Kentucky Water Resources Research Institute

Annual Technical Report

FY 1999

Introduction

The FY 1999 Annual Technical Report for Kentucky consolidates the reporting requirements of the Section 104(b) base grant and regional competitive grant awards in a single technical report which includes: 1) a synopsis of each ongoing research project and each research project completed during the period, 2) a list of related reports published, 3) a brief description of information transfer activities, 4) a summary of student support during the reporting period, and 5) notable achievements and awards during the year. The activities supported by Section 104 (b) and the required matching funds are interwoven into the Kentucky Water Resources ResearchInsitute's total program. Other elements of the program during FY 1999 included: 1) the Environmental Systems Certificate graduate program, 2) the Environmental Protection Scholarship program, and 3) Research and Service activities funded by other sources. Memorandum of Agreement Projects with the Kentucky Division of Water included: 1) Evaluation of the Impact of Gravel Dredging on Buck Creek, 2) Nonpoint Source Management Program Support, 3) Nonpoint Source Management Program Support - Part II (GIS/Data Management), 4) Continued Development of a Watershed-Based Water Quality Assessment and Management Methodology for the Kentucky River. Several additional projects were funded by the Kentucky Cabinet for Health Services (CHS), the Kentucky Department of Military Affairs (DMA), and the Kentucky River Authority (KRA): 1) Technical Support for the Paducah Gaseous Diffusion Plant (CHS) 2) Technical Support for the Maxey Flats Disposal Site (CHS) 3) Technical Support for Environmental Construction, Kentucky National Guard (DMA) 4) Kentucky River Basin Watershed Management Coordination, Phase II (KRA) 5) Kentucky River Basin Watershed Management Coordination, Phase III (KRA)

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Natural attenuation of trichloroethene in wetland soils and paleowetland sediments
Project Number	C-03
Start Date	09/01/1997
End Date	08/31/2000
Research Category	Water Quality
Focus Category #1	Groundwater
Focus Category #2	Wetlands
Focus Category #3	Water Quality

Focus Category #3	Water Quality
Lead Institution	University of Kentucky

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Alan E. Fryar	Assistant Professor	University of Kentucky	01
Mark S. Coyne	Associate Professor	University of Kentucky	02
Anastasios D. Karathanasis	Professor	University of Kentucky	03
David L. Balkwill	Professor	Florida State University	04
Stepahn A. Macko	Professor	University of Virginia	05

Problem and Research Objectives

We are examining the intrinsic capability of wetland soils and paleowetland sediments in the vicinity of the Paducah Gaseous Diffusion Plant (PGDP) to bind or degrade trichloroethene (TCE), a priority pollutant. Within the Regional Gravel Aquifer (RGA), TCE plumes extend several km from PGDP toward the Ohio River. Ground water discharges to wetlands and streams in the river's flood plain. Beneath PGDP, some seepage occurs from the RGA to the underlying McNairy Formation, which contains lignitic, pyritic silts.

Methodology

We are conducting laboratory experiments to assess TCE degradation and sorption in soils and sediments. We collected soil from wetlands in the West Kentucky Wildlife Management Area (WKWMA) and Metropolis Lake State Nature Preserve; McNairy cores from PGDP and a gravel pit north of Brookport, Illinois; and lignite and pyrite from a McNairy outcrop near Hico, Kentucky. We also installed piezometers in a tupelo swamp in the WKWMA and along Metropolis Lake and monitored water levels and temperatures. For soil and sediment samples, students measured organic carbon (OC) and enumerated sulfidogenic, methanogenic, and methano- trophic bacteria, which have been implicated in TCE degradation elsewhere. Students also examined TCE biodegradation in methanogenic enrichment cultures and soil/sediment microcosms and TCE sorption to pulverized samples in batch experiments.

