Analysis and Treatment of Waters From Hydraulically Fractured Oil and Gas Wells

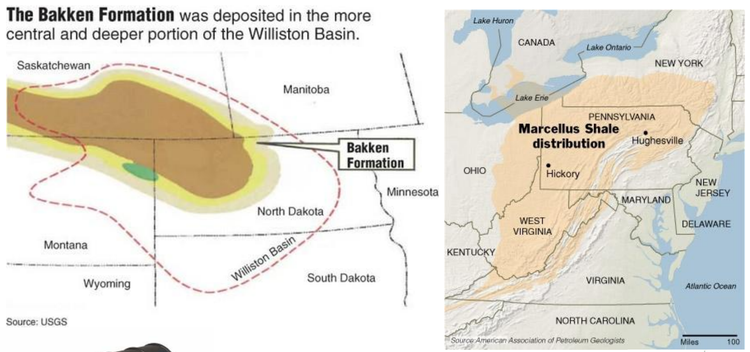
Lawrence P. Wackett, Lisa C. Strong, Trevor Gould, Michael J. Sadowsky, and Alptekin Aksan

BioTechnology Institute, Department of Biochemistry, Molecular Biology, and Biophysics, Department of Mechanical Engineering University of Minnesota, Tewin Cities

Abstract

Hydraulic fracturing of shale formations is an important and expanding process used for unconventional oil and natural gas extraction. The process has contributed to an increase in gas and oil production within the United States and it is predicted that the U.S. will be world's leading producer by 2020. Each hydraulic fracturing, or fracking, event uses millions of gallons of water and wells can be fracked multiple times. On the order of thirty to forty percent of the water comes back to the surface as flowback and produced water. Many users are seeking innovative methods to handle the returned waters since conventional approaches, that include evaporation, filtration and landfilling, are expensive. The waters contain suspended solids, inorganic compounds, organic compounds, and microorganisms. Our research is largely focused on analyzing the chemical and microbiological components of the waters. In addition, we are conducting studies to biodegrade the organic pollutants within flowback and produced waters to develop the potential for inexpensive bioremediation technologies. We have explored a process of encapsulating biodegrading bacteria within silica spheres and showed that the biosilica catalysts extensively degrade organic contaminants and demonstrate long catalyst lifetimes.

Source of waters and analytical methods



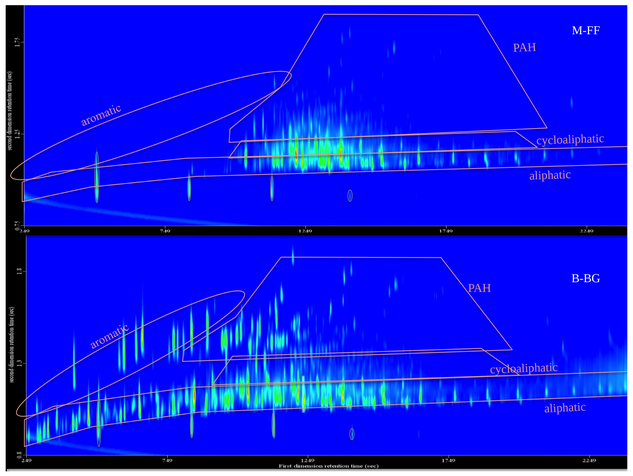
Waters were obtained from Bakken (oil) and Marcellus (gas) wells, respectively, and shipped on ice to Minnesota. Samples were analyzed for pH, salinity, total organic carbon, inorganics, and organic constituents. The latter was determined using a Leco Pegasus-4D GC x GC-TOF-MS instrument. GC x GC-MS was also used to analyze biodegradation by native and silica-encapsulated bacteria. DNA sequencing was performed using an Illumina Mi-Seq instrument.

