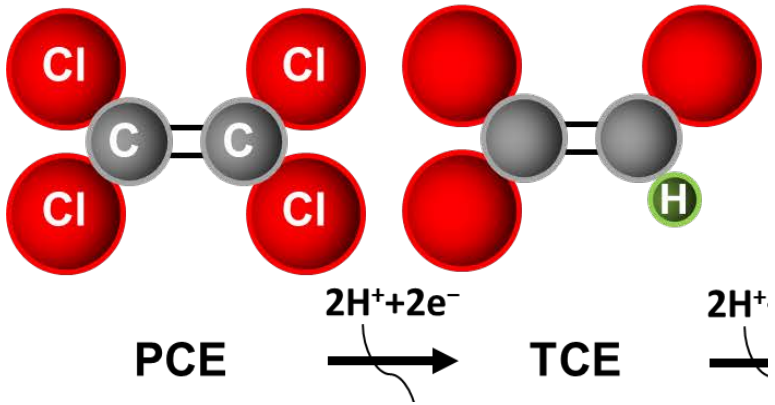
CBBG
Center for Bio-mediated & Bio-inspired Geotechnics

Hydrogen-Based Microbial Interactions for Successful Bioremediation

Rosa Krajmalnik-Brown
Environmental Protection and Restoration
Thrust leader
Professor, Arizona State University
School of Sustainable Engineering and