Principal Findings and Significance

Hydraulic gradients indicated ground-water throughflow at the tupelo swamp and discharge along Metropolis Lake (when not flooded). Among bacterial groups of interest, only methanogens were culturable in McNairy sediments, while sulfidogens, methanogens, and methanotrophs were culturable in surface soils. Biodegradation of TCE over periods as long as 17 months was not statistically significant except in surface soil from the tupelo swamp. OC ranged from 0 to 3.8% in surface soils and 0.92 to 4.42% in McNairy sediments (excluding a lignite sample, with OC = 39.4%). Quasi-equilibrium values of the Freundlich sorption coefficient (KF) ranged from 0.0104 to 0.146 (mg TCE/g solid)/(mg TCE/L solution) E(1/n), where n is a measure of sorption isotherm nonlinearity. As expected, KF was highest for lignite (sorption typically increases with the amount of OC). Values of KF normalized relative to the fraction of OC (Koc) ranged from 0.371 to 0.936. Koc was lowest for lignite, which is

counterintuitive because sorption is typically greater for sedimentary (aged) OC than for soil OC. We are examining Carbon 13 solid-state NMR spectra of soils, sediments, and lignite in an effort to resolve this issue. DNA analyses of bacteria, studies of Carbon 13 fractionation during TCE sorption, and studies of TCE degradation by pyrite are pending.

Descriptors

biodegradation, sorption, trichloroethene, wetlands, ground water

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

Butler, D.L., 1999, Assessment of potential trichloroethene biodegradation in wetland soils, McCracken County, Kentucky: M.S. Thesis, Geological Sciences, Arts and Sciences, University of Kentucky, Lexington, Kentucky. Etienne, Nadège, 1999, Assessing potential biodegradation of trichloroethene in deep sediments at the Paducah Gaseous Diffusion Plant, Kentucky: M.S. Thesis, Agronomy, Agriculture, University of Kentucky.

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

None

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Using Neural Networks to Identify and Quantify Significant Sources of Encysted Protozoa in Watersheds
Project Number	C-05
Start Date	08/01/1998
End Date	12/31/2000
Research Category	Biological Sciences

Focus Category #1	Non Point Pollution
Focus Category #2	Models
Focus Category #3	Water Quality
Lead Institution	University of Kentucky

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Gail M. Brion	Assistant Professor	University of Kentucky	01
Srinivasa Lingireddy	Assistant Professor	University of Kentucky	02

Problem and Research Objectives

The overall objective of the proposed research is to develop a neural network based microbial source identification model for different types of fecal sources, both pathogen and non-pathogen associated, in surface waters. To achieve this grand objective, several sub-objectives need to be completed. They are: 1) To discover distinctive microbial fingerprints for different types of non-point source fecal inputs, such as those from horse farms, cattle grazing areas, suburban activities, and human waste releases under normal dry weather and rainfall conditions, 2) To optimize the system of microbial indicators selected to determine the presence and source of fecal inputs in source waters, 3) To define and statistically evaluate the relationships between the selected indicators, pathogenic oo/cysts, land use practices, and fecal sources, 4) To develop an efficient neural network model and to train the model using a state-of- the-art technique such as genetic algorithm, and 5) To define the universality of the locally trained model to other sites in Kentucky and other southeastern agriculturally impacted states.

Methodology

Samples of water were collected by both grab sampling and in-field, filtration collection from several different study sites in selected reservoirs, along the river, and in the identified karst aquifer. Sites suspected of being impacted by human fecal material through bacteriophage results or other observations were also sampled for biolipids. At each site, samples were collected year-round during dry and wet weather events in order to capture geographic and temporal (seasonal) distributions of encysted parasites and indicators. Water samples collected during and after major precipitation events were used to examine the impacts of storm water runoff into surface waters, and surface water infiltration from agricultural areas into ground water, on the occurrence and concentrations of encysted parasites and indicators. Water samples were analyzed for the following quality parameters: total coliforms, fecal coliforms, fecal streptococci, total coliphage, male-specific coliphage, pH, turbidity, alkalinity, hardness, phosphate, and nitrate. The microbial and chemical data from each site were examined individually and as part of larger subsets. Sample sites were classified into one of three land use groups: (i.) primarily agricultural, (ii.) primarily suburban, and (iii.) mixtures. A further division of the data was applied to separate human, animal, and mixed fecal sources. The resultant data groups were examined for significant correlations through an all-possible multiple linear regression and

Spearman correlation utilizing the statistical program Sigma Stat. These analyses aid in determining which indicators are most useful in predicting the presence and concentrations of pathogens and in distinguishing between types or sources of fecal contamination from humans and the different animal sources. Indicators were also evaluated on the basis of sensitivity, specificity, accuracy, reliability, technical difficulty, speed and cost. A robust mathematical model, that would indicate the nature of a contaminating source when provided with physical and microbial data at a source of interest, was developed. The research employs a neural network approach to identify the sources of microbial contamination in water bodies.

