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Characterization and Stimulation of Selenium Reducing Microbial Consortia from Real Flue Gas Desulfurization Wastewater Biological Treatment System

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Background

Selenate (SeO_4 - Soluble) → Selenite (SeO_3 - Soluble) → Elemental Selenium (Insoluble)

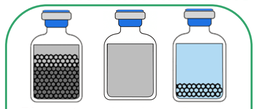
- Coal is still a significant source of electricity generation in the US and globally.
- Energy generation from coal creates several waste streams and associated treatment trains.
- Biological treatment is known as one of the best available technologies to treat FGD WW.
- FGD wastewaters show promise for elemental Selenium recovery

Methods

Field Sampling

Coal Fired Power Plant in Appalachian Region of the US

Stimulation Reactors



Bioreactor Mimicking Stim (BMS) | Liquid Derived Stim (LDS) | Solids Derived Stim (SDS)

40°C | 7 Days
N_2 Headspace
Elevated SeO_4/SeO_3

DNA Analysis

MiSeq — 16S Metagenome

qPCR — ~Biomass

Chemical Analysis

IC

Chemistry

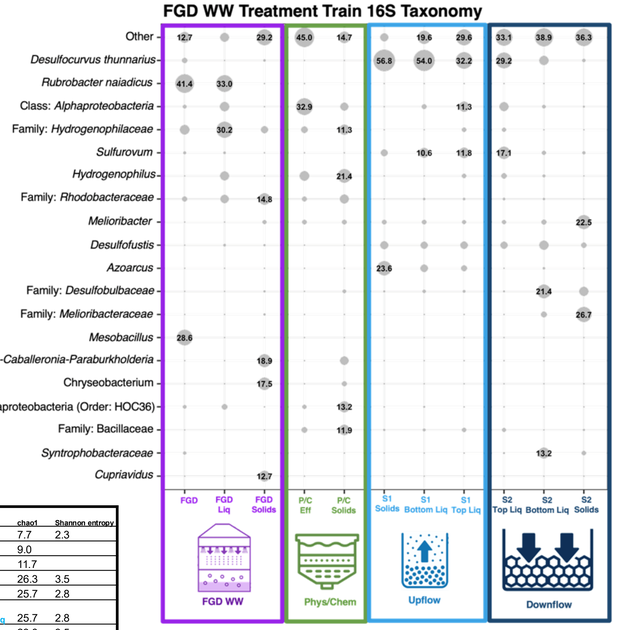
Particle Analysis

SEM

spICP-TOF-MS

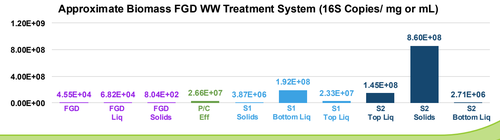
Distinct Microbial Communities in Each Step of Real Treatment System

FGD WW Treatment Train 16S Taxonomy



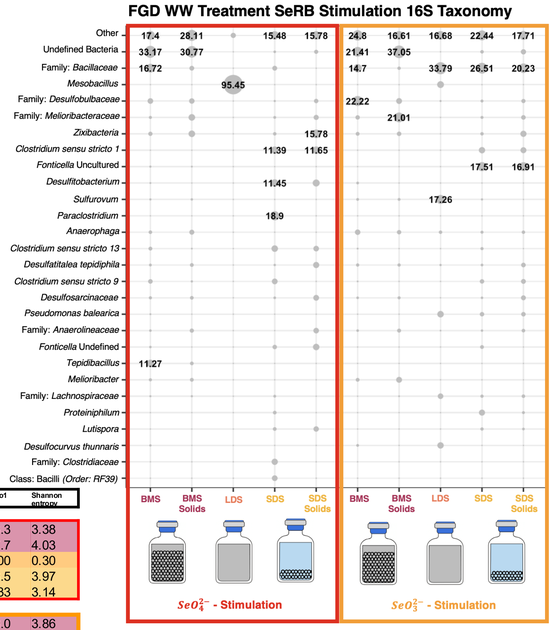
	chao1	Shannon entropy
FGD	7.7	2.3
FGD Liq	9.0	
FGD Solids	11.7	
P/C Eff	26.3	3.5
S1 Solids	25.7	2.8
S1 Bottom Liq	25.7	2.8
S1 Top Liq	23.0	3.5
S2 Top Liq	23.5	3.4
S2 Bottom Liq	44.8	4.2
S2 Solids	25.6	3.5

Approximate Biomass FGD WW Treatment System (16S Copies/ mg or mL)



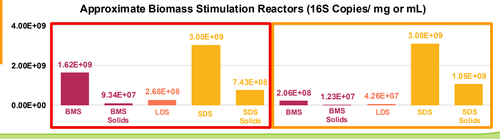
Microbial Consortia Remains Diverse Despite Se Stimulations

