Abstracts - AIPG 2007 Annual Meeting

Assuring the reliability of your sampling results

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Abstract

Sample analyses constitute one of the fundamental data types forming the basis of our professional work. But do the analytical results actually reflect what we think they do? Have the sampling, sample preparation, and analytical procedures been tested by a quality assurance/ quality control program that demonstrates the reliability and repeatability of the sampling results? Failure to include appropriate quality assurance/quality control procedures renders the sampling results at least suspect and potentially as totally unreliable. The submission of blind, duplicate samples is required at a minimum. For samples of elements or compounds that are very small portions of the total, say in 0.1% quantities, or less, such as precious metals and some contaminants, the use of standard and blank samples should also be part of the quality assurance/quality control program. For samples testing major constituents of the sample, for example, the $CaCO_3$ content of a limestone, the use of standard and blank samples may not be needed.

The analytical results of quality assurance/quality control are easily analyzed. The duplicate samples should yield the same result and standard samples the standard result within acceptable analytical limits. Just because a laboratory routinely runs its own quality assurance/quality control program (if it doesn't, don't use the lab) does not demonstrate that your sample results are reliable. The use of independent analytical laboratories cannot, in and of itself, ensure that a reliable sampling, preparation, and analytical program has occurred. You must test the process.

Reductive Dechlorination of Carbon Tetrachloride in Groundwater within Unconsolidated Quaternary Sediments

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Abstract

A pilot-scale treatment zone (TZ) injected across the width of a carbon tetrachloride (CT) plume effectively decreased the concentration of CT in groundwater with no accumulation of degradation products. The CT plume extends from a grain elevator approximately 2,500 feet downgradient where it discharges into a small creek; the highest concentrations of CT (2,500 µg/L) are located near the source area The geologic history in the study area resulted in a mix of interbedded sand, gravel, clay, and silt overlying Permian age shale.

Bench-scale testing was conducted to identify the preferred remedial technology – injection of Adventus EHC™ into saturated sand units across the plume width near the source area. EHC combines controlled-release, fibrous organic carbon, and micro-scale zero-valent iron and acts through *in situ* chemical reduction to create strongly reducing conditions that stimulate rapid dechlorination of CT and other chlorinated solvents.

Groundwater sampling results 13 to 22 months after installation of the TZ have shown a 97% decline in CT concentration 70 feet downgradient of the TZ. Groundwater sampling results 22 months after installation of the TZ have shown a 88% decline in CT concentration 600 feet downgradient of the TZ. Implementation of

this remedial technology as a pilot test has allowed us to achieve cleanup goals. Following implementation of the EHC TZ and upon acquiring groundwater data that document the success of this remedial technology, our client received an approved voluntary cleanup plan from the state regulatory agency as part of a long-term remediation solution.

Hydrogeology and Geochemistry of a Potential Spring Water Source for Consumer Bottled Water Products, Newaygo County, Michigan

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Abstract

A groundwater spring aquifer was investigated for potential development for the Ice Mountain brand of bottled spring water. The FDA definition of "spring water" requires that spring water pumped from a well (1) be from the same underground stratum as the spring, as shown by a measurable hydraulic connection between the borehole and the natural spring, and (2) have all the physical properties, and be of the same composition and quality, as the water that flows naturally through the spring.

Regional geology of the project site consists of glacial outwash flanked by glacial moraine deposits. Subsurface soil consists of medium to coarse sand with gravel, and thin layers of fine-grained sand, silt, and clay. Regionally, groundwater is present in an unconfined aquifer, but separated locally into upper and lower hydrostatic units by a layer of fine-grained sediments. Springs occur where surface topography intersects the water table.

Aquifer tests at the test well indicated a hydraulic connection between the well and springs, however, water samples indicated a difference in chemistry between the upper and lower portions of the aquifer. Field parameters indicated a reducing environment within the lower portion (negative ORP and low DO), along with high levels of iron and manganese. The upper portion (including the spring) exhibited an oxidizing environment with positive ORP and high DO. Conductivity, TDS, and hardness are higher in the lower portion than in the upper portion.

The test well satisfied one aspect of the FDA standard -- a measurable hydraulic connection between the well and the spring -- but not the other. Water samples from the well had a different mineral composition than the water flowing through the spring, and had a different mineral composition than spring water currently bottled as Ice Mountain.

A 50-Year Recount and Forecast of Groundwater Use and Availability in the Upper Huron River Basin

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Abstract

Previous work by the eminent Dr. George R. Kunkle (1960) suggested that in the year 2010 groundwater extraction would begin to produce progressive declines in the water table of the Upper Huron River Basin when well withdrawal reaches 10.5 billion gallons per year (BGY). This data suggests the declines in the water table will occur first where demand is high and underflow is low. For example, Kunkle hypothesized that some areas, such as northeastern Pittsfield Township, in which availability of groundwater is low and demand is high were entering a period of progressive groundwater level declines in 1960.

The current authors have compiled water well use and other hydrologic information for the Upper Huron River Basin to assess the current conditions relative to Kunkle's prediction and to estimate impacts to ground water sustainability for the next 50 years. Data is evaluated using the hydrologic equilibrium equation in conjunction with assumptions made by Kunkle. Present data suggests the well extraction rates are approaching 10.5 BGY and underscores need for more direct empirical study.