Principal Findings and Significance

The data collection portion of this research is complete and we are now in the data analysis portion. Although weekly samples have been concluded, there are still a few follow-up analyses on protozoa and biolipids in the watershed that are being completed. A new bacterial ratio (atypical to total coliforms) has been uncovered that can be used to predict the age of fecal inputs as well as provide source definition. The ratio is statistically different for water impactedby urban or agricultural runoff as well as for impounded versus flowing streams. Impounded urban runoff has the highest ratio while raw domestic sewage has the lowest. The ratio changes during rainfall towards that expected of water impacted by fresher fecal inputs. The amount of change could be useful for determining priority for implementation of best management practices on urban creeks. Those areas with ratios most similar to that of human sewage during rainfall could be targeted so that the final receiving stream quality would improve. This simple bacterial ratio seems to provide the same type of information on animal fecal material during composting. The joint project with Dr. Mark Coyne has provided data that is currently under analysis with the objective of submitting a paper of the findings by late summer 2000, but preliminary inspection shows a distinct difference in the bacterial ratio for horse versus cow manure. The ratio changes with age of manure in the same way as it does for streams. It may be that this ratio is the universal component of the locally trained neural network model that will allow exportation of this approach to watershed managers everywhere. Watershed monitoring for encysted protozoa continues. The method for recovery of protozoa from turbid waters continues to be effective. Urban creeks that are suspected of having leaking sewer systems have been shown to be consistently loaded with both Giardia and Cryptosporidium. The paper on the improvement to the EPA 1622 method was initially turned down by the journal Applied and Environmental Microbiology, but the article is being re-submitted with additional data. Most importantly, after obtaining a 2-year, multiparameter database from Tom Atherholt of the State of New Jersey, neural network analysis was successful at predicting encysted protozoa concentrations for both Giardia and Cryptosporidium when statistical methods were not. This meets the stated objective of developing efficient neural networks for protozoan risk prediction. This finding has been accepted for publication fall 2000 in the Journal of the American Water Works Association and will be presented at the International Water Health Microbiology conference in Paris, France during summer 2000. Another post-doctoral research assistant has been hired and is completing the analysis of the combined data. New types of genetic algorithms are being assessed for their impact upon training the neural networks. So far, back-propagation has performed equally as well as these other training schemes, but work is continuing. A part-time graduate student has been retained for the analysis of the phosphate and nitrate data. This person is determining if the bacteria ratio defined by this research is correlated with nutrient levels. A grant application was submitted to EPA, but was not recommended for funding. The approach of utilizing the new bacterial ratio has been promoted to researchers interested in defining the impacts of the local PRIDE (Personal Responsibility In a Desirable Environmnet) efforts and the PIs are participating in another grant to the Kentucky Water Resources Research Institute headed by Dr. Lindell Ormsbee. A subcontract to the Agronomy department has resulted in the support of an undergraduate in civil engineering and

graduates in other departments to expand the approaches first discovered by this KWRRI grant.

Descriptors

microbial indicators, encysted protozoa, fecal contamination, land use, agriculture, surface water quality, neural networks

Articles in Refereed Scientific Journals

Brion, G.M., T.R. Neelakantan, and S. Lingireddy, 2000, Using Neural Networks to Predict Peak Cryptosporidium Concentrations, Journal American Water Works Association, Initially Accepted 1-00, Final Acceptance 4-00 Brion, G.M., H.H. Mao, and S. Lingireddy, 2000, New Approaches to Use of Total Coliform Test for Watershed Management, In Press, Water, Science, and Technology. Brion, G.M. and H.H. Mao, 2000, Use of Total Coliform Test for Watershed Monitoring with Respects to Atypicals, ASCE Journal of Environmental Engineering, Vol. 126, No. 2, 175-181.