the Built Environment

Chlorotehenes in Groundwater

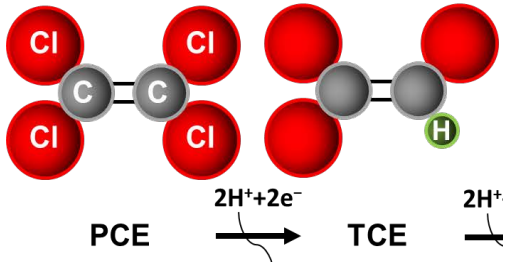


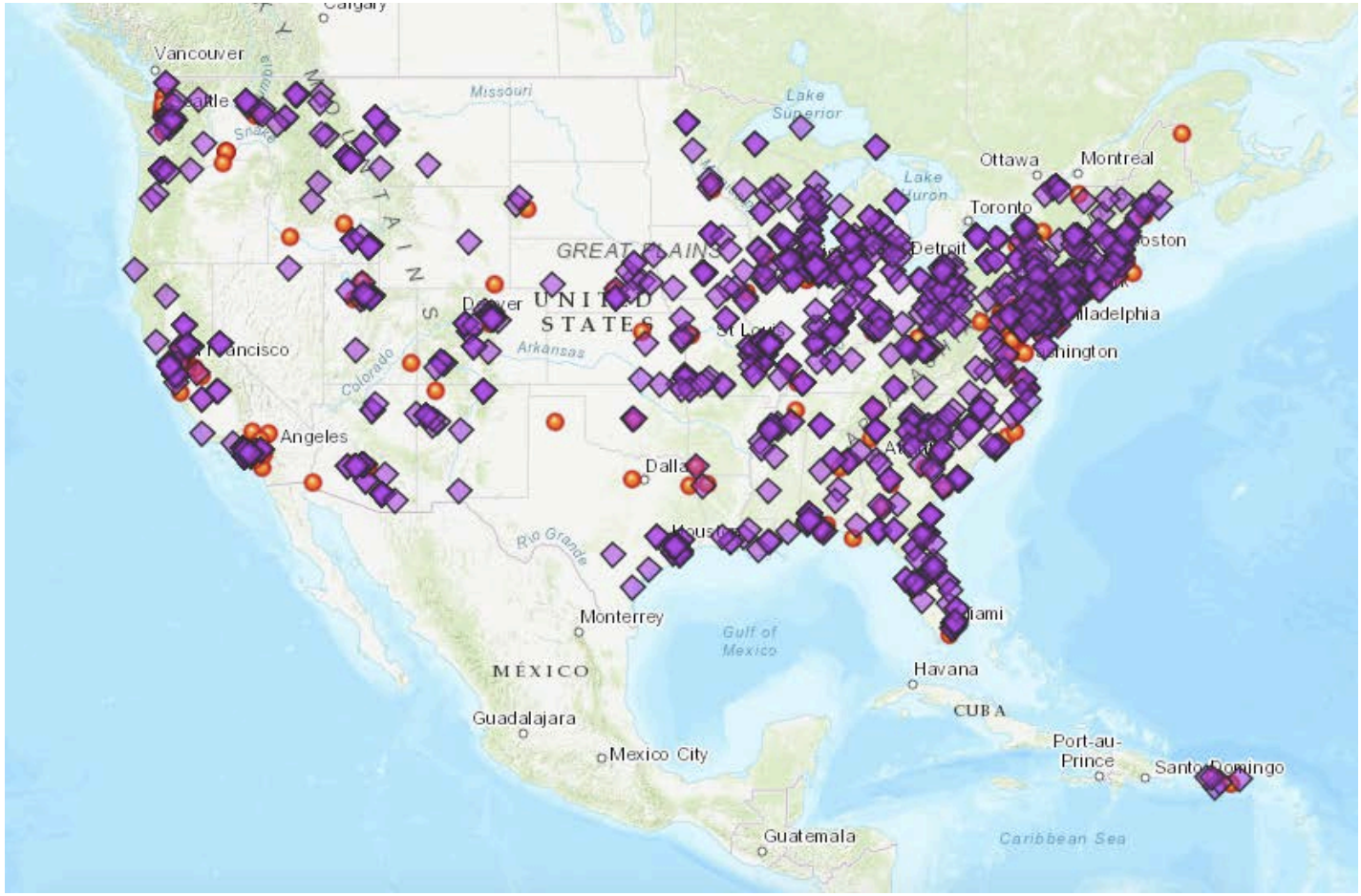
1. The problem
2. Bioinspired and Biomediated solution
3. Some contributions from my lab towards enhancing Bioinspired solution
4. New H_2 based insight