MANAGING CONFLICT-INCREASING PROFITS

Lawrence A. Cerrillo, CPG 2763

Abstract

As professionals in our respective disciplines we interface on a daily basis with others in our profession that may be of a different discipline, in addition to clients, subcontractors, governmental agency personnel, special interest groups, and numerous others. Because of inherent differences, limited resources, organizational structure, misinformation, etc., the potential for destructive conflict is thus quite high and perhaps even inevitable. What is not inevitable is that all conflict be negative. Constructive conflict can provide positive, productive and progressive environments.

More than 50% of personnel turnover in a company can be attributed directly or indirectly to destructive conflict. The direct and indirect costs of replacing these individuals ranges from 75-150 percent of a persons annual salary. Depending on the size of your company, it can be the difference between a profit or loss year. Project overruns, loss of clients, passive aggressive behavior, reduction in quality of service and more resulting from conflict that goes unnoticed or worse, unaddressed all add to these costs.

This workshop will help you to recognize the sources of conflict, what the continuum of conflict is, conflict styles, anger, causes of dysfunctional teams and how to move from destructive conflict to constructive conflict and thereby increase profits.

Using Non-Intrusive Geophysical Techniques to Identify Potential Hazards at the Decommissioned Camp Lucas Military Facility in Sault Ste. Marie, MI

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Camp Lucas is a decommissioned military facility located in the northeastern part of Michigan's Upper Peninsula in the town of Sault Ste. Marie. There are concerns that defense department materials remain buried at the site. The primary objective of this geophysical investigation was to identify potential underground hazards at the site.

This investigation utilized magnetic, electromagnetic, electrical resistivity and ground penetrating radar techniques in order to detect the presence of subsurface materials. The geophysical survey suggests that multiple bodies with varying characteristics are buried at the site. Models created for the magnetic anomalies were consistent with the susceptibility of ferrous materials and had dimensions of two meters or less. These sizes indicate that the most likely cause for the large anomalies is due to targets such as pits or trenches with various ferrous materials.

The geophysical methods used provided coverage of the survey area in a short period of time and were non-intrusive. The results obtained from the different techniques were complimentary and indicate caution should be exercised when developing the area. Further investigation is necessary to determine if the buried materials are hazardous to the environment.

Coal R & D to Support National Energy Policy: A New National Research Council Report

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Abstract

A recently-completed study by the National Research Council titled, "Coal Research and Development to Support National Energy Policy," was initiated by Congress to investigate research and development in areas of the coal fuel cycle. The study's final report recommends $144 million in new federal spending for coal R & D for the "upstream" side of the coal fuel cycle including: coal reserves, miner health and safety, environmental protection and CO_2 management, and mine productivity. Currently, 90 percent of federal spending goes for "downstream" activities, utilization and transmission, while only 10 percent goes for "upstream" activities in the coal cycle.

About one quarter of all energy used in the U.S. and over half of the country's electricity is produced from coal. Forecasts for the next 25 years predict increasing demand for electricity in the U.S. and therefore increasing use of coal by as much as 60 to 70 percent. There is a potential for larger increases if coal-to-liquids and coal-to-gas technologies are developed. Many factors are considered in the forecasts for coal, and particularly significant are concerns over CO_2 emissions and global climate change. Potential controls on greenhouse gas, especially CO_2 emissions, and the technical and economic feasibility of CO_2 control measures are significant issues affecting the outlook for the future of coal in the U.S.

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Push-Ahead© Vertical Aquifer Sampling Methodology with Sonic Drilling

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Mannik & Smith Group, Inc. 2365 Haggerty Road South, Canton, MI; Dennis Robins, Branch Manager, Boart Longyear, Inc. 6215 Lehman Drive, Flint, MI; and Walter J. Bolt, CPG, Vice President, The Mannik & Smith group, Inc. 2365 Haggerty Road South, Canton, MI

Abstract

Groundwater investigations of dense non-aqueous phase liquid (DNAPL) or brine plumes that extend hundreds of feet deep into unconsolidated sediments present drilling and sampling challenges that can increase project time and cost. Sonic drilling methodology is a preferred sampling method in these environments for its superior drilling speed, good recovery of undisturbed, large-diameter core samples, significant reduction of derived waste, uniform boreholes with a minimum of drift and the ability to seal off saturated zones from one another without setting permanent multiple outer-well casings. However, the required inducement of water during drill stem advancement can greatly increase time and expense where the collection of vertical aquifer profile (VAP) sampling is desired. PROSONIC Corporation (recently acquired by Boart Longyear, Inc.) has developed a new Push-Ahead© sampling device that can collect representative ground water VAP samples while minimizing purge volumes and sampling time.

The sonic drilling Push-Ahead© sampler was developed to overcome sampling difficulties at a State of Michigan Department of Environmental Quality (MDEQ) Site investigation of a 7-mile long TCE plume located in the vicinity of Mancelona, Michigan. From 2004 through 2006, the State retained PROSONIC to advance twenty-six (26) VAP borings and install thirty-two (32) monitoring wells. Glacial alluvial sediments were explored to depths approaching 600 feet below ground level. Use of the Push-Ahead© VAP sampling device lead to significantly reduced purge water volumes and sampling time. Comparison of data and quality objectives are assessed using the New Push-Ahead© VAP sampling method from those employed using traditional sonic drilling and sampling techniques.

Global Warming and Anthropogenic CO2: Supporter, Doubter, or Denier?

