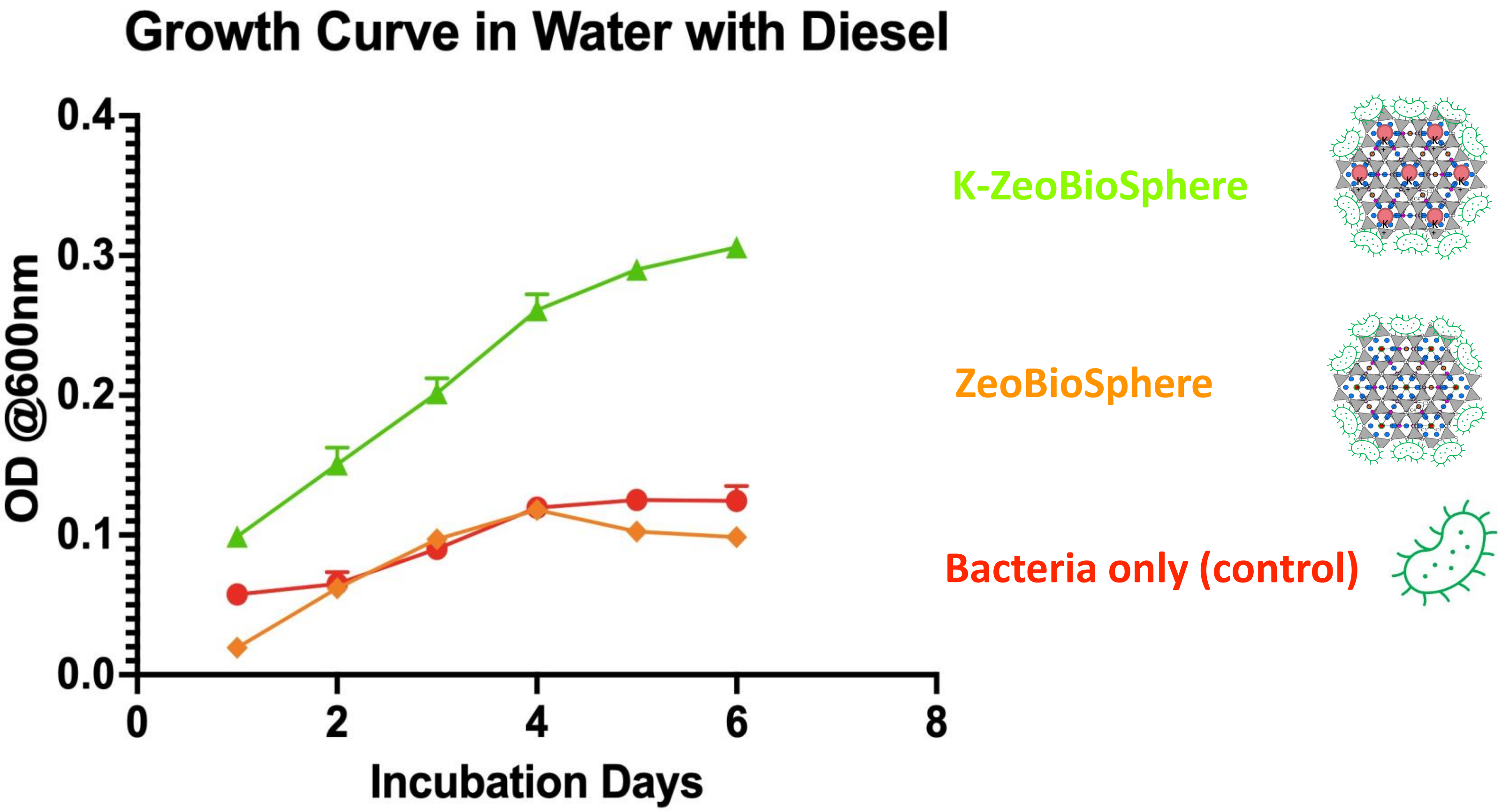
Objective 3: Evaluating K-form Zeolite Biocompatibility & Suitability as a Soil Amendment