www.biogeotechnics.org

Center for Bio-mediated & CBBG Bio-inspired Geotechnics

Chlorotehenes in Groundwater





U.S. Superfund Sites:

- More than 1000 sites
- 60% polluted with PCE/TCE

Image: https://www.epa.gov/enforcement/map-superfund-enforcement-cleanup-work

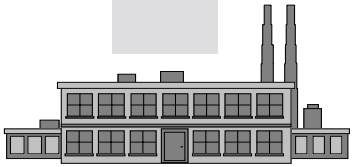
Bioinspired solution?

Center for Bio-mediated & CBBG Bio-inspired Geotechnics

Halogenated Organics

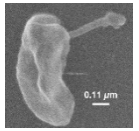
Biogenic

Geogenic



Anthropogenic

Halogenation

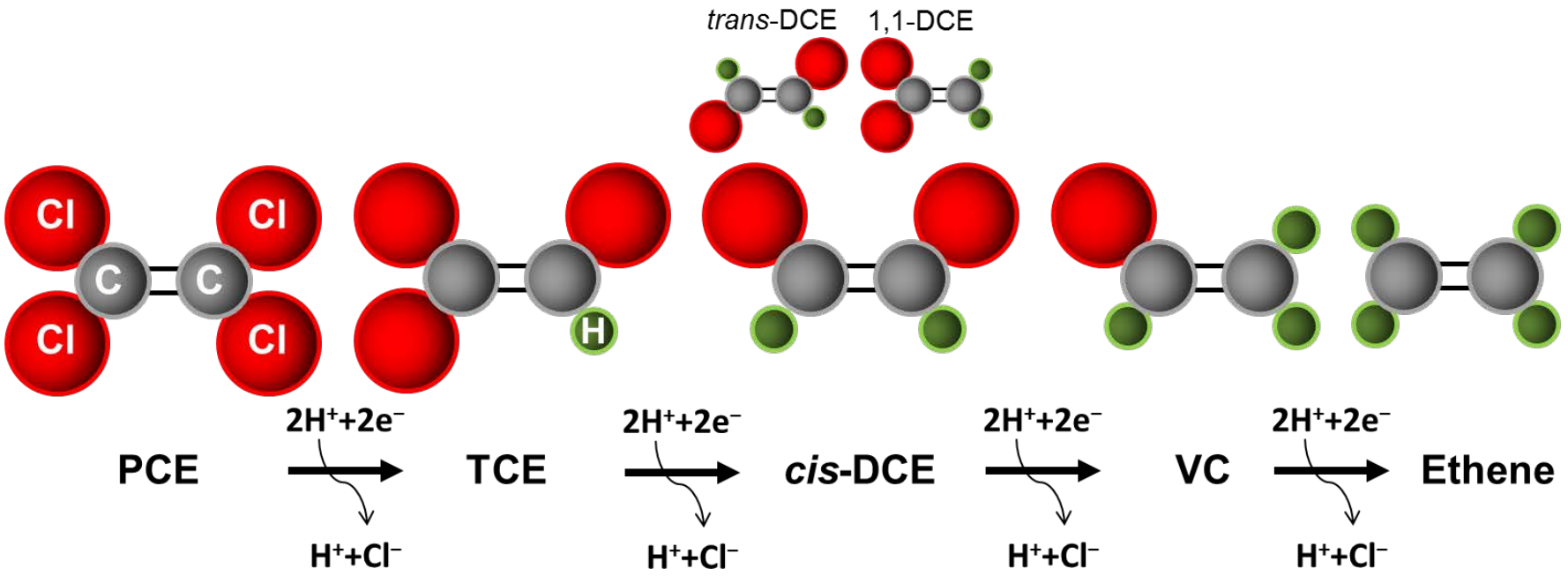


Microbial Dehalogenation

$F^- Cl^- Br^- I^-$

Organic Compounds

Reductive dechlorination



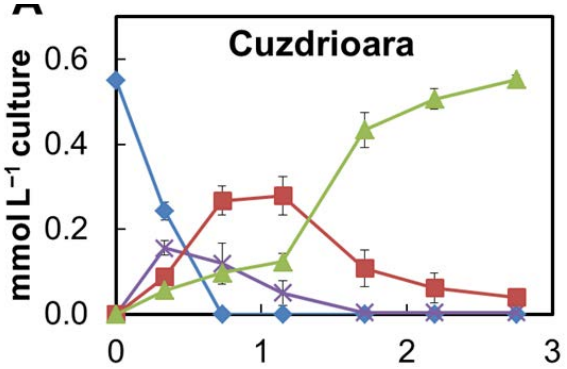
- Bioremediation of PCE and TCE to ethene occurs under anaerobic conditions via reductive dechlorination with H_2 as electron donor.
- ***Dehalococcoides mccartyi*** **are the only microbes capable of detoxification of chlorinated ethenes to ethene.**

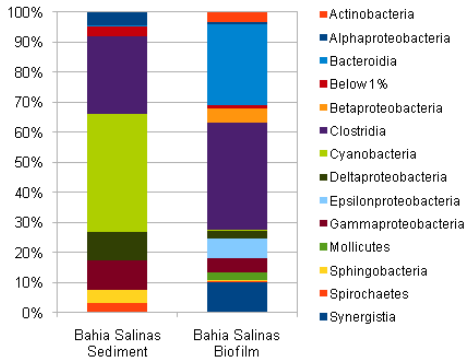
Development of fast dechlorinating cultures