Robert G. Corbett, CPG 4502, Normal, Illinois, Gary T. Dannemiller, CPG 5118 Lansing, Michigan

Abstract

Earth has warmed and sea level has risen since the last interglacial began. Science behind climate change and the role of greenhouse gases are poorly understood. The link between global warming and CO2 is a prediction approach, not a cause and effect explanation.

What constitutes an argument? **Mere correlation is not enough to establish causation, unless there are no other variables that can reasonably explain the situation**.

The argument: humankind is burning increasing amounts of carbon-based fuels, releasing carbon dioxide. CO2 content increases in the atmosphere, and that prevents some heat from re-radiating to space. Conclusion: burning more fossil fuels causes the Earth to become warmer.

This argument involves classic ***false cause and effect.*** Why? Other causes for global warming are possible. **This does not prove or disprove one theory**, but it does invalidate the fast conclusion.

An explanation independent of CO_2 is presented by Singer and Avery (2007). They cite failures of the Greenhouse theory, and many world- and culture-wide evidences that relate to climate. The Dansgaard-Oeschger cycle, an irregular 1470 year moderate warming and cooling cycle is based on O18/O16 in ice cores, although no single solar cycle matches.

If anthropogenic CO_2 is not the cause, humankind shall err on many fronts.

Why doubt? We need clear proof that the increase in CO_2 from burning fossil fuel is enough of a factor for humankind to curtail burning of fossil fuels.

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Late Precambrian Paleontology and Stratigraphy of the Carolina Slate Belt, South-Central North Carolina

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Abstract

The Carolina Slate Belt (CSB) or Carolina Terrane of south-central North Carolina is a younging southward sequence of late Precambrian to Middle Cambrian sedimentary units derived from mafic volcanic source areas. The CSB volcanosedimentary sequence in this area lies conformably on felsic rhyolite and tuff units of the Uwarrie Formation.

In south-central North Carolina, the CSB volcanosedimentary sequence is about 3,000 meters thick and has been subjected to low grade regional metamorphism as well as local contact metamorphism associated with Mesozoic intrusions. This sequence begins with the Tillery Formation above the Uwharrie Formation. The Tillery can be subdivided into lower, middle and upper portion, but overall is characterized by thin couplets, interpreted as seasonal deposits, or as distal turbidite units. Above the Tillery is the McManus Formation, which likewise can be internally subdivided, but overall is a massively bedded siltstone-claystone unit that contains late Precambrian body fossils and trace fossils.

In 1968, two body fossils on a stream boulder from Stanly County, North Carolina, were identified as the trilobite (*Paradoxides carolinensis [new species]*), which appeared to agree with radiometric dates, as Middle Cambrian. In 1982, two similar body fossils were found, also not in place, and identified as the Late Precambrian Ediacaran genus *Pteridinium.* Revisiting the earlier described fossils revealed the earlier trilobite identification to be erroneous, effectively re-setting timing on the deformational history by about 100,000,000 years. In addition, trace fossils were also discovered, several being on the same bedding surfaces as the *Pteridinium*. Abundant sedimentary structures have been noted, providing additional information on which to interpret depositional environments. The *Pteridinium* in North Carolina, provides information relative to late Precambrian plate geometry.

Capping the shallowing upward nature of this volcanosedimentary unit is the Yadkin Graywacke, a nearshore submarine to subaerial sand units.

Hydrogeologically, the CSB has little primary porosity. Secondary porosity is controlled by very closely-spaced, mainly closed, vertical to near-vertical cleavages, making completing potable water wells with reasonable flow rates a challenge. The CSB is one of several accretionary wedges attached to the east side of the North American cratonic core. Prior to 1850, North Carolina was the top gold producing state in the country, much of that gold being recovered from the CSB. Gold is still panned from streams crossing the CSB.

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STUDENT INTEREST IN GEOLOGY AS A PROFESSION BEGINS IN THE K – 12 CLASSROOM HOW CAN WE HELP?

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Abstract

College faculty complain about the preparation of entering freshmen. Professionals attending annual meetings comment about the paucity of truly qualified individuals applying for positions. K-12 teachers are often weak in content knowledge, in part because of their background and in part because of the lack of discipline-specific professional development opportunities. How can I help?

There are several ways to assist teachers in K-12 classrooms. Serving as Science Fair judges at school competitions is rewarding. This is a once a year, half day commitment for a school. Some schools have monthly "Lunch Buddies" programs where professionals join a specific class for lunch, and talk with the students.

If you have a child in elementary school, get to know the teacher. Learn what the State Standards in science require. Offer to do classroom presentations. Donating mineral and rock samples to a class or classes is a plus. Make sure the teacher is comfortable with using these samples in the future. Stay in contact with the teacher.

For the professional organization such as AIPG, invite local K-12 teachers to meetings. Encourage them to participate in field trips and make them welcome. Include teachers in your communications lists. State AIPG sections can have membership in State Science teacher groups, have displays and mineral / rock giveaways at the annual science meetings, and present hands-on workshops (mineral identification, etc.). For those AIPG members so inclined, submit papers to and hold membership in the National Earth Science Teachers Association or the National Association of Geoscience Teachers.

