Bureau of Economic Geology

Carbon Dioxide Injection into Shallow Sedimentary Aquifer Systems to Assess Potential Degradation of Groundwater Quality at Geological Carbon Sequestration Sites

Technical Progress Report

Prepared by: Changbing Yang, Bridget Scanlon, and Jean Philippe Nicot

Summary of Activities Performed During this Period: August 1, 2010 – September 30, 2010

Task 1: Laboratory Batch Experiments

A new postdoctorate research associate joined the research team and started to conduct laboratory experiment. Four sediment samples from depth of 200ft to 240 ft were chosen to do SEM and XRD analysis for characterizing mineralogy of the rocks. About 100 g of rock samples (mainly unconsolidated sands) at depth of about 223 ft were prepared and disassembled. These samples will be uniformly distributed into four beakers by adding 100 g water taken from the Cranfield aquifer (shown in Figure 1).

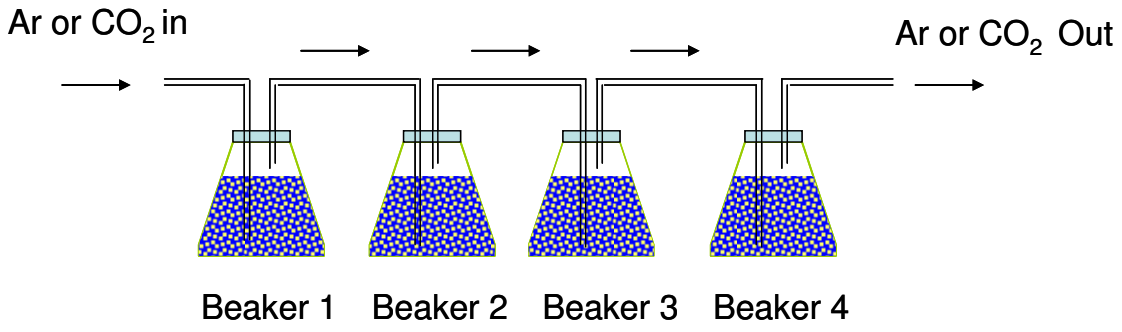

Figure 1 Schematic setup of batch experiment

The procedure for conducting batch experiment will be the following:

1) Bubble Ar gas into the system for about 4 to 5 days so that water is equilibrated with rocks; every 6 to 12 hours, pH will be checked. Once water has been equilibrated with solids, one water sample will be taken from one of the four beakers as baseline water chemistry before CO_2 is bubbled.
2) Bubble food level CO_2 gas into the system. Water will be sampled from those beakers at 30 minutes, 1 hour, 2 hours, 4 hours, 8 hours, 12 hours, 1 day, 2 day, 4 day, 8 days, 12 days, 15 days after CO_2 was bubbled into the system.

Water samples collected will be sent to the Department of Geological Sciences, The University of Texas at Austin for chemical analysis for major ions and trace elements.

Some water samples will be sent out for analyzing carbon and strontium isotopes. We are still looking for a reliable chemical lab to analyze carbon and strontium isotopes.

Task 2: Modeling Design of Field Push-Pull Tests

The chemical parameters of water-rock-CO2 for modeling design of field push-pull tests rely on the results of batch experiments which are being conducted soon. In order to understand water-rock–CO_2 interactions, a numerical model was setup to simulating chemistry data from the previous batch experiment conducted by Gulf Coast Carbon Center in 2008. The rock sample was taken from the outcrop at the Carnfield site and reacted with distill water. Comparison of model results and experimental results are shown in Figure 2. Once the new batch experiments are finished, we will use a similar model to interpret results of the batch experiments.

