Report as of FY2007 for 2006ND126G: "Collaborative Research on In Situ Denitrification and Glyphosate Transformation in Ground Water: NAWQA Eastern Iowa Basins Study Unit"

Publications

Project 2006ND126G has resulted in no reported publications as of FY2007.

Report Follows

COLLABORATIVE RESEARCH ON IN SITU DENITRIFICATION AND GLYPHOSATE TRANSFORMATION IN GROUND WATER: NAWQA EASTERN IOWA BASINS STUDY UNIT

1. Synopsis Contamination of ground water by nitrate and pesticides is widespread in some areas of the country and can threaten drinking water supplies. It is well known that the most important removal mechanism of nitrate and most pesticides from ground water is biodegradation, but the *in situ* transformation rates are largely unknown. In this study, two 180-L stainless steel chambers forming *in situ* mesocosms (ISMs) of aquifer sediments will be installed below the water table at the NAWQA agricultural chemicals study sites in the glaciated region of Iowa. This work will extend the use of this technique to examine denitrification in an area characterized by high dissolved iron concentrations and to measure the transformation rate of the extensively-used herbicide, glyphosate.

The objectives for the research are the following:

1. Measure the denitrification and glyphosate transformation rates in the two ISMs.
2. Determine whether the denitrification is better fit by zero-order or first-order reaction rates.
3. Determine what donors are contributing electrons for the denitrification and their relative amounts.
4. Incorporate the results of the two ISMs into the existing databank of nine other ISM sites in glacial outwash aquifers in the Upper Midwest.
5. Update the available data of the apparent isotopic enrichment factor for ^{15}N in nitrate versus denitrification rate among of ISM sites.
6. Update the nitrate vulnerability index and extrapolate the findings to similar, unmonitored agricultural and environmental settings.

Aquifer sediment samples will be collected from the Iowa site and analyzed for grain-size distributions, mineralogy, and major e^- donors (organic carbon, inorganic sulfide, organic sulfur, and ferrous iron) to determine optimum locations for installation of the ISMs, provide insights on the types and heterogeneity of e^- donors at the site, and provide the e^- donor supply data at the Iowa site that can be compared to previous ISM studies in the Upper Midwest. After the ISM chambers are installed, they will be purged and then amended with nitrate and bromide, which serves as a tracer for nitrate. The ISMs will be sampled over time (months) and the decreases in nitrate concentrations compared to bromide concentrations will be used to calculate rates of denitrification. Modeling of the evolution of the geochemistry in the ISMs will provide insights into what e^- donors contributed electrons to the denitrification and their relative amounts. The field experiment will be repeated a second time; however, in addition to nitrate and bromide, glyphosate will be added. The attenuation and transformation of glyphosate (with the dominate metabolite, AMPA) will be studied in both the presence and absence of nitrate to determine the fate of glyphosate in oxidizing and reducing conditions. The results of this study will provide site-specific transformation rates for nitrate and glyphosate and

extend the aquifer nitrate vulnerability index that was developed in earlier studies. This information is vital for the development of tools and quantitative methods to characterize the transport and fate of agricultural chemicals in the Eastern Iowa Basins Study Unit, the Upper Midwest, and beyond.

2. Project Progress The starting date for the grant was August 1, 2006 and the first progress report was written in June, 2007. Since then, one trip was taken to the Iowa field site in November, 2007, to install the pair of ISMs and one trip was taken to Ames, Iowa, in March, 2008, to attend the 8th Annual USGS Agricultural Chemical Team Meeting. The ISM installation was successful and they have been sampled monthly. Preliminary results indicate that denitrification is progressing in the ISMs, but rates are relatively slow. The ISM protective casings were flooded in June, 2008. Subsequent analyses will determine if the flooding interfered with the ISM tracer tests in-progress, but significant interference is unlikely. From the site, 50 aquifer sediment samples have been analyzed for texture (gravel, coarse sand, medium sand, fine sand, silt, and clay) and the electron donor concentrations: organic carbon, ferrous iron, and inorganic sulfide. Organic sulfur analyses were done on 14 sediment samples, but concentrations were judged to be too low to continue this analysis for the remainder of the samples. Preliminary results indicate little correlation between sediment texture and sample depth and little correlation between electron donor concentrations and sample depth; however the finer grain sizes are positively correlated, and coarser grain sizes negatively correlated, with electron donor concentrations. Further analysis is on-going. Depending on denitrification rates and if, and how much, the flooding influenced the current tracer tests in-progress in the ISMs, we plan to initiate at least one new ISM tracer test later this summer, or early fall, with glyphosate. Ground-water samples for isotopic analysis (^{15}N and possibly ^{18}O for the nitrate remaining in the ISMs) will be sent to The University of Waterloo later this summer.

The project is on schedule based on the timeline given in the project proposal.

3. Students supported and level of support under the project. Mr. Bijesh Maharjan started on the project on January 1, 2007, as a half-time research assistant ($1,312/month). Bijesh is working on an M.S. in Environmental Engineering and hopes to complete his degree by December, 2008.