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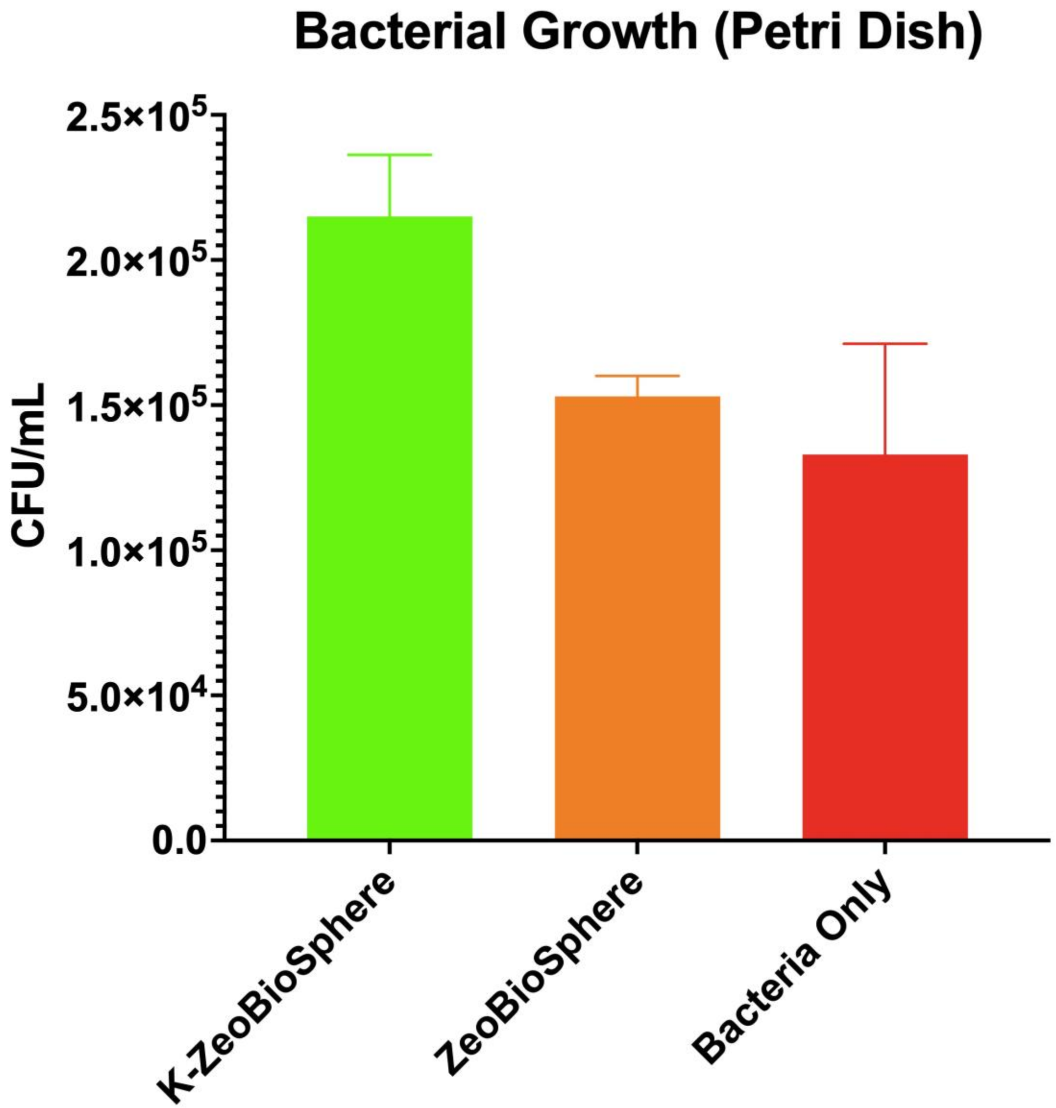
Objective 3: Evaluating K-form Zeolite Biocompatibility & Suitability as a Soil Amendment