Development and grow CE to ethene *Dehalococcoides* cultures

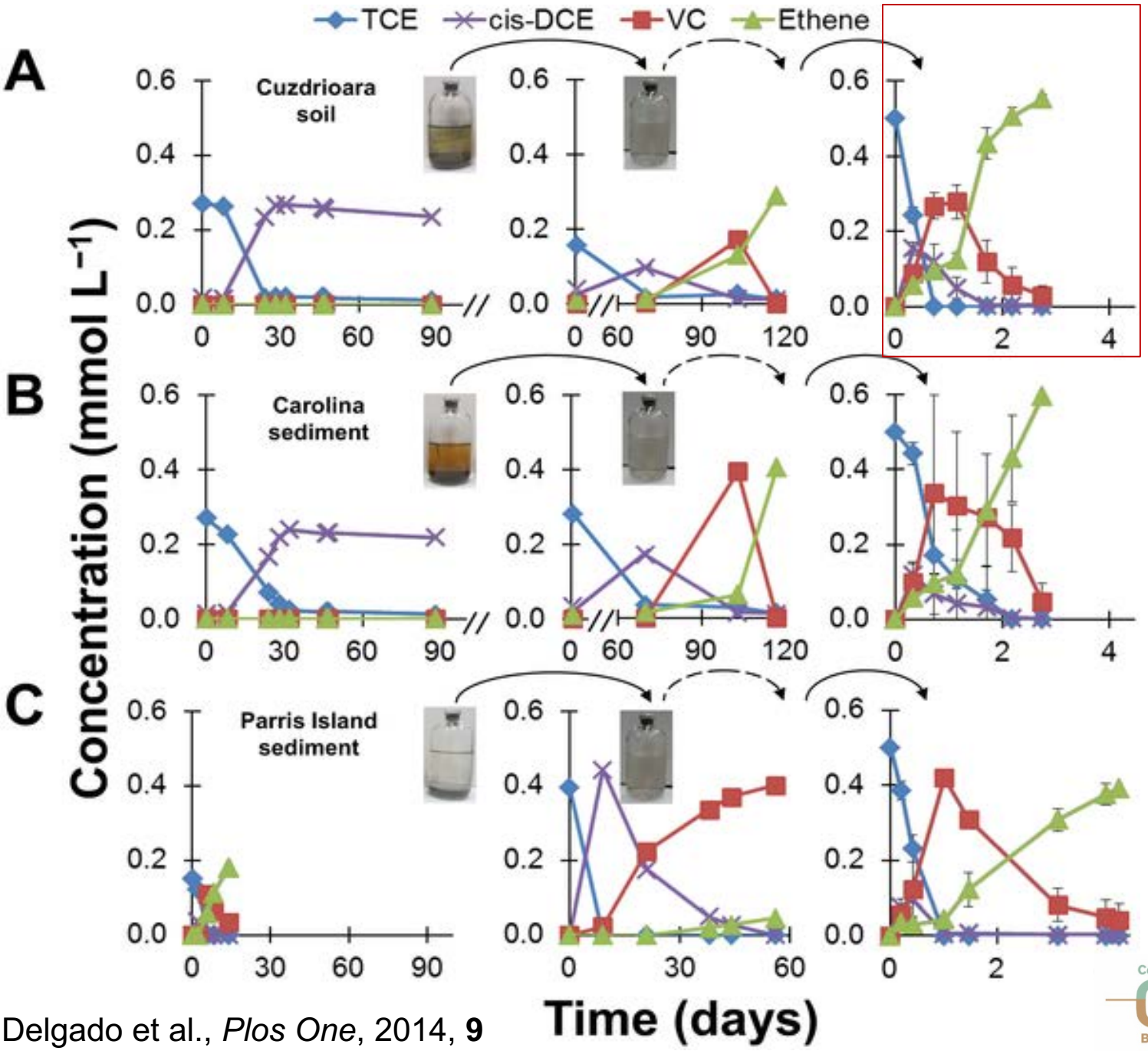
Sediment

Anaerobic medium & nutrients

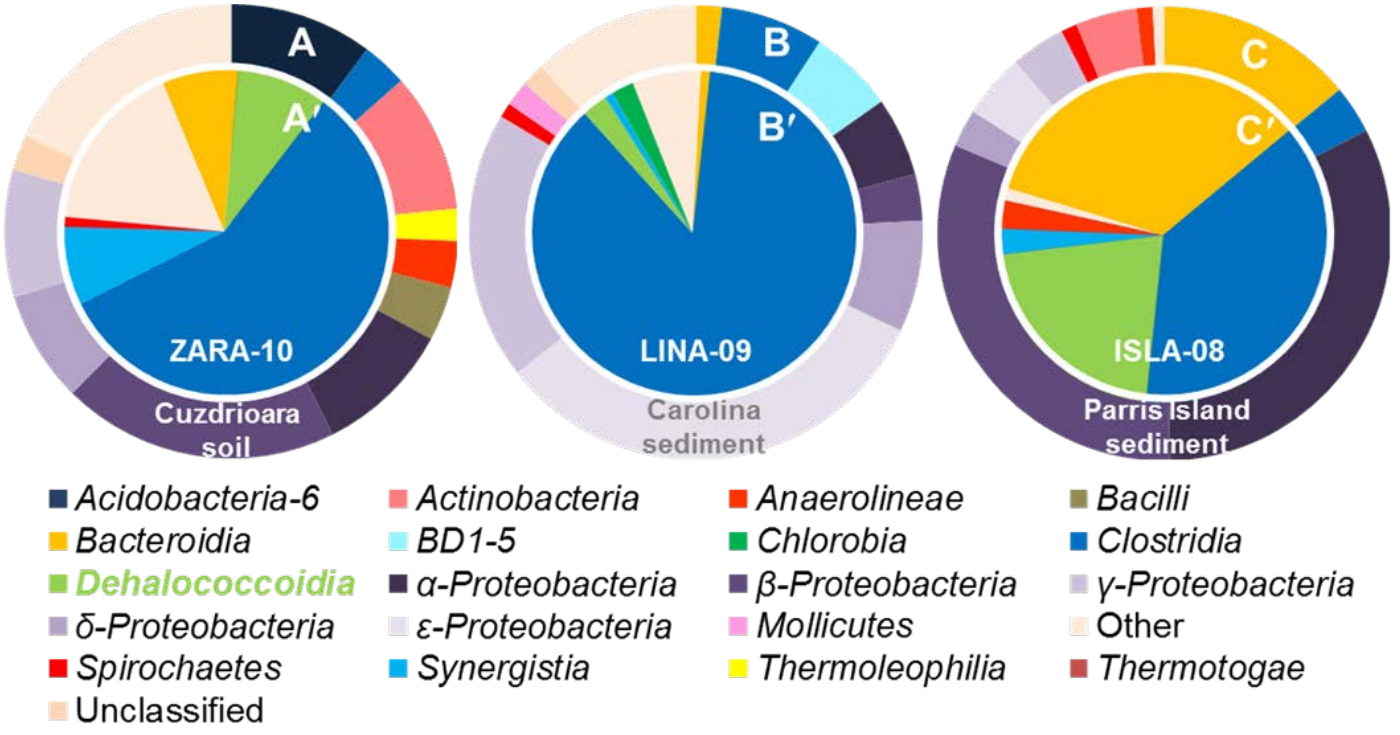


