

Report as of FY2010 for 2006FL143B: "Evaluation of the Geochemical and Microbial Processes Controlling Arsenic Mobilization during Artificial Recharge (AR) and Aquifer Storage and Recovery (ASR)"

Publications

- Articles in Refereed Scientific Journals:
 - ◆ Wallis, I., Prommer, H., Pichler, T., Post, V., Norton, S., Annable, M.D., Simmons, C.T., (In Review), A process-based reactive transport model to quantify arsenic mobility during aquifer storage and recovery of potable water, submitted to ES&T April 15, 2011.
- Conference Proceedings:
 - ◆ Stuart Norton and Mike Annable. Evaluation of Trace Metal Mobilization during Managed Aquifer Recharge (MAR). UF Water Institute Symposium. February 24, 2010. - Awarded 1st Place Prize.

Report Follows

WRRC 104B

Fiscal Year 2010

Project Status Report

Investigating Arsenic Mobilization During Aquifer Storage Recovery (ASR)

May 1, 2011

Student: Stuart B. Norton – U.F. Environmental Engineering Sciences

Advisor: Dr. Mike Annable – U.F. Environmental Engineering Sciences

Student's Dissertation Topic

Evaluating Trace Metal Mobilization During Managed Aquifer Recharge

Project Background

Due the growing demand on water resources within the State of Florida, Managed Aquifer Recharge (MAR) has become an increasingly attractive water storage option for many municipalities. MAR techniques, such as Aquifer Storage and Recovery (ASR) and Artificial Recharge (AR), have the potential to provide much of the seasonal or long-term storage needed within areas of increased water demand. However, as with any engineered water supply process, these facilities must meet stringent Federal and State regulations to insure the protection of human health and the health of the environment.

Recently, facilities in southwest Florida utilizing the Suwannee Limestone of the Upper Floridan Aquifer for ASR have reported arsenic concentrations in recovered water at levels greater than 112 $\mu\text{g/L}$ (Arthur et al., 2002). On January 23, 2006 the Maximum Contaminant Level for arsenic was lowered from 50 $\mu\text{g/L}$ to 10 $\mu\text{g/L}$ (FDEP: Chapter 62-550 F.A.C., Table 1). Arsenic has become the primary constraint for implementing these MAR techniques.

Research has been conducted to determine the abundance and mineralogical association of arsenic within the Suwannee Limestone (Pichler, et al., 2006). This research suggests that the bulk matrix of the Suwannee Limestone generally contains low concentrations of arsenic. However, according to this research, arsenic is concentrated within the Suwannee Limestone in arsenic bearing minerals such as pyrite.

The potential mechanisms by which arsenic may be mobilized during ASR have been investigated (Arthur, et al., 2002) and suggested by others (Pichler, et al., 2006). The conclusions of this research suggest that the introduction of injectate containing oxidants, such as oxygen and chlorine, into a highly reduced groundwater environment produces a geochemical response that releases arsenic from the aquifer matrix.

Several ASR projects are under testing in southwest Florida. Of these, the recently constructed Bradenton Potable ASR facility presents several benefits for further research including the following:

- Both small volume (40 MG) and large volume (160 MG) recharge and recovery cycles have been performed at the facility, with additional tests planned.
- The data sets collected to date at this facility are fairly extensive.
- The City of Bradenton, in conjunction with the Southwest Florida Water Management District, St. Johns River Water Management District, South Florida Water Management District (SWFWMD) and Peace River Manasota Regional Water Supply Authority are cooperatively developing a pretreatment degasification and dechlorination system for this site.
- The City of Bradenton has authorized the use of the data set in this study and has granted site access.

Project Status

The following research was completed during Fiscal Year 2010 or are currently underway:

Demonstration Testing at Project Site

The first full-scale low-DO (degasification) ASR cycle test was completed at the Bradenton ASR site. Results indicate that degasification and dechlorination prior to recharge can control arsenic mobility during ASR. In addition to incorporation into Mr. Norton's dissertation, test results are being summarized in a manuscript for submittal to a peer-reviewed journal article.

Reactive Transport Modeling

A reactive transport model has been developed for the Bradenton ASR site to simulate high-DO test conditions. A summary of the model results has been submitted for publication (see below). The model is currently being extended to simulate the low-DO test event and continuous cycle testing under high-DO (standard ASR) conditions.

Core Collection and Preservation

Over 145 ft of 2-inch core material has been collected and preserved for use during this project. The core was preserved in core-storage vessels designed and built for this

project. The core material has been used in batch studies and preliminary column studies, discussed below.

ASR Batch Studies

Batch studies have been completed at the FGS laboratory in Tallahassee to investigate the effects of using preserved versus un-preserved core materials in ASR batch studies. These tests simulated both native groundwater and ASR conditions.

Core-column Design

The design of intact core-column experiments is nearly complete. Falling head permeameters were constructed and tested in the lab to evaluate the hydraulic seal around the outer-wall of the core and to test vertical conductance of the rock. The FHP tests form the basis for the design of core-column experiments. Preliminary intact core-column experiments have been completed to determine the magnitude and timing of the peak arsenic concentration observed during column experiments. This information will be used to improve the design of the column experiments.

Ph. D. Examinations

On May 12, 2010, Mr. Norton successfully completed the Ph.D. qualifying exam, including a written and oral defense of his research proposal.

Mr. Norton is preparing to defend his dissertation in late June or early July, 2011.

Presentations and Publications

Wallis, I., Prommer, H., Pichler, T., Post, V., Norton, S., Annable, M.D., Simmons, C.T., (In Review), A process-based reactive transport model to quantify arsenic mobility during aquifer storage and recovery of potable water, submitted to ES&T April 15, 2011.

2nd UF Water Institute Symposium - Poster Session:

Stuart Norton and Dr. Mike Annable - *Evaluation of Trace Metal Mobilization during Managed Aquifer Recharge (MAR)*, February 24, 2010 - Awarded 1st Place Prize

References

Arthur, Jonathan D., Dabous, Adel A., and Cowart, James B., 2002, Mobilization of arsenic and other trace elements during aquifer storage and recovery, southwest Florida: USGS Open-File Report 02-89

Price, Roy E., and Pichler, Thomas, 2006, Abundance and mineralogical association of arsenic in the Suwannee Limestone (Florida): Implications for arsenic release during water-rock interaction: *Chemical Geology*, Vol. 228, pp. 44-56