Hydrogeological Evaluation for Millennium Park, Kent County, Michigan

Gillett, Bruce E., (Fishbeck, Thompson, Carr & Huber)

Abstract

A hydrogeological evaluation was performed for Millennium Park located on the southwest side of Grand Rapids, Michigan. The study was completed to assist the Kent County Parks Department with design and development of the park which, at 1500 acres, will be one of the largest urban parks in the nation. The vision for the park includes not only greenspace preservation, but also reclamation and restoration of

natural habitats from many years of industrial uses including gypsum mining, oil and gas production, and sand and gravel mining.

Millennium Park is situated along the Grand River and includes three streams as well as numerous lakes, ponds, and wetlands. Some of the existing and proposed park features, such as the beach, playgrounds, boat launch, and canoe trail, are dependent upon the geology and hydrology of the park. Water levels in the lakes and streams at the site are known to vary considerably due to both rainfall events and Grand River flooding. Due to the changing nature of water levels and complex interrelationships of the site geology, lakes, ponds, streams, wetlands, and water quality, a detailed hydrogeological and surface water evaluation was necessary.

The results of the evaluation help answer critical park development questions and allow the Parks Department to effectively integrate the natural features of the property into the park design. Among other things, the evaluation indicated the eastern lakes were impacted to some extent by the gypsum mines, portions of the park will flood due to both local rainfall events and Grand River flooding, and some of the lakes should not be directly connected to form a canoe trail.

Geologic Carbon Dioxide Sequestration -- Overview

Gorman, Robert F., Vice President, NTH Consultants, Ltd, Farmington Hills, Michigan

Abstract

Understanding the processes involved in sequestering carbon dioxide in deep rock formations has advanced quickly in just the past few years. This has been fueled by the need to find options to remove carbon dioxide from stationary source emissions to the atmosphere. The US Department of Energy has funded a significant study of the issue and has launched a series of seven "Carbon Sequestration Partnerships" across the country.

Geologic sequestration of carbon dioxide involves permanent storage of this gas in underground formations after it has been captured from power plants or other large industrial operations. Geologic sequestration targets include depleted oil and gas fields, deep, ‘saline’ formations and unmineable coal seams. Experience from existing enhanced oil recovery projects and underground natural gas storage projects provide valuable information to assess gas storage behavior and carbon dioxide sequestration feasibility.

Examples and selected information from case studies from the Michigan and Illinois Basins are used to present an overview of these options. These are useful in understanding the elements of a feasibility analysis.

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Occurrence of Methane at a Former Petroleum Refinery

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Abstract

The presence of methane (CH_4) at a 70-year old abandoned petroleum refinery is documented as a case study for use by regulators, consultants and academics. Methane in soil-gas can pose environmental risks because it can be an asphyxiant in basements of receiving structures, and is an explosion hazard when present at concentrations between 5 and 15 percent by volume in air. Proper characterization of methane sites is important to determine environmental liability and the selection of an appropriate remedy.

Successful investigation at the 75-acre study area included:

- Use of sonic drilling techniques, continuous profiling of soil, and down-hole methane screening.
- Monitoring of redox conditions in groundwater.
- Groundwater sampling using pressurized manifold system to maintain aquifer pressure to collect dissolved methane (Isotech Method).
- Deployment of 50 near-surface "punch-bar" soil-gas sampling locations and 12 off-site vapor monitoring points.
- Frequent re-sampling and analysis of groundwater and soil-gas, and

- Development of a conceptual site model addressing the source and migration of methane at the site.

Methane identified at the study area may be classified as anthropogenic methane, derived from biological weathering of spilled refined petroleum. High dissolved (>10,000 ug/L) and soil-gas methane (1,000 to 100,000 ug/L) concentrations strongly correlate spatially to known petroleum plume boundaries. This is consistent with published literature suggesting a "causal relationship" between petroleum-impacted soil and methanogenesis. Direct indicators of methanogenesis included documentation of sub-surface anaerobic aquifer conditions and presence of gaseous and dissolved methane. Challenges include differentiating naturally-occurring methane in organic-rich soils from "plume-derived" methane.

Analyzing Ground Water Hydrology and Jurisdictional Wetland Hydrology Monitoring using Pressure Transducer Data Loggers.

Hayes, Brian L. P.G. Environmental Scientist II, KCI Technologies, Inc., Raleigh, NC

Abstract

Monitoring shallow ground water hydrology is the key to documenting hydrologic success in wetland restoration projects. With our nation's "No net loss" policy, successful restoration projects are crucial. A number of methods have been developed to measure and record depth to ground water, each with its own strengths. The pressure transducer data logger is reasonably priced, durable, easy to install and replace in the field, quick to download, and easy to reprogram. A typical data logger can hold at least 21,000 lines of data, so that at 12 hour recording intervals there is more than enough memory for the typical five-year monitoring period of a restoration site. A pressure transducer is totally enclosed and therefore is less susceptible to mechanical failure than resitivity gauges, and can be set at any depth within the range of the instrument as opposed to pre-set depths based on the manufactured length of the gauge. A data logger is installed in a shallow monitoring well, the well is surveyed at ground level and top of well, and the data are analyzed to evaluate ground water conditions against the jurisdictional wetland success criteria. When graphed with onsite precipitation data the effects of evapotranspiration can be evaluated as well as the response of the water table to a given storm. Reliable, accurate data are the keys to documenting hydrologic success in a wetland restoration project, and as Dave Rosgen says, "There is no substitute for data."