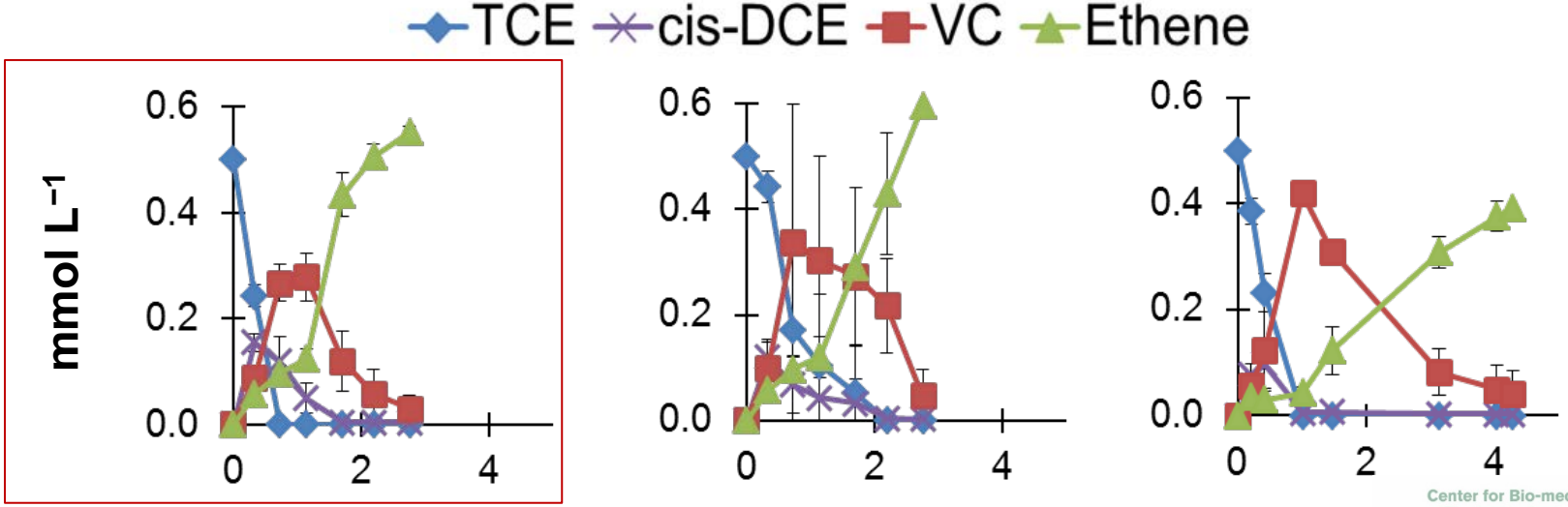


Center for Bio-mediated &
CBBG
Bio-inspired Geotechnics



Delgado et al., *Plos One*, 2014, **9**