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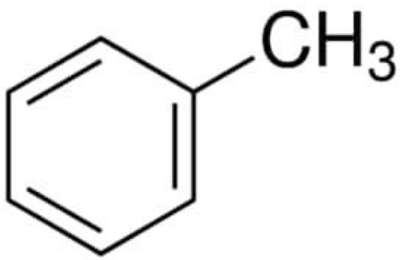
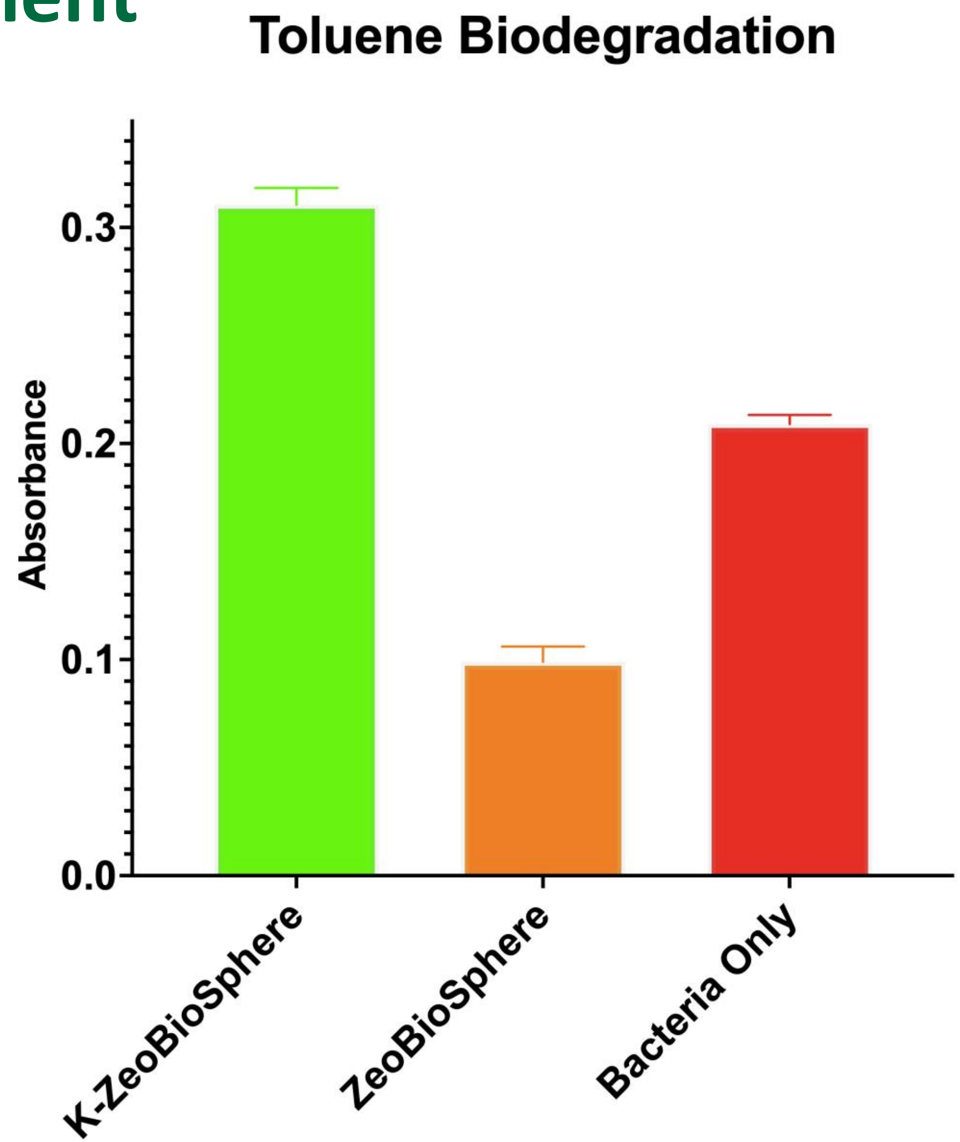
Objective 3: Evaluating K-form Zeolite Biocompatibility & Suitability as a Soil Amendment