Book Chapters

Brion, G.M. and S. Lingireddy, 1999, Identification of Pollution Sources Via Neural Networks, in R.S. Govindaraju and A.R. Rao eds., Kluwer Publishing.

Dissertations

Houghland, Sarah, 2000, A new microbial indicator to predict fecal age. M.S. Thesis, Engineering, Civil Engineering, Univeristy of Kentucky, Lexington, Kentucky.

Water Resources Research Institute Reports

None

Conference Proceedings

Neelakantan, T., G.M. Brion, and S. Lingireddy, 2000, Neural Network Modeling of Cryptosporidium and Giardia Concentrations in the Delaware River, (Submitted January 2000, Accepted for oral presentation March 2000), IWA Paris 2000: Health Related Water Microbiology, Paris, France, July 2000. Brion, G.M., H.H. Mao, and S. Lingireddy, 1999, New Approach to Use of Total Coliform Test for Watershed Management, Use of Total coliform Test for Watershed Monitoring with Respects to Atypicals, 7th International Conference of the Israel Society for Ecology and Environmental Quality Sciences, cosponsored by IAWQ, Jerusalem, Israel.

Other Publications

None

Basic Project Information

Basic Project Information	
Category	**Data**
Title	A full-scale plant evaluation of the removal of microcystin from drinking water
Project Number	B-01
Start Date	03/01/1999
End Date	08/31/2000
Research Category	Water Quality
Focus Category #1	Toxic Substances
Focus Category #2	Treatment
Focus Category #3	Water Quality
Lead Institution	Northern Kentucky University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Judy Westrick	Professor	Northern Kentucky University	01
Miriam Steinitz Kannan	Professor	Northern Kentucky University	02

Problem and Research Objectives

The objective of the study was to determine the extent of removal of microcystin, a hepatotoxin produced by the cyanobacteria Microcystis, from drinking water by full-scale treatment methods at the City of Newport Drinking Water Plant. A conventional treatment system and the Actiflo ballasted flocculation treatment system were to be assessed. However, the Actiflo system was not put on-line until October 21, 1999. It was originally scheduled to go on-line in March, 1999, and the duration of the study was to be from March of 1999 through March of 2000. Conventional treatment methods for the removal of microcystin were assessed from March 1, 1999 to October 20, 1999. Actiflo assessment began October 21, 1999, and will be completed August 21, 2000 via an extension of the grant. However, due to the installation delay, the data presented at the conferences listed under the "Publications" heading focused on assessing water quality differences between the Ohio River and the storage reservoir and will be discussed in this synopsis. The City of Newport Drinking Water Plant coagulates water after it is held in a storage reservoir, and has, until recently, considered the reservoir as its source of treatable water. However, the Ohio River is considered its source of treatable water under promulgated federal regulation. The reservoir serves as a barrier against upsets in the river, such as floods, algal blooms, and industrial spills. The reservoir also decreases production costs by acting as a buffer against rapid turbidity changes in the river and decreasing sludge removal during coagulation. Despite these advantages, reservoir water can be difficult to treat due to the proliferation of algae. This problem can be accentuated by the proliferation of cyanobacteria. Thus, the objectives of this study were 1) to determine water differences between the two sources, 2) to monitor differences in algal densities, especially cyanobacteria, in the river and the reservoir, and 3) to analyze samples from the river and the reservoir for dissolved microcystin. Assessing these differences will allow Newport to

optimize its water treatment methods.

Methodology

Water samples were collected weekly from the Ohio River and the storage reservoir from March to September of 1999, and monthly from October of 1999 to February of 2000. Turbidity, pH, TOC, and chlorophyll a levels were measured according to Standard Methods. Paired t-tests were conducted to determine significant differences in each parameter. Samples were also analyzed for dissolved microcystin using an Enzyme Linked Immunosorbent Assay (Chu, 1990). The ELISA method uses polyclonal antibodies against different microcystin variants. ELISA kits were purchased from EnviroGard and have a detection limit of 0.2 ppb. Samples were filtered through a 0.45 micron filter, assayed, and read on a spectrophotometer. Algal counting was conducted biweekly from March to September of 1999, and monthly from September of 1999 to February of 2000. Samples were placed in a settling chamber for 24 hours. Single and colonial units of algae were then counted on an inverted microscope to determine amounts of cyanobacteria, diatoms, and green algae in one liter of water (Wetzel, 1991). Due to algal preservation problems, there is no algal counting data from March or April 1999. Chu, F., Huang, X., and Wei, R. 1990. Enzyme-linked immunosorbent assay for microcystins in blue-green algal blooms. Journal of the Association of Analytical Chemists 73: 451 p. Wetzel, R., and Likens, G. 1991. Limnological Analyses. 2nd ed New York: Springer-Verlag. 391 p.

