NAME: Karrie Weber

ORGANIZATION: University of Nebraska-Lincoln

PROGRAM AFFILIATION: SBR

ABSTRACT TITLE: Impact of viral infection of microbiota on subsurface biogeochemistry

ABSTRACT: Microbially mediated metabolisms have been identified as significant factors either directly or indirectly impacting biogeochemical cycling. To date the role that viruses play a significant role influencing microbial mortality and resulting community in terrestrial sedimentary systems is poorly understood. The objective of this project is to investigate viral infection of subsurface bacteria and the formation of contaminant-bearing viral particles and approached by examining the following hypotheses: (*i*) subsurface microorganisms are susceptible to viral infections, and (*ii*) viral surfaces will adsorb heavy metals and radionuclides.

In an effort to assess the significance of viral infection in subsurface microbial communities, the production of viral like particles in response to biostimulation was investigated by amending sediment slurries with dissolved organic carbon (^{13}C-labeled acetate) and nitrate. This stimulation resulted in the production of VLPs (Virus to Bacteria ratio ca. 480 to 2,400). Interestingly, the production of VLPs was positively correlated with acetate consumption and $^{13}CO_2$ production; whereas changes in bacterial abundance were correlated neither with acetate consumption or $^{13}CO_2$ production. Thus, indicating that viruses contribute to cell lysis and are sensitive indicators of microbial activity. Furthermore, the microbial community shifted from one favored by Betaproteobacteria to Gammaproteobacteria. This could simply be a result of "killing the winner" or microbial cell lysis could cross-feed the microbial community. These results suggest that viral infection could be playing a role in carbon flux thereby altering available carbon pools in subsurface environments.

The *in situ* addition of O_2 into a reduced well field at the Old Rifle Field site, well-field Exp. Plot C, resulted in an increase in VLPs in background and stimulated wells ($9.5 \times 10^5 – 3.1 \times 10^6$ in CU01; $2.2 \times 10^6 – 3.2 \times 10^6$ in CD01, respectively), suggesting viral response during redox shifts. VLP abundance decreased ($3.1 \times 10^6 – 1.3 \times 10^6$ in CU01; $3.2 \times 10^6 – 3.2 \times 10^5$ in CD01) concurrent with a sharp change in geochemical parameters of the aquifer 21-28 days after injection. The VLP abundance decrease was associated with an increase in the ORP, decrease in pH and Fe(II) concentration and increase in sulfide concentrations. Viral abundance fluctuated with geochemical changes; whereas cell abundance did not similarly respond. This result is consistent our prior laboratory experiments demonstrating a correlation between carbon consumption and viral abundance, but not cell abundance. Together these results indicate that virus-to-cell ratio and viral abundance may be better indicators of biological activity than cell abundance alone as dynamic viral infection mediates cell lysis.

The production of VLP's in groundwater has implications for nanoparticulate carbon or metal transport. Initial experiments indicate that metals (Zn^{2+}) will adsorb to the surface of *Escherichia coli* phage T4. Interestingly, as Zn^{2+} concentrations increased (ca.60 µM), infectivity increased. Results demonstrated an increase of plaque forming units (PFUs) for viruses incubated with Zn^{2+} relative to negative controls. Thus, indicating that Zn^{2+} enhances the infectivity of phage T4. Together, the results suggest that the sorption of metals to the surface of viruses could not only contribute to nanoparticulate transport but could also enhance infectivity further contributing to cell lysis. It is therefore necessary to establish potential relationship(s) between viruses, cells, carbon, and metals/radionuclides to provide sufficient scientific understanding to incorporate coupled physical, chemical, and biological processes into agent based and reactive transport models.