General characteristics of Marcellus (M) and Bakken (B) waters

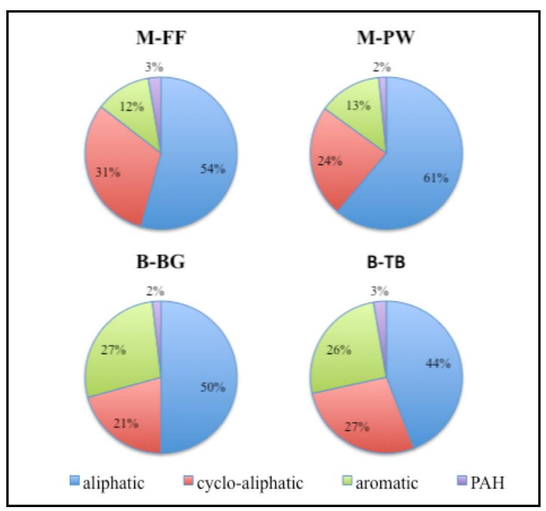
Waters	pH	TOC (mg/L)	Salinity, NaCl (M)
M-FF	7.1	990	0.47
M-PW	7.0	1112	0.89
B-BG	8.0	4589	3.55
B-TB	6.5	1741	0.03

FF = Fracturing fluid; PW = Produced water; BG = Broken gel; TB = Tank bottom

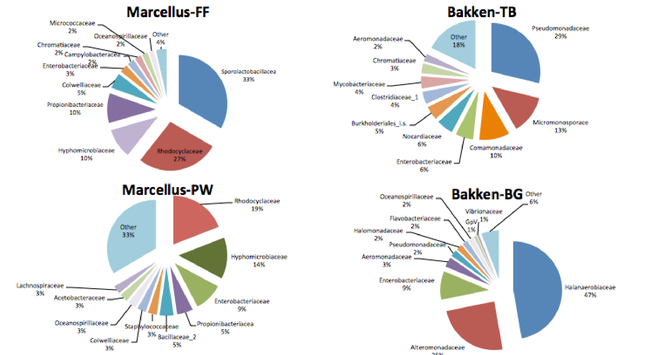
GC x GC-TOF-MS chromatograms of waters



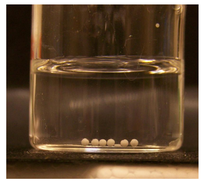
Classes of organics found in the waters



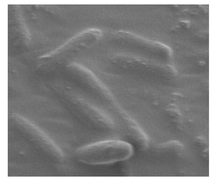
DNA sequencing showed waters are teeming with bacteria



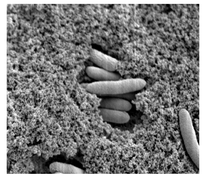
Bacteria in silica gel showed enhanced biodegradation



Si beads in vial

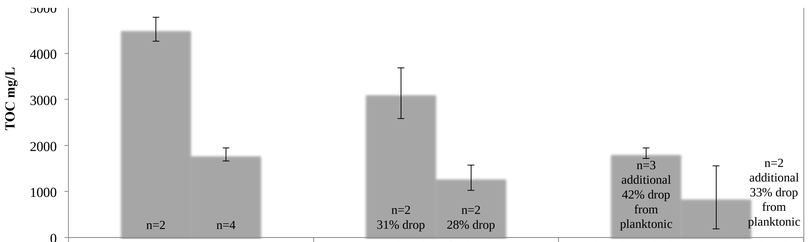


Surface SEM



Internal SEM

Silica-encapsulated bacteria decrease TOC significantly



	Starting waters	Incubated w/planktonic	Incubated w/(planktonic + encapsulated)
B-BG	4523	3134	1832
B-TB	1804	1300	871

Acknowledgements

This research has been partly supported by a grant from the National Science Foundation Partnerships for Innovations program, BIC-1237754, and from the Minnesota Futures program of the University of Minnesota.

References

Reátegui, E, E. Reynolds, L. Kasinkas, A. Aggarwal, M.J. Sadowsky A. Aksan, L.P. Wackett (2012) Silica gel encapsulated AtzA biocatalyst for atrazine biodegradation. *Appl. Micro. Biotech.* **96:** 231-240.

World Intellectual Property Organization 2012/116013 A2, Silica encapsulated biomaterials, pending.