Principal Findings and Significance

Total algal densities, including those of cyanobacteria, were higher in the reservoir on the majority of sampling dates. Chlorophyll a levels were also monitored. Paired t-tests demonstrated that chlorophyll a levels and pH were significantly higher in the reservoir than in the river. Water samples from the river and the reservoir were tested for dissolved microcystin using the ELISA method, and results were negative. Frozen Microcystis cells were lysed and microcystin was not detected. High levels of cyanobacteria, high levels of chlorophyll a, and high pH measurements in the reservoir suggest that the City of Newport should cater its water treatment methods to the water quality parameters of the reservoir, and not to the river. However, monitoring the above factors will enable government agencies to more effectively perform risk benefit analyses of storage reservoirs.

Descriptors

microcystin, Microcystis, cyanobacteria, drinking water, water quality, hepatotoxin

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

Westrick, Judy, Heather Millson, Brian Bertsch, Nichole Brinkman, and Miriam Steinitz-Kannan, 1999, Water Quality Differences between the Ohio River and the Storage Reservoir of the City of Newport Drinking Water Plant, Ohio River Basin Consortium for Research and Education. Westrick, Judy, Heather Millson, Brian Bertsch, Nichole Brinkman, and Miriam Steinitz-Kannan, 1999, Water Quality Differences between the Ohio River and the Storage Reservoir of the City of Newport Drinking Water Plant, Kentucky Academy of Sciences Annual Symposium. Westrick, Judy, Heather Millson, Brian Bertsch, Nichole Brinkman, and Miriam Steinitz-Kannan, 2000, Water Quality Differences between the Ohio River and the Storage Reservoir of the City of Newport Drinking Water Plant, in Proceedings Kentucky Water Resources Annual Symposium, p 43-44. Westrick, Judy, Stuart Oehrle, and Miriam Steinitz-Kannan, 2000, Algal Monitoring on the Ohio River: An Increase in Cyanobacteria Concentration, International Conference on Toxic Cyanobacterial Blooms. Westrick, Judy, Heather Millson, Brian Bertsch, Nichole Brinkman, and Miriam Steinitz-Kannan, 2000, Water Quality Differences between the Ohio River and the Storage Reservoir of the City of Newport Drinking Water Plant, American Water Works Association 2000 Water Quality Technology Conference. Accepted for publication.

Other Publications

None

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Measurement and prediction of solute transport parameters for Kentucky soils
Project Number	B-02
Start Date	03/01/1999
End Date	02/28/2000
Research Category	Ground-water Flow and Transport
Focus Category #1	Solute Transport
Focus Category #2	Water Quality
Focus Category #3	Agriculture
Lead Institution	University of Kentucky

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Edmund Perfect	Assistant Professor	University of Kentucky	01

Problem and Research Objectives

Widespread use of agricultural chemicals and increasing applications of animal wastes to soils pose a threat to ground water quality in the Southeast region. To manage these non-point sources of pollution it is vital that we are able to predict transport process in the variably saturated (vadose) zone underlying agricultural fields. Solute transport in this zone can be predicted using the convection-dispersion equation (CDE). However, estimates of the input parameters required to run this model are currently unavailable for Kentucky soils. The objectives of this research were: 1) To experimentally determine solute transport and water retention parameters for a wide variety of Kentucky soils and 2) To develop pedotransfer functions to predict solute transport parameters from the water retention curve and other more easily measured soil properties.

Methodology

Paired water retention and solute breakthrough curves were measured on 69 undisturbed soil cores from 6 different Kentucky soils as described in the original proposal. The water retention curves were parameterized in terms of the air-entry value and b-exponent of the Campbell model. The solute breakthrough curves were parameterized in terms of the dispersivity (D) obtained by inverse estimation from the CDE and by moment analysis.