Toluene bioassay experiment





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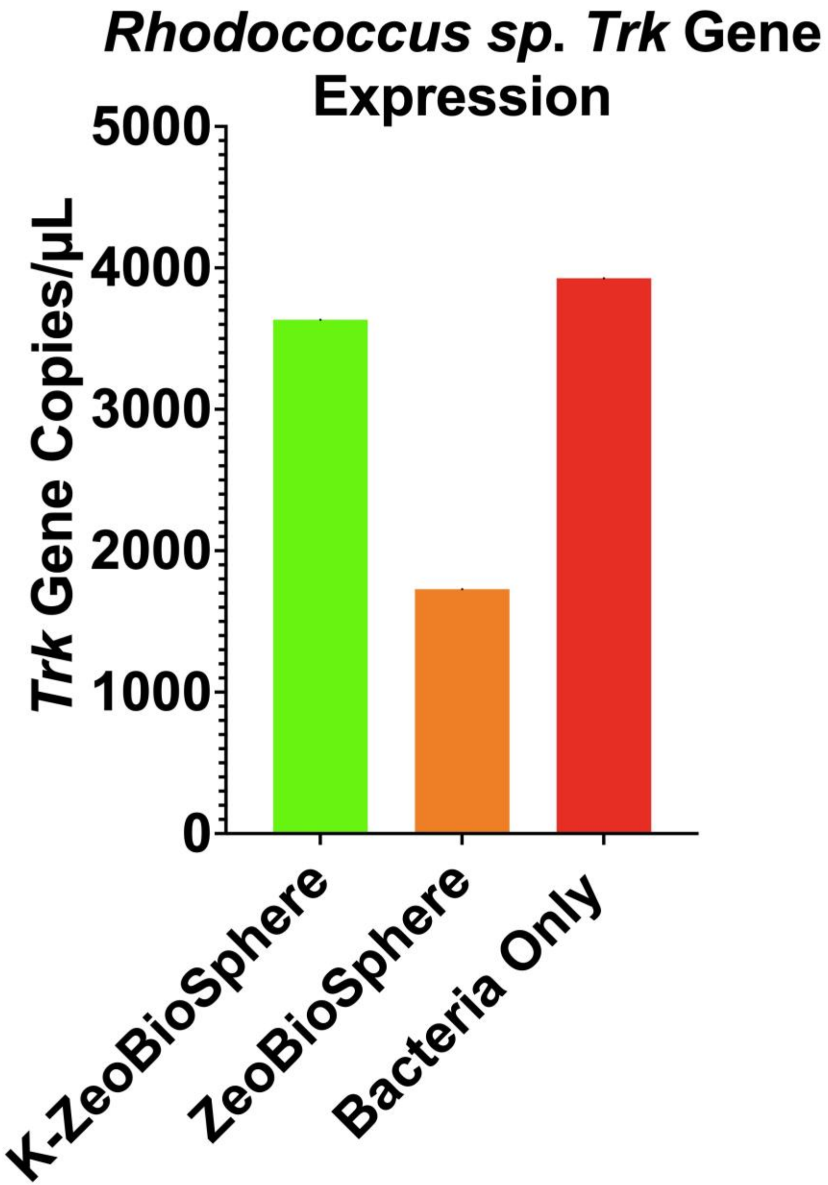
Objective 3: Evaluating K-form Zeolite Biocompatibility & Suitability as a Soil Amendment

