CBBG Center for Bio-mediated & Bio-inspired Geotechnics

Bioremediation Microbe Detox

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Bio156 - Introductory Biology for Allied Health

Glendale Community College North - MCCCD

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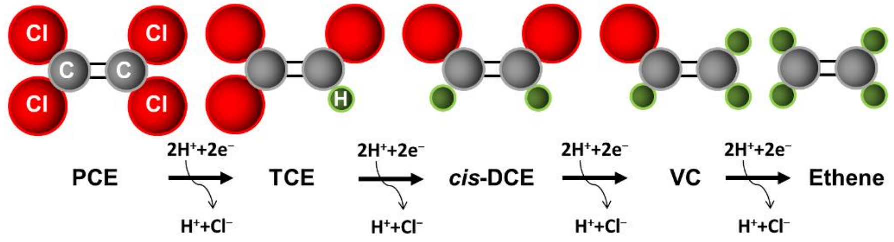
NSF

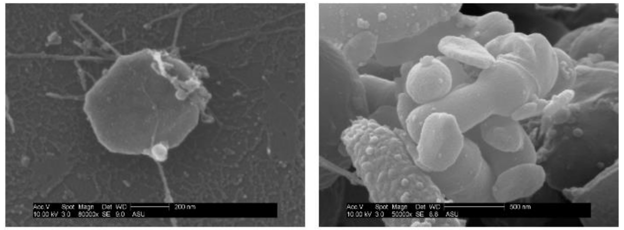
Arizona State University · UC Davis University of California · Georgia Institute of Technology · NM State University

RET Lab Experience Research Summary

Research Background

- Toxic chlorinated solvents are present at a majority of Superfund Sites.
- Reductive dechlorination is a method to remediate them, where *D. mccartyi* use H_2 to convert chlorinated solvents to non-toxic ethene/ethane.
- Typically, fermentation provides H_2, but issues can arise like bioclogging and competition from methanogens.
- Microbial-chain elongation (MCE) is a H_2-producing metabolism and could potentially replace fermentation to optimize reductive dechlorination.
- Successful MCE-driven reductive dechlorination will depend on the substrates injected into the subsurface.





Dehalococcoides mccartyi

Image credit: Anca Delgado/ASU. *D mccartyi* detoxify chlorinated ethenes into nontoxic non-chlorinated ethenes. https://engineering.asu.edu/news/bio-based-decontamination/

RET Lab Experience Research Summary

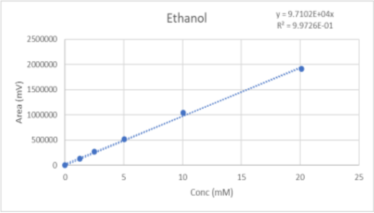
Research Objectives

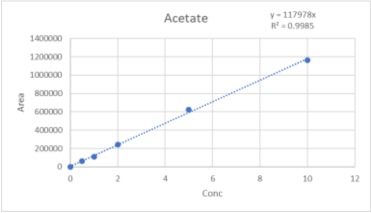
- Set up calibration points for MCE products (volatile fatty acids C1-C8, lactate, ethanol, butanol, and hexanol) on High Performance Liquid-Chromatography (HPLC) to evaluate MCE products at a superfund site.
- Through DNA extraction assess microbial community abundance and quantify relevant organisms (methanogens and *D. mccartyi*) using qPCR.
- Data comparison (MCE products, microbial community abundance, quantity of relevant microorganisms) to evaluate groundwater at superfund site with new MCE substrate of ethanol and acetate (9:1, respectively) vs. more complex organic fermentable substrates of potassium lactate, sodium lactate, molasses, and emulsified vegetable oil, previously used.