Geothermal: A Role in Reducing Energy Costs and Global Warming

Heinzman, James R., Michigan Department of Environmental Quality, Lansing, Michigan

Abstract

Rising energy costs, global warming, and pollution are rapidly becoming national policy concerns. Increased use of geothermal resources can address these concerns through large-scale development and implementation.

Geothermal resources, including soil, groundwater and surface water are proven, reliable, and accessible commodities for development. Heat pump technology to access this resource for heating and cooling is efficient, easily implemented, and capable of dramatically reducing carbon emissions. It is far more economical, long term, when compared to other heating and cooling systems. Increased use of this technology can also result in reducing our dependence on foreign oil.

Earth has a daily, seasonal, and annual energy budget. Heat is continually transferred from sun to air to soil to ground and surface water by climate and weather patterns. This constant weather-related energy influx provides a sustainable resource. Geothermal resources need to be part of a full range of existing domestic and alternative energy options currently under development. This resource has proven capabilities to stimulate a new energy-related economy while reducing carbon dioxide emissions.

A geothermal system can heat and air condition homes, businesses or industrial complexes with substantial cost reduction. Waste heat from coal generation and industrial processes can be recycled and distributed to customers. Large-scale design and management of geothermal heat systems for neighborhoods, municipalities, industries, and regional utility companies are areas of development that relate directly to geology.

The talk intends to generate discussion about geothermal heating as a significant component of a sustainable energy policy.

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Risk Avoidance: Oxymoron?
Reduce Liability Exposure and Still Give Cutting-Edge Advice

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Abstract

Nearly everything we do in our professional and personal lives creates and involves a decision about risk. Although risk can't be eliminated, it can be reduced. During the presentation, we'll explore the ways geologists create risk, and how to reduce risk and exposure to potential liability while still serving our clients.

Find in Bay

Holly, Mark, Northwestern Michigan College

Abstract

Underwater archaeologists and divers from the Grand Traverse Bay Underwater Preserve Council have discovered the remnants of what could be an ancient shoreline in Grand Traverse Bay. This feature consists of a 1000 foot long line of boulders that was most likely formed between 7,000 and 10,000 years ago when water-levels in Lake Michigan were substantially lower. Preliminary investigations of the individual boulders indicate that they consist of granite, limestone and dolomite and there is evidence that some of the

stones could have been set in a circle by humans. One of the largest granite boulders discovered thus far displays what is arguably an image of a mastodon. While this image is very clear, considering the boulder was part of a dynamic beach zone, the authenticity of its human manufacture has yet to be established with certainty. Experts in this field are currently being consulted. The image is of the full body of a single mastodon (type of prehistoric elephant) with the head, trunk, ears, back and legs having the clearest definition. There is also what has been interpreted as a spear protruding from the animal's mid-section, perhaps in the area of the heart. The skeletal remains of mastodons have been found in many locations throughout southern Michigan but as yet not in the Northwestern part of the state. Mastodons are known to have existed during the period when lake-levels were considerably lower and archaeologists have long posited that they were a food source of Paleo-Indians, some of the first people to inhabit the area after the last glaciation. If the image is authenticated, it could prove to be some of the earliest evidence of ancient mans activities in the region and is a highly significant find.

Dr Holley teaches the introduction to underwater archaeology course offered by Northwestern Michigan College and is the underwater archaeologist for The Grand Traverse Bay Underwater Preserve Council.

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Stratigraphic Analysis – A Classical Approach to Environmental Problem-solving

Howard, James F., PhD, Private Environmental Consultant, Owensboro, Kentucky

Abstract

Modern environmental investigations are heavily dominated by mechanistic approaches to Site Evaluation. Many proposed remedial solutions do not incorporate thorough analysis of the geologic controls on contaminant occurrence and transport, either due to lack of time, money or staff understanding of the basic principles and techniques of stratigraphic analysis. This is particularly true when understanding the site setting requires involvement of dynamic changes in hydrogeologic setting due to fluctuations of controlling parameters through time.

This presentation will summarize some of the basic techniques applicable to both large and small site environmental assessments. Case history examples to illustrate the use of these stratigraphic analysis techniques in assessing time-dynamic controls in contaminant occurrence and migration, particularly in unconsolidated depositional regimes, will then be presented. The case histories will include locations in the glaciated, marginal marine, fluvial and arid depositional systems with special emphasis on using the concept of time in assessing dynamic variation in Site hydrogeologic conditions.

Emphasis in the presentation will be placed on integration of geologic framework with hydrogeologic controls to enhance efficiency of both site assessment and selection of the most effective remedial technology applicable to the site.

Rapid NAPL Recovery using Two Different Enhanced Flushing Processes

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$gPRO_{HP}$ System developed by inVentures Technologies, Inc.

Abstract

Rapid free product removal of hydrocarbons and solvents has been a major challenge over the past three decades of remediation. Failing rapid removal of free product allows for long-term dissolution around the edges of the NAPL, providing a continuing and unabated source of dissolved groundwater contamination. Two different enhanced flushing processes have been developed within the past two years to rapidly remove gasoline free product from within an aquifer. Process 1 involves a field trial in Ontario, Canada. Supersaturated Water Injection (SWI) technology was used with carbon dioxide saturated water injection for controlled mobilization of VOCs to the water table for collection with soil vapor extraction (SVE) or dual phase extraction where NAPL was present. In the SWI process, water was supersaturated with CO_2 in the $gPRO_{HP}$. mass transfer system. The saturated water was injected into an aquifer test cell were a 200 liter hydrocarbon mixture had been placed forming a residual NAPL zone. CO_2 bubbles nucleated at the targeted area of the aquifer. The rising CO_2 bubbles contact with VOC NAPL ganglia in the saturated zone and cause volatilization of the VOCs into the vapor phase and mobilization of NAPL trapped in pores.