Principal Findings and Significance

Pedotransfer functions, developed using stepwise multiple regression analysis, explained 31% of the total variation in the inversely-estimated D and 44% of the total variation in the moment analysis D. Dispersivities increased as both the b exponent and air-entry value increased.

Descriptors

soil water, water retention curve, solute transport, dispersion coefficient, dispersivity

Articles in Refereed Scientific Journals

Perfect, E. 1999. Estimating soil mass fractal dimensions from water retention curves. Geoderma 88:221-231. Taguas, J.F., M.A. Martín, and E. Perfect. 1999. Simulation and testing of self-similar structures for soil particle-size distributions using iterated function systems. Geoderma 88:191-203. Perfect, E., and M.C. Sukop. 2000. Models relating solute dispersion to pore space geometry: A review. Soil Science Society of America Special Publication, Madison WI (in press). Bejat, L., E. Perfect, V.L. Quisenberry, M.S. Coyne, and G.R. Haszler. 2000. Solute transport as related to soil structure in unsaturated intact soil blocks. Soil Science Society of America Journal (in press).

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

Perfect, E., and M.C. Sukop. 2000. Modeling solute dispersion in irregularly shaped soil pores, in Proceedings of the 4th Soil Structure/Carbon Workshop, Leamington, Ontario, Canada, (in press).

Other Publications

A manuscript describing the pedotransfer functions developed to predict solute dispersion from water retention curve parameters is currently being prepared for submission for publication.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Records of Holocene climatic change and hydrologic variability in spring tufa from Kentucky: Will global climate changes affect water availability in karst terrains of the mid-continent area?
Project Number	B-03
Start Date	03/01/1999
End Date	02/28/2001
Research Category	Climate and Hydrologic Processes
Focus Category #1	Water Quantity
Focus Category #2	Climatological Processes
Focus Category #3	Hydrogeochemistry
Lead Institution	University of Kentucky

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Slawek Tulaczyk	Assistant Professor	University of Kentucky	01

Problem and Research Objectives

This research is aimed at testing the hypothesis that future global warming may be associated with increased occurrence of droughts. This test will be performed using geochemical evidence for past droughts that may exist in secondary calcite deposits from south-central Kentucky. The underlying assumption is that the warm "Holocene climatic optimum" may be used as an analog of the future global warming (Conway, 1998). Originally, the record of past conditions was supposed to be obtained from tufa of Three Hundred Springs, near Cave City. However, initial petrologic investigations of calcite cores obtained from this locality has revealed that the tufa is not suitable for the purpose of this study because: 1) it does not contain well-developed (annual?) banding required to obtain the desired high-resolution chronology, and 2) the sampled tufa deposit is solid only at the top surface (<15 cm) but is very porous and crumbly underneath. Thus, search for another suitable sampling locality in the same general area has taken several additional months. After investigating several caves in the vicinityof Cave City and Bowling Green, we selected a flowstone from the Lost River Cave, Bowling Green. Access to this sampling site was provided through cooperation with Dr. N. Crawford (Western Kentucky University). This flowstone formation has water flowing over it and the presumption is that it is still being actively deposited. Beyond this change, the scientific objectives of this study remain the same: 1) to construct a detailed Holocene chronology of the secondary calcite deposits, 2) to obtain a record of variations in elemental and stable isotope composition of the Holocene calcite, and 3) to derive quantitative estimates of the possible variations in drought frequency and severity during the Holocene climatic optimum.

Methodology

The selected flowstone from the Lost River Cave was cored with a gas-powered hand-held Pomeroy drill to obtain a single core that is 2.5 cm in diameter and 25 cm long. The acquired core was then split lengthwise with a diamond saw. Subsamples from the top and the bottom of the core (ca. 2 grams each) were sent off for U-Th dating to the UCSC TIMS facility. In addition, one half of the core was used to prepare thin sections for petrologic investigations and micro-banding analysis. The latter analysis were done using a video camera mounted on a petrographic microscope and connected to a PC that had commercial image-processing software (ImagePro) installed. Fourier analysis of banding width was performed with a program written in Matlab. Small (ca. 10 mg) subsamples of powdered calcite were obtained from 14 parts of the cores that were selected based on microscopic analysis. The powdered calcite was generated by drilling into the core with a Dremel hand-held microdrill. The powder samples have been analyzed for major and trace elements using the ICP-MS available at the Center for Applied Energy Research. As stated in the proposal, more such analysis are planned, as well as additional carbon and oxygen isotope analyses at an outside laboratory.