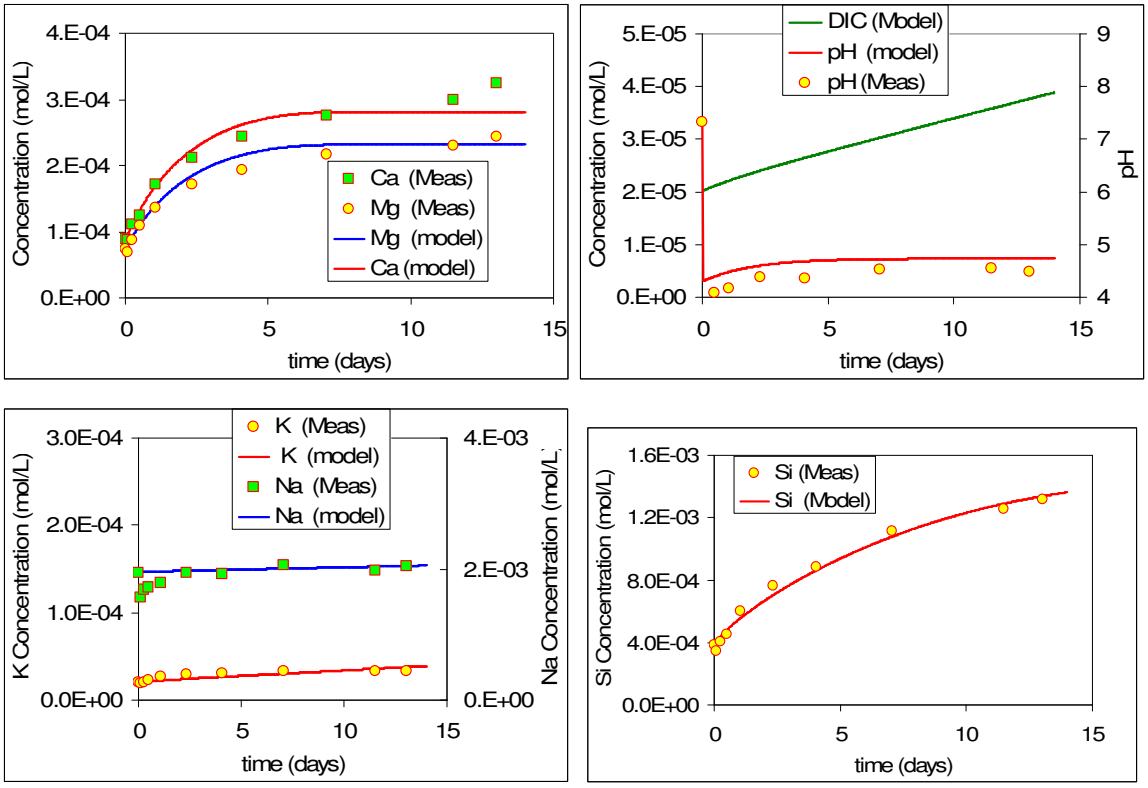

Figure 2 Comparison of model results with concentrations of Ca, Mg, K, Na, and Si and pH measured in the batch experiment conducted in 2008

Task 3. Conduction of Push-Pull Tests in the Field

Although we are not ready to conduct push pull tests at Cranfield for this project, baseline water chemistry data of about 40 water samples taken from 11 wells (See Figure 3) at this area over one year were characterized. Water chemistry data show that groundwater quality of the shallow aquifer is mainly dominated by silicate mineral weathering (Figure 4).