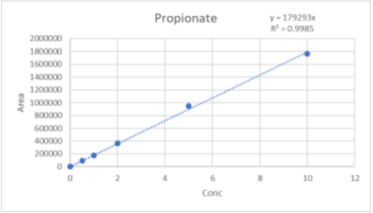
RET Lab Experience Research Summary

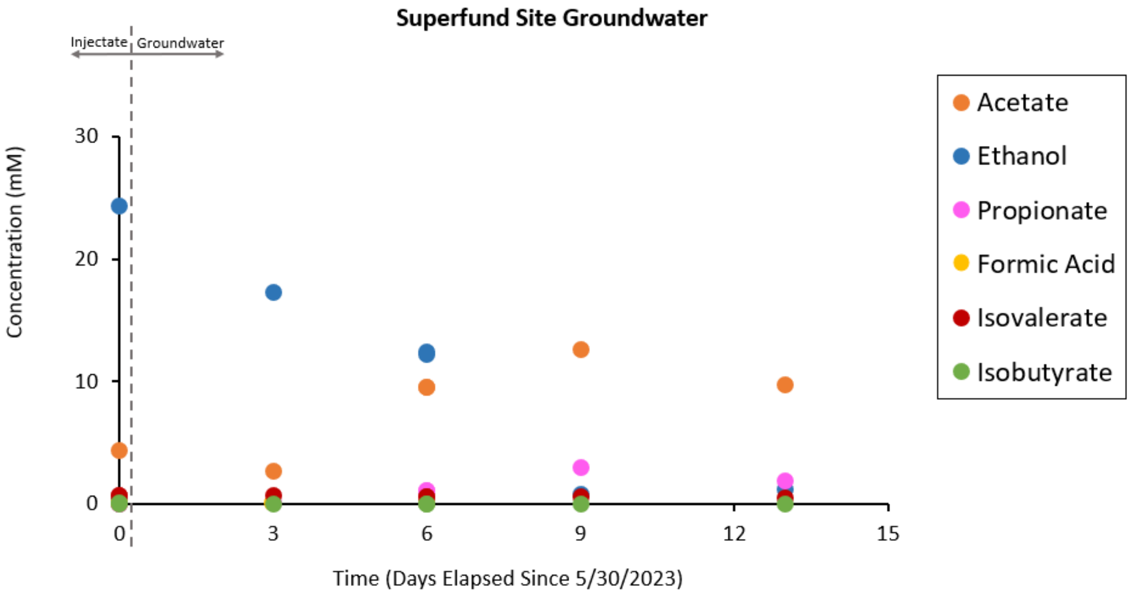
Research Conclusions

- Data based on days 0-13.
- Propionate was the major MCE product.
- Acetate was consumed until day 3. After day 3, acetate was produced - likely a product of MCE.
- Ethanol was rapidly consumed after day 6.
- Further research is needed to assess the microbial community and determine if MCE microorganisms fed with the new substrates are driving reductive dechlorination.









RET Instructional Lesson Implementation

Lesson Description

- Flipped-Lesson: Investigate chlorinated solvent trichloroethylene (TCE).
- Use scientific method to perform an experiment and gain knowledge of bioremediation. Specifically, cleanup of groundwater using microorganisms.
- Provided with a protocol, students will use sugar (pollutant) and yeast (bacteria) exposed to varying environmental conditions (temperature, pH, salinity) to find optimal settings for organisms to degrade pollutants.
- Degradation measured through CO_2 collection (conversion of pollutant to a harmless gas) and presentation of data.
- Pre- and post assessments administered to assist comprehension.

crushed ICE	DI H_2O HOT	vinegar COLD	vinegar HOT	salt	baking soda	tap H_2O COLD	tap H_2O HOT	sugar	yeast	DI H_2O rm T
x								x	x	x
	x							x	x	x
		x						x	x	x
			x					x	x	x
				x				x	x	x
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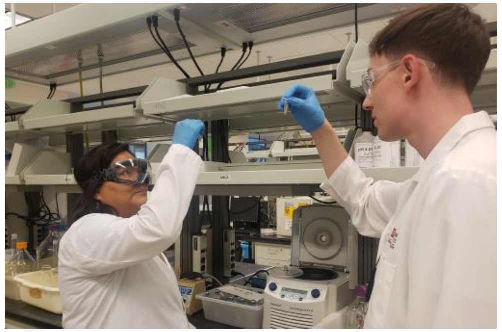
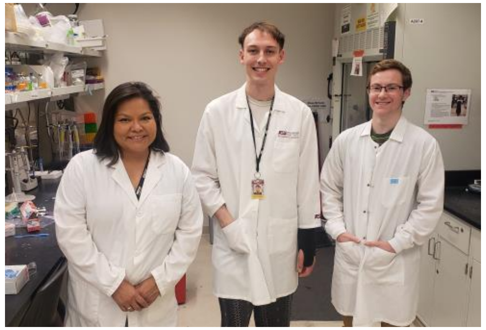
	x			x	x			x	x	x
	x		x	x				x	x	x

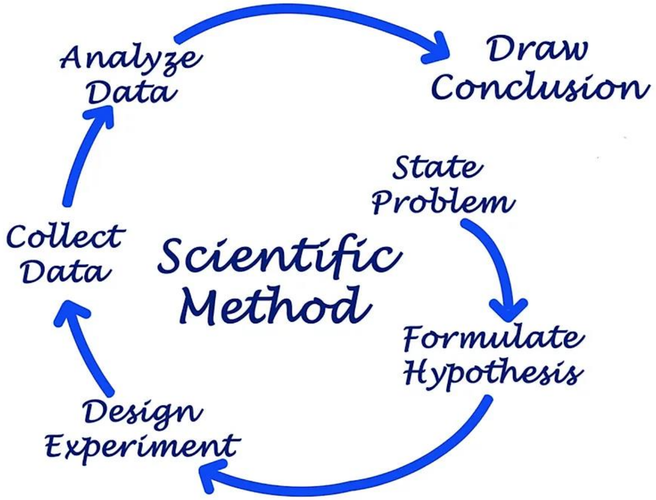
RET Instructional Lesson Implementation

Lesson Objectives

- Gain background on chlorinated solvents and bioremediation.
- Application of the scientific method.
- Introduction to the importance and impact of living aerobic/anerobic microorganisms (bacteria) and their contribution to bioremediation.
- Make connections between biology, chemistry, and environmental engineering.
- Discuss implications of ongoing real-world ASU research this lesson is modeled after.
- Engage students in science, research, and opportunities for work (CBBG).







Thank you!
This experience has been invaluable!!

Questions?
Recommendations?

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