Principal Findings and Significance

1. Three Hundred Springs tufa is not suitable for this study because it disintegrates upon drilling (except for a top thin layer) and does not contain well-developed macro- and micro-banding. 2. Cave flowstone collected from an active formation from the Lost River Cave represents an alternative source of calcite suitable for this research. 3. A 25-cm long core of the Lost River Cave flowstone contains macro- and micro-banding throughout its thickness. Petrographic analysis indicates that this material has not recrystallized and that the visible banding is a result of impurities (fine-grained minerals and organic material). 4. Fourier spectral analysis shows that the calcite banding has variable thickness (as shown by lack of strong peaks in the power-spectrum graphs). 5. ICP-MS elemental analysis indicate presence of the elements of interest (e.g. Sr, Mg, Mn) in a sufficient concentration for meaningful analysis (dozens to hundreds of ppm). There is also significant variability in the concentration of elements from one part

of the core to another. For instance, Sr varies in concentration from 95 to 169 ppm amongst the 14 analyzed samples.

Descriptors

climate change, drought, karst hydrology, isotopes, trace elements

Articles in Refereed Scientific Journals

None

Book Chapters

None

Dissertations

None

Water Resources Research Institute Reports

None

Conference Proceedings

None

Other Publications

None

Information Transfer Program

The Institute's information transfer program has numerous components: The Environmental Systems Seminar Series is managed with assistance from the Institute. Graduate students working toward the certificate are required to participate in this seminar for two semesters, but the presentations are also open to the general public. Speakers address environmental issues that are normally related in some way to water due to the strong emphasis on the systems approach to environmental problems. The Kentucky Water Resources Annual Symposium was held on February 25, 2000. This one-day symposium allowed individuals from universities, government, and the private sector to present information on completed and ongoing research and program activities. Twenty-three platform presentations and two poster presentations were included in the program and the abstracts were printed and distributed as a proceedings volume (abstracts are also available on the Institute Web page). The conference program also featured a panel presentation by the Kentucky Watershed Watch volunteer program (they conducted a series of water quality monitoring events in 1999 at over 330 stations throughout the Commonwealth). There were approximately 175 registrants at the annual symposium. The Institute also serves as the co-sponsor for the Kentucky Nonpoint Source Conference. Due to a shift in the conference schedule from fall to spring, no conference was held during FY 1999. However, planning began for the 2000 conference which was held May 23-25, 2000 in Bowling Green, Kentucky. The program planning committee arranged two field trips (karst features,