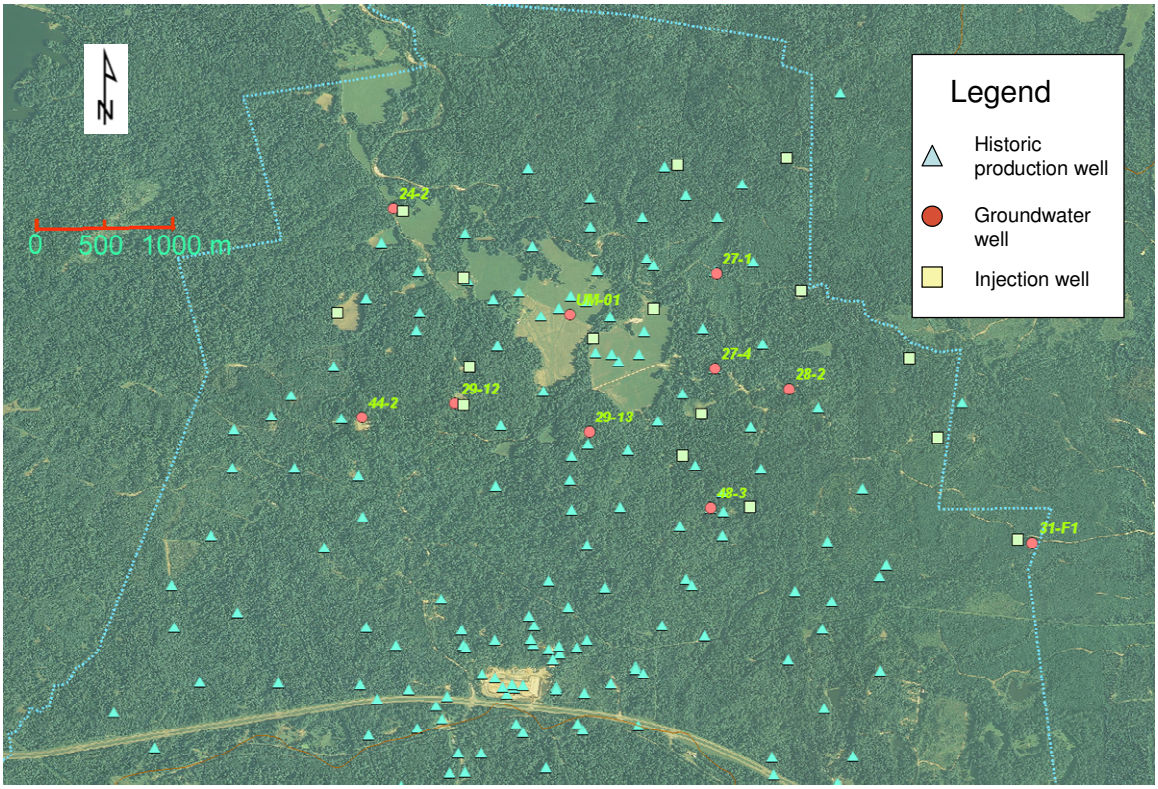

Figure 3. Location of water wells at the Cranfield where groundwater samples were taken (note that water well labeled as UM-01 which will be conducted push-pull test)