Extraction and reinjection wells were used to recirculate the CO_2 saturated water.. The CO_2 is distributed by flowing water resulting in effective gas distribution followed by heterogeneous bubble nucleation and continuous growth of gas bubbles in situ. A gas saturation front developed which expanded laterally and vertically towards the water table. VOCs mobilized to soil gas were extracted with a SVE system. Results indicated a significant proportion of VOCs were removed by SVE.

Process 2 was performed at a former tank pit at a northern California containing used hydraulic oil that was trapped beneath the saturated zone. Process 2 used a two-step flushing process which included high-pressure air injection and biosolvent injection to thin and mobilize the heavy oil, which was measured up to 41 cm in height in one well. The high-pressure air injection and biosolvents were used with high-vacuum extraction to recover both the used hydraulic oil and the biosolvent. The final stage separated the heavy oil from the unspent biosolvent and groundwater. Over 11 barrels of free product were removed and a similar volume of biosolvent was recovered during the one week process. Site closure is imminent. Geologic aspects of the free product removal design will also be discussed.

Unsaturated Zone Hydrology: Connection to Ground Water

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Abstract

This presentation will focus on testing methods, computer modeling tools, and applications of vadoze zone hydrology for geologists focusing on ground water problems. Flow through unsaturated soils is important because vadose zone is the connection between the ground surface and ground water. Ground water recharge or contaminant impacts to ground water occur through the vadose zone. Unsaturated hydraulic properties of soils play a vital role when surficial geology and ground water regime are of interest. Compared to ground water modeling, unsaturated flow modeling is more complex due to highly non-linear

nature of soil-water retention functions and related changes in the unsaturated hydraulic conductivities of soils. In addition, unsaturated models are more data intensive. In this presentation, state-of-the-art methods to measure unsaturated hydraulic properties of soils (e.g., hanging column, water potentiometer, tempe cells, instantaneous profile method, etc), use of sensors for field applications, and computer modeling using the most commonly used numerical models (HYDRUS-2D and Vadose/W) will be discussed. Example problems including water balance of landfill caps and subsurface liquid distribution systems will be presented to give a preview of unsaturated flow modeling.

Ex-Situ Chemical Oxidation of Pentachlorophenol at a Former Manufacturing Facility in Lester Prairie, Minnesota

Blakely, Robert; Kinsman, Larry; Orin Remediation Technologies, McFarland, Wisconsin

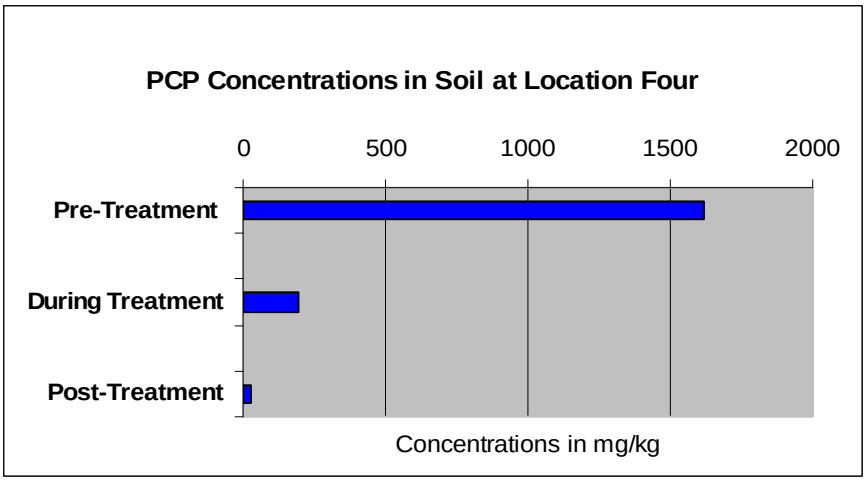
Abstract

The project used ex-situ chemical oxidation methods to successfully remediate soils contaminated with creosote compounds at a former wood frame manufacturing plant in Lester Prairie, Minnesota. Two onsite areas, Location One and Location Four, were selected for remediation using two differing treatment chemistries, Iron-activated Hydrogen Peroxide (Fenton's Reagent) and Alkaline-activated Sodium Persulfate, respectively.

Prior to conducting onsite remediation, bench-scale testing was performed using representative samples from Locations One and Four and both treatment chemistries. Bench-scale testing allowed ORIN to evaluate different treatment chemistries and dosage rates for optimal contaminant oxidation of pentachlorophenol. The Fenton's Reagent successfully treated the soil from Location One but was unable to treat soil from Location Four, even after multiple applications, due to high petroleum concentrations. However, the Sodium Persulfate chemistry successfully treated soil from Location Four in one application and therefore was subsequently chosen for full-scale remediation.

Subsequent to bench-scale testing, onsite ex-situ remedial activities were implemented. Ex-situ remediation consisted of spraying the treatment chemistry directly onto the contaminated soil while simultaneously mixing the soil using an excavator within the excavation. The soil was fully saturated with treatment chemistry to ensure contact with contaminants. At Location Four, the lime catalyst was added as a solid and subsequently mixed.