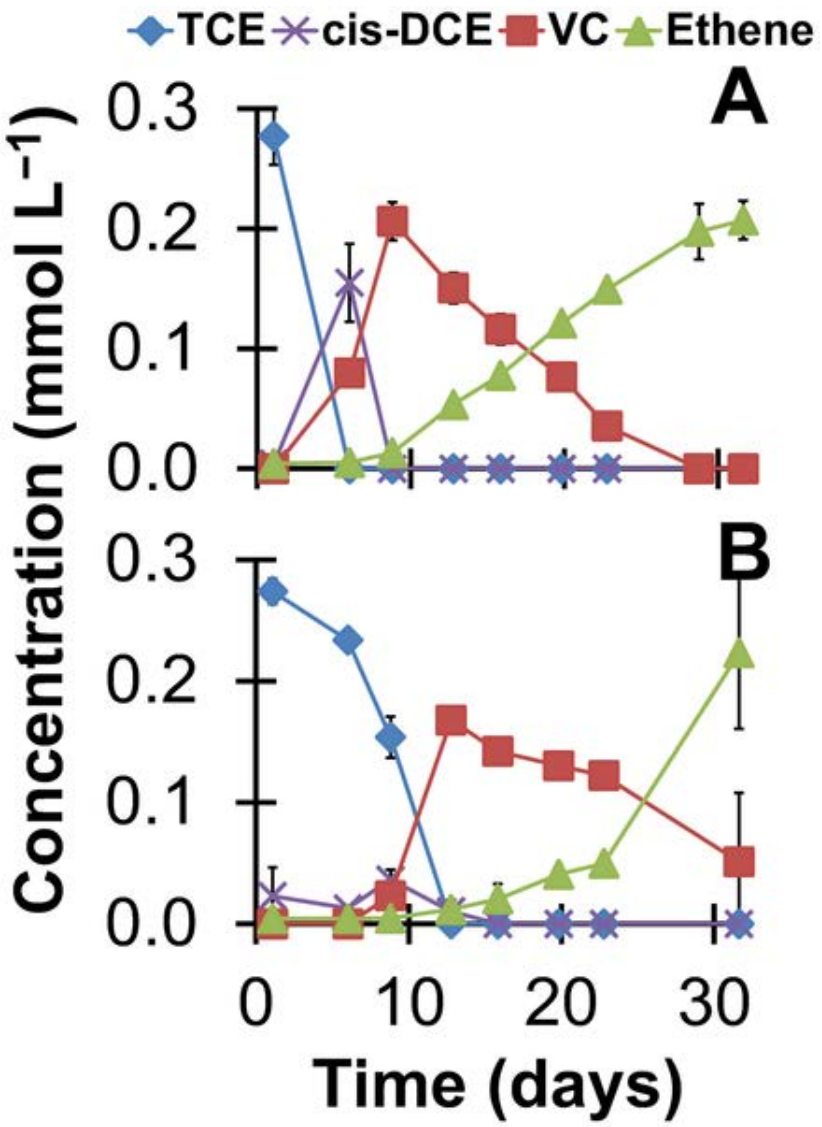




Delgado et al., *Plos One*, 2014, **9**

Center for Bio-mediated & CBBG Bio-inspired Geotechnics

Bioagmentation on the same soil?