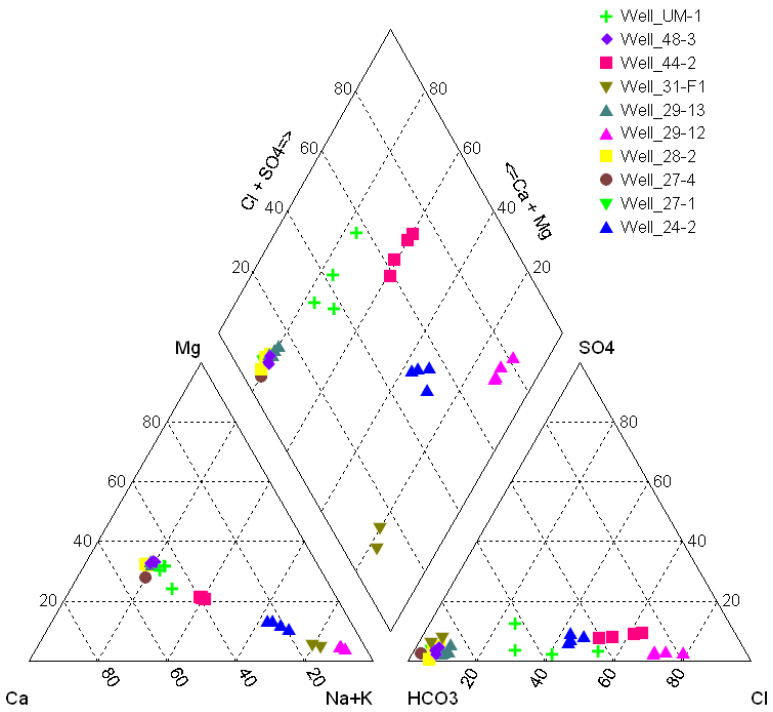

Figure 4 Piper plots of groundwater samples collected from the Cranfield site

The water well, UM-01 were also logged for apparent electrical conductivity and gamma activity to understand stratigraphy of the aquifer (Figure 5).

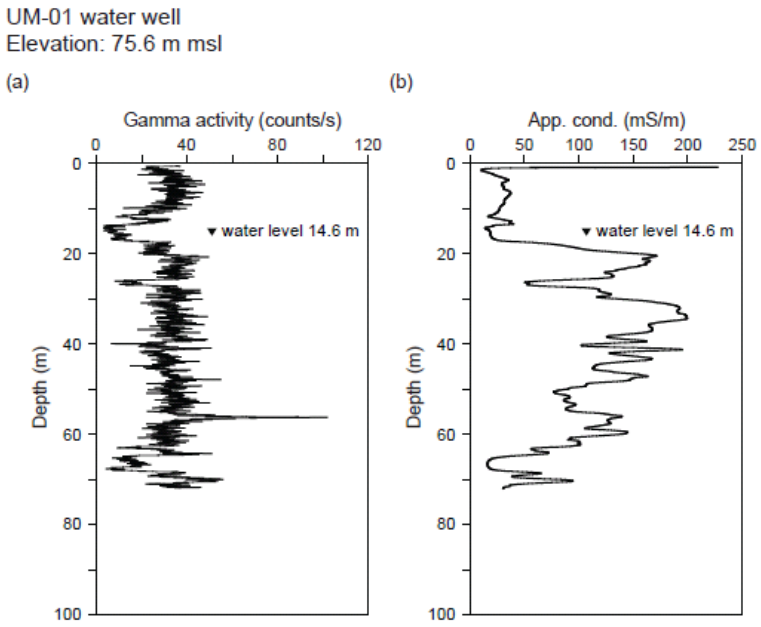

Figure 5 Gamma activity and apparent conductivity logged at UM-01.

We are aware some other groups in the world conducting similar researches and planning to communicate with those groups. ZERT experiment is one of the near-surface CO_2 injection experiments led by national labs (LANL, LBNL, NETL, LLNL, PNNL) and Montana State University and West Virginia University. We are reviewing field experimental results which may be useful for our push-pull tests. Electric Power Research Institute is conducting another CO_2 injection test at shallow aquifer near Plant Daniels (Mississippi Power). Five wells were used in the injection experiments: one injection well, one discharge well and three observation wells. University of Kiel, Institute of Geoscience is planning to conduct CO_2 injection test at a former military field, about 100 km northwest of Berlin, Germany. CO_2 injection is being planned at the lower aquifer at a depth of 18 meters below surface and gaseous CO_2 will be released through 3 lances with a filter screen of 0.2 m. SF6 is used as a tracer gas. The total injection period is about 10 days. Detailed comparison of these field tests will be present in the next quarterly report.

Dr. Nicot attended the GHGT-10 held in 19th-23rd September 2010, RAI, Amsterdam and discussed with other scientists who also attended this conference on this topic. GHGT-10 is a principal international conference on greenhouse mitigation technologies especially on CCS (CO_2 Capture and Storage). About 10 papers with topic on impact of CO_2 leakage to fresh groundwater quality were present in this conference. Detailed summary of these papers in this conference will be included in the next quarterly report.

Task 4. Modeling of Field Experiments

This task can only be conducted after the field experiments have been performed.

Task 5. Communication

Once we develop preliminary results we will post them on the web site.