constructed wetlands for swine waste management), two workshops (319 grant management, newcomers introduction to the 319 program), 3 invited speakers (cave biota, Kentucky legislative update, phoshorous management), 20 platform presentations, 22 poster presentations, and numerous exhibits. The Institute nesletter - WATERWORKS continued to provided a forum for the disseminatipon of research results and water news of interest to researchers, regulators, and the general public. A 1999 Annual Report describing all of the activities of the Institute during the calendar year was also published and distributed. The Institute maintained a Publications List and research reports were provided to organizations and individuals requesting them. The Institute also maintains a Kentucky Water Resources Research Faculty and Staff Directory to provide a ready reference for Kentucky university water-resource investigators experienced in dealing with specific water-resource problems. This directory helps to facilitate information transfer and documents the vast expertise available in the Commonwelath to address water resource issues. The Institute maintains a homepage on the Internet that provides electronic access to information such as the Annual Report, newsletters, the Kentucky Water Resources Research Faculty and Staff Directory, and all of the abstracts from the Kentucky Water Resources Annual Symposium. The Internet site documents all of the programs of the Institute (not only activities supported by Section 104), provides personnel profiles, and furnishes direct e-mail linkage for those wishing to contact the staff of the Institute: http://www.uky.edu/WaterResources/ Information Transfer Program Publications: Kentucky Water Resources Research Institute 1999 Annual Report, February 2000, Kentukcy water Resources Research Institute, Lexington, KY, 24 p. Proceedings Kentucky Water Resources Research Annual Symposium, 2000, Kentucky Water Resources Research Institute, February 25, 2000, Lexington, KY, 52 p. Information Transfer Presentations Related to Research Projects: Project C-03 (Fryar) Assessing potential biodegradation of trichloroethene in deep sediments at the Paducah Gaseous Diffusion Plant, Kentucky: talk by Nadège Etienne, presented to Bechtel Jacobs Company and the U.S. Department of Energy, Paducah, Kentucky, April 19, 1999. Assessment of potential trichloroethene biodegradation in wetland soils, McCracken County, Kentucky: talk by David Butler, presented to Bechtel Jacobs Company and the U.S. Department of Energy, Paducah, Kentucky, April 19, 1999. Natural attenuation of contaminants: a watershed perspective: talk by Alan Fryar, presented to the Department of Geology, Miami University, Oxford, Ohio, October 6, 1999. Natural attenuation of contaminants at the Paducah Gaseous Diffusion Plant: a watershed perspective: talk by Alan Fryar, presented to the Department of Agronomy, University of Kentucky, Lexington, October 15, 1999. Project C-05 (Brion) Using Neural Network Analysis to Classify Runoff Sources, Soil Science Society of America 2000: Agronomy, Crop, and Soil Sciences: Stars of the 20th Century - Beacons for the 21st. Minnesota, MN, November 2000. Neural Networks for Water Quality, Seminar to Research and Production Staff of the Louisville Water Treatment Facilities, February 2000. New Bacterial Ratio for use in Watershed Management, Seminar to Research and Production Staff of the Louisville Water Treatment Facilities, February 2000. Indicator Organisms for Water Quality: Trends and New Developments, Drinking Water Analysts Annual Training School, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Louisville, KY, April 1999. New Approaches to the Use of Total Coliform Tests for Watershed Management, UK Geological Sciences Seminar, Lexington, KY, October 1999. Other Information Transfer Activities: The Institute convened an interdsiciplinary water supply technical panel to establish consensus positions related to projected water demand, water supply alternatives, costs, and implementation issues for central Kentucky. The findings were presented to the Lexington-Fayette Urban County Council at a series of work sessions (September - December, 1999). The findings are being used by the Council and the Kentucky River Authority to form plans for augmenting water supplies in Lexington and other surrounding communities along the river's main stem in support of projected water-supply needs over the next 20 years.

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	7	1	0	0	8
Masters	1	4	0	0	5
Ph.D.	1	0	0	0	1
Post-Doc.	1	2	0	0	3
Total	10	7	0	0	17

Awards & Achievements

Project C-05: Awarded a special grant ($4,500) from the Vice Chancellor of Research and Graduate Studies on April 15, 1999 to support expansion of encysted protozoa monitoring in the local watershed. Project C-05: Awarded one year pilot project ($30,000) via Kentucky Senate Bill-271 program grant to fund "Training and Testing of Neural Netwok Models for Identifying Non Point Source Pollution by Animal Wastes. Co PIs are: Dr.Coyne (Agronomy), Dr. Edwards (Biosystems and Agricultural Engineering), Drs. Brion and Lingireddy (Civil Engineering). Project B-01: Poster describing study placed second in the Northern Kentucky University Center for Integrated Science and Mathematics Poster Competition.

Publications from Prior Projects

Articles in Refereed Scientific Journals

None Reported

Book Chapters

None Reported

Dissertations

None Reported

Water Resources Research Institute Reports

Perfect, Edmund, M.S. Coyne, M.C. Sukop, G.R. Hazler, V.L. Quisenberry, and Ligia Bejat, 1998, Solute and Bacterial Transport through Partially- Saturated Intact Soil Blocks, Kentucky Water Resources Research Institute Report #204, Kentucky Water Resources Research Institute, University of Kentucky, Lexington, Kentucky, 46 p. Project C-01

Conference Proceedings

None Reported

Other Publications

None Reported