3D Digital PCR:
Potassium Transport gene (*Trk*) detection in *Rhodococcus sp.*



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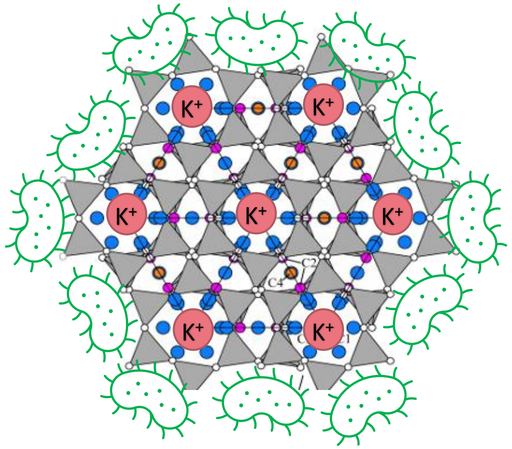
Key Findings

- Effective K-recovery from potash byproducts to create K-form zeolite
- K-form zeolite can be augmented with PHC-degrading bacteria
    - Rapid growth, toluene (PHC) biodegradation, water, and nutrient supplementation compared to controls
- Cost effective to create and apply to soils

K-ZeoBioSphere



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Implications – Conventional Practice: A 'Linear Economy'

Mine → **Process** → **Byproducts**

Potash Ore

Potash-Based Fertilizer

Potash Tailings & Brines

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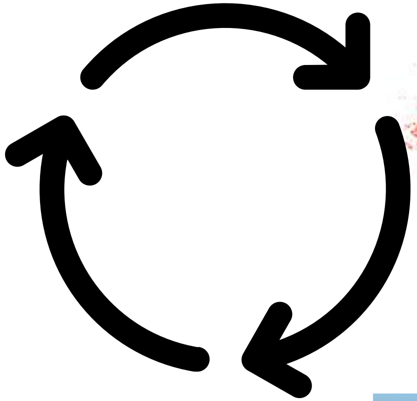
Implications – Contemporary Practice: A 'Circular Economy'

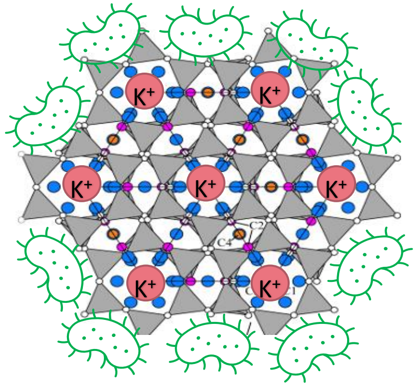
Mine
Potash Ore

Restore
Contaminated Oilfield Sites



Process
Potash-Based Fertilizer

Convert
Byproducts into a Soil Amendment



Recover
K^+, $,
Social Capital

Byproducts
Potash Tailings & Brines

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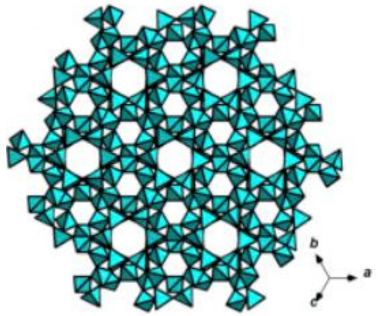
Acknowledgments

- Principal Sponsor:

ZMM
Canada Minerals Corp.



Advanced Zeolite Materials

- Additional Funding:

Mitacs Accelerate

NSERC CRSNG

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Thank You

- Brandon Stoner, M.Sc. Candidate, G.I.T., University of Saskatchewan
  - brandon.stoner@usask.ca
  - 306-491-8528

- Prof. Wonjae Chang, PhD, P.Eng., Associate Professor, University of Saskatchewan
  - wonjae.chang@usask.ca
  - 306-966-5373

- LuVerne E.W. Hogg, P.Geo., CEO, ZMM® Canada Minerals Corp.
  - verne@zmmcanadamineralscorp.com
  - 250-767-6788

Questions?

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