FGD WW Treatment SeRB Stimulation 16S Taxonomy

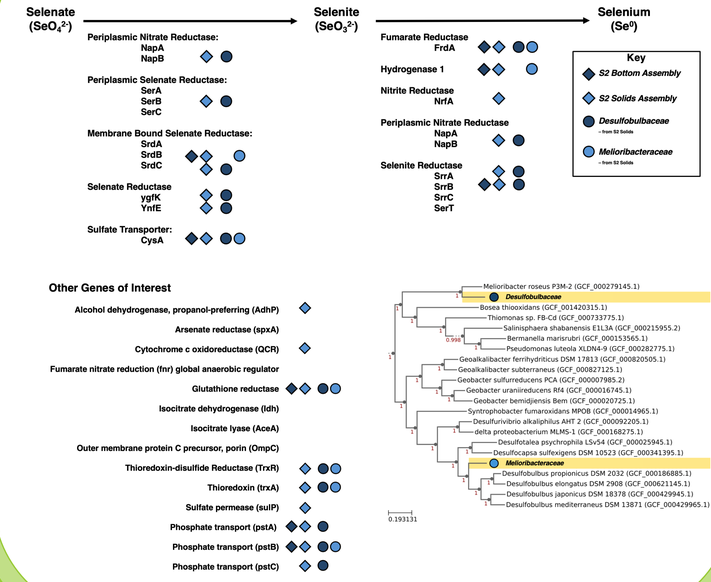


	chao1	Shannon entropy
BMS	33.3	3.38
BMS	37.7	4.03
LDS	3.00	0.30
SDS	33.5	3.97
SDS Solids	8.33	3.14
BMS	28.0	3.86
BMS	25.7	3.50
LDS	21.7	3.10
SDS	25.5	4.18
SDS Solids	22.0	

Approximate Biomass Stimulation Reactors (16S Copies/ mg or mL)



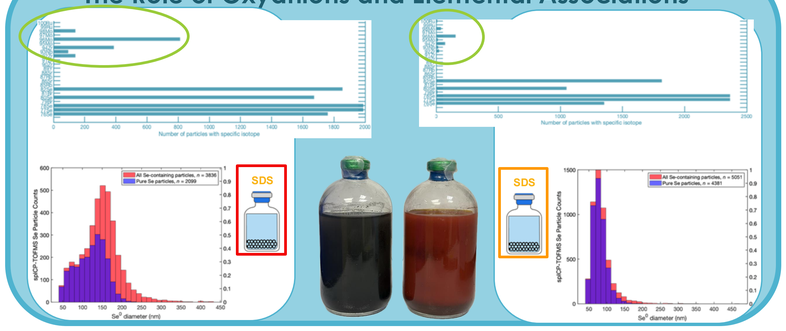
Known Selenium Oxyanion Reduction Genes Matched in Assemblies and MAGs



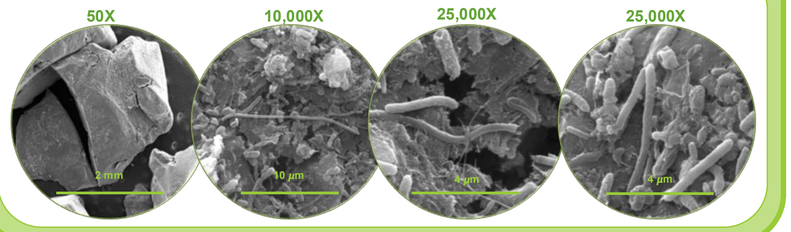
Other Genes of Interest

- Alcohol dehydrogenase, propanol-preferring (AdhP)
- Arsenate reductase (spxA)
- Cytochrome c oxidoreductase (QCR)
- Fumarate nitrate reduction (frn) global anaerobic regulator
- Glutathione reductase
- Isocitrate dehydrogenase (Idh)
- Isocitrate lyase (AceA)
- Outer membrane protein C precursor, porin (OmpC)
- Thioredoxin-disulfide Reductase (TrxR)
- Thioredoxin (trxA)
- Sulfate permease (sulP)
- Phosphate transport (pstA)
- Phosphate transport (pstB)
- Phosphate transport (pstC)

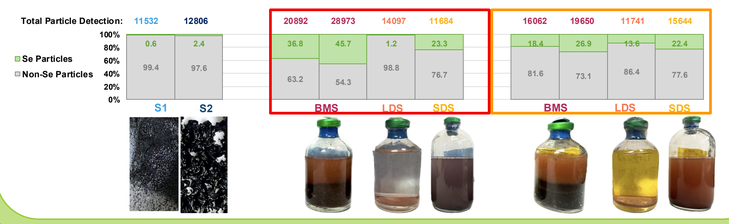
The Role of Oxyanions and Elemental Associations



Filamentous Bacteria Colonize Carbon Beds



More Selenium Detected in Stimulations



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