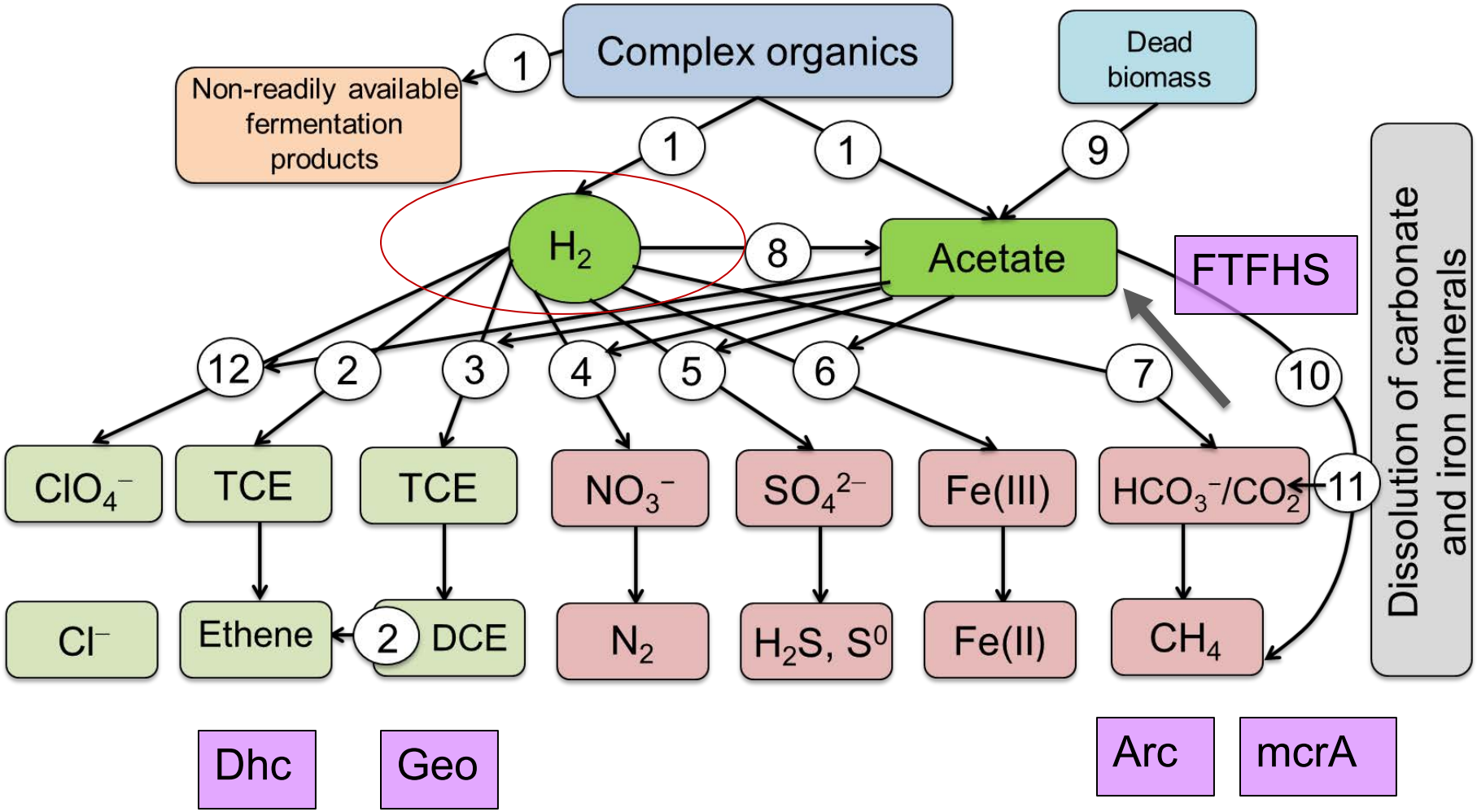


Cuzdrioara bioaugmentation

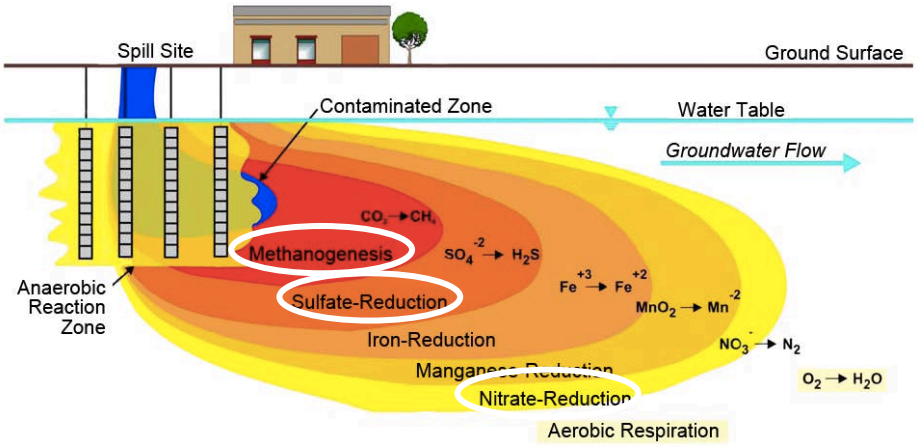
Carolina bioaugmentation

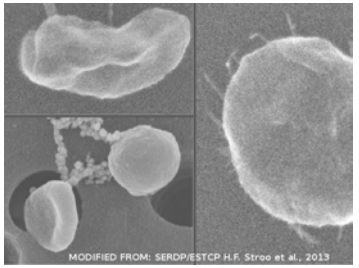
[9]Delgado et al., *Plos One*, 2014, **9**

Center for Bio-mediated & Bio-inspired Geotechnics



Hydrogen ”demand” in the subsurface





Objectives

1. Track H_2 consumption in a variety of soils and sediments
2. Which electron accepting processes dominate under a regime of excess H_2.

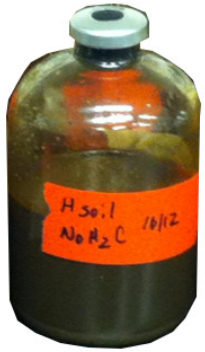
Image: https://clu-in.org/

15 soils and sediments

NO_3^-

Organic C SO_4^{2-}

Fe^{3+}



COD

Inorganic C

illumina®

100 days

Center for Bio-mediated & Bio-inspired Geotechnics

CBBG
Center for Bio-mediated & Bio-inspired Geotechnics

Lessons learned

- Robust Enrichment process, scale up and application at the field scale.
- Inorganic carbon metabolism (acetogenesis and methanogenesis) dominated in most soils.
- Organic carbon and Humics can consume H_2 and perhaps release it later for processes like reductive dechlorination.

Center for Bio-mediated &
CBBG
Bio-inspired Geotechnics

Thank you!

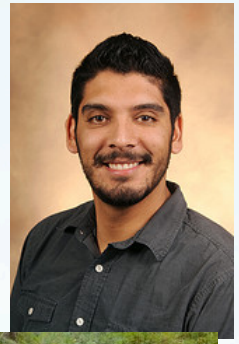
ASU BIODESIGN INSTITUTE
ARIZONA STATE UNIVERSITY

ESTCP
Environmental Security Technology Certification Program

NSF

ASU Ira A. Fulton Schools of Engineering
ARIZONA STATE UNIVERSITY

MATRIXNEWORLD
Engineering Progress




Questions?
Dr.rosy@asu.edu
krajmalnik.environmentalbiotechnology.org
Like us on **Facebook** Dr.Rosy's Lab-The lab of Dr Rosa krajmalnik-Brown.