Results from Location Four are summarized in the chart below. The lime used for alkaline-activation served a dual purpose: it catalyzed the creation of the sulfate radical necessary for oxidation by increasing soil pH while desorbing the pentachlorophenol from the creosote.



Oxygen-Enhanced Air Sparging for Remediation of NAPL at a Former Manufactured Gas Plant

Mark R. Klemmer, PE (ARCADIS, Novi, Michigan)
Robert A. Ferree, CPG (ARCADIS, Novi, Michigan)
Kevin R. Wilson (ARCADIS, Novi, Michigan)
Roger C. Whiting, PE (Consumers Energy, Jackson, Michigan)

Air sparging and soil-vapor extraction (AS/SVE) have been in operation at the site of a former manufactured gas plant (MGP) in Manistee, Michigan since 2003. The site, located along the Manistee River, was an operating MGP from 1882 to 1950. Soil and groundwater impacts at the site consist of polynuclear aromatic hydrocarbons and benzene, toluene, ethylbenzene, and xylenes (BTEX), with residual non-aqueous phase liquids (NAPL) in a smear zone from approximately 18 to 22 feet below grade.

The AS/SVE system was installed to prevent migration of dissolved-phase impacts to the Manistee River. After three months of operation, concentrations of BTEX compounds at the site were reduced to below cleanup criteria. Naphthalene concentrations in the NAPL smear zone area have persisted above cleanup goals.

In 2007, liquid oxygen was used to increase the oxygen content of the injected air. Dissolved oxygen concentrations have reached 16 milligrams per liter in the deep zone, yet remain below 0.5 milligrams per liter in the shallow zone.

A biological activity assessment was performed to quantify the rate of naphthalene degradation and the approximate time required to degrade the residual NAPL smear zone. Collection of vapor samples for carbon dioxide and groundwater samples for biological oxygen demand; plate counts for aerobic, heterotrophic bacteria; interfacial tension; and dissolved oxygen; in addition to field observation of byproducts of aerobic respiration have shown the rate of naphthalene degradation at the site could be as much as 35 pounds per day. Performance monitoring of the system is ongoing.

Altering the Geochemistry of a Glacial Outwash Aquifer to treat a TCE Groundwater Plume

Michael Kovacich (mkovacich@geotransinc.com), David Beck and Tammy Rabideau
(GeoTrans, Inc., Ann Arbor, Michigan USA)
Michael Zack and Michael Cannaert (Visteon Corporation, Van Buren Twp., Michigan, USA)

Abstract

The goal of this study was to use results from a pilot test biobarrier to design and install a full-scale biobarrier to treat a tricholoroethene (TCE) plume. The Site is located in central Indiana, where historic use of TCE has impacted an unconfined aquifer glacial outwash aquifer. A plume consisting primarily of TCE has migrated from west to east across the Site toward a regionally significant river. The plume is approximately 1,100 feet wide, 6,300 feet long, and up to 50 feet deep. The horizontal groundwater flow velocity is estimated to be 2.0 to 5.0 feet/day. Site geochemical and volatile organic compound (VOC) data did not indicate the natural attenuation of TCE. A bench test indicated that bioaugmentation could be successfully applied at the site. A pilot test combining direct-push injection of emulsified vegetable oil with 5% lactate in 14 drive points with a circulation cell, followed by bioaugmentation with halorespiring bacteria, was completed at the site. Complete dechlorination of TCE to ethene was observed in select monitoring wells and significant dechlorination of TCE was observed in all other monitoring wells within the circulation cells. Halorespiring bacteria (*Dehalococcoides*) growth throughout the pilot test plot was confirmed using Real-Time Polymerase Chain Reaction (PCR) techniques.

A full-scale biobarrier was installed along the downgradient property boundary and extended 1,200 feet perpendicular to the groundwater flow direction. The biobarrier consisted of two rows of electron donor injection points at the northern and southern margins of the plume and three rows in the central portion of the plume. A combination of 105 temporary points and 60 permanent points was used to construct the biobarrier. The permanent points were installed to provide locations where bacterial inoculum and future electron donor application could be applied. Each permanent point was screened across the entire saturated thickness of the impacted aquifer.

A total of 60,000 lbs of electron donor, an emulsified vegetable oil with lactate product (EVO), was applied to the biobarrier to condition the aquifer prior to bioaugmentation. Three groundwater extraction wells were used to supply make-up water to three different portions of the biobarrier. The make-up water was used to prepare a 20% EVO solution, which was delivered to the subsurface. The central extraction well was located in an area where a viable bacterial population persisted from an earlier bioaugmentation pilot test. The EVO donor solution prepared from this water successfully "pre-seeded" the central portion of the biobarrier. Two months following donor addition, 330 liters (L) of dechlorinating bacterial culture (KB-1) was applied to the entire length of the biobarrier including the pre-seeded area. PCR techniques confirmed that *Dehalococcoides* was present four weeks after inoculation, and a significant increase in the percentage of the *Dehalococcoides* microbial population was observed after eight weeks. Subsequently, 13 months of very positive dechlorination trends have been observed at every inoculation point and local down-gradient monitoring wells and complete dechlorination has been observed in one down-gradient well. Additional monitoring results will be presented.

Economical Application of the Self-Potential Method to Remedial Investigation and Treatment System Monitoring at a Petroleum Release Site, Muskegon, Michigan.

Lint, Robert J. CPG, and Mankowski, Leonard C., MACTEC Engineering & Consulting, Traverse City, Michigan.

Abstract

Using physical sampling and analysis to map groundwater contamination can be costly, time consuming, and obtrusive work. A self-potential geophysical survey was conducted to quickly and inexpensively locate a gasoline contaminant plume in groundwater. The naturally occurring breakdown of gasoline contaminants in groundwater results in depletion of electron donors, with a corresponding decline in redox potential. The area of electron donor depletion was measured indirectly from the ground surface using the self-potential method.

Based on traditional investigation methods, a contaminant plume was identified flowing beneath a residential neighborhood. Contamination impacts an unconfined aquifer consisting of generally homogeneous sand. The depth to water ranges from 8 to 25 feet below grade level. The redox potential of groundwater within the plume is several hundred millivolts lower than regional levels. The redox anomaly was detected from the ground surface with a self-potential survey conducted within road right-of-ways. Results of the self-potential survey correlate well with data collected by conventional methods and accurately locate the longitudinal axis of the contaminant plume.

A single person completed the field survey in a few hours with less than 100 dollars of reusable equipment. Survey equipment consists of two or more porous pot electrodes, 1,000 ft of 18 gauge insulated wire, and a digital volt meter. Electrode construction, field methods, and data reduction techniques will be discussed.

Finally, the self-potential method is being applied to remediation monitoring of newly installed groundwater circulation wells and opportunities to inexpensively monitor the efficacy of new treatment technologies is further discussed.

Development of a 3-Dimensional Geotechnical Model Using Diamond Drill Hole Data

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Predicting the required ground support in underground excavations and the cost of that support is critical in underground mine planning. It was identified at the East Boulder Mine, that a tool for predicting the geotechnical parameters of an area would facilitate better coordination between departments for planning, scheduling and cost analyses of new excavations. The 3-Dimensional model is based on an existing 2-Dimensional model in use at the Stillwater Mine[1]. A methodology was developed, utilizing Vulcan software, to create a 3-Dimensional block model from existing 3-Dimensional solids and surfaces that correspond with the zone to the South of the mineralized zone, the mineralized zone, and the zone to the North of the mineralized zone. After the geometry of the model is defined, the unconfined compressive strength, block size, friction angle, stress reduction factor and rock mass quality are calculated based on values of rock quality designation, joint set number, joint roughness number, joint alteration number and point load index that are observed in the diamond drill holes for the 3 zones. The data is length weight composited and treated as sample points for each zone with only samples that are flagged for each zone being used to estimate blocks in each zone[2,3]. Graphical representations of the model can then be plotted using a color-coded key for different variables corresponding to minimum ground support criteria. The resulting 3-Dimensional model provides a powerful prediction tool allowing better planning, scheduling and cost analysis prior to excavation.

References

[1] Langston, R. (2006) Re: Data and equations, e-mail to Gretchen Moore (gmoore@stillwatermining.com), 13 Feb [accessed 13 Feb 2006].

[2] Kirsten, H.A.D.K., Langston, R. Rock Engineering Aspects Investigated During May Visit to Mine. Steffen, Roberson and Kirsten Report to Stillwater Mining Co. # 208592/4, June 1997.

[3] Kirsten , H.A.D.K., Langston, R. Rock Engineering Aspects Investigated During April Visit to Mine. Steffen, Robertson and Kirsten Report to Stillwater Mining Co. # 208592/5, August 1998.

Three-Dimensional Groundwater Model of a Gold Mine Near Republic, Washington

Sinton, Peter[1,], James Flynn[1], Ron Dixon[2], David Banton[3], Leslie Smith[4], and Joanna Moreno[5]
1: URS Corporation, Seattle, Washington and Denver, Colorado
2: Department of Ecology, Yakima, Washington
3: Golder Associates, Seattle, Washington
4: University of British Columbia, Vancouver, British Columbia
5: Adventus Americas, Conifer, Colorado

Abstract

Groundwater flow at this site is strongly-influenced by fault zones and the flow properties of heterogeneous glacial deposits, the gold ore is hosted in deposits of complex shape, and the underground mine will have numerous access portals and haulage tunnels to access ore up to 500 feet below land surface.

The objectives of the modeling were to:

- Develop a conceptual model that incorporates local data collected over a 10-year period (water levels, aquifers tests, borehole logs, stream baseflow).
- Predict the pre-mining recharge-discharge and groundwater flow conditions by calibrating the model to measured water levels and stream baseflow.
- Predict potential post-mining impacts on groundwater levels and flow patterns, and on stream baseflow under average, seasonal, and drought conditions.

A groundwater model using FEFLOW was prepared and calibrated to simulate 3D groundwater flow patterns over an area of about 60 km^2 (**Figure 1**). The model simulates flow in the discrete features (tunnels and fault zones) using 1D and 2D high-permeability elements embedded in the 3D model. Time-dependent material properties are used to represent mine development and backfilling.

The model was calibrated to seasonal river flows under baseline and drought conditions and then predictions were made for pre-mining, during mining, post-mining, and recovery phases under different climate assumptions (see, for example, **Figure 2**). Detailed flow balances for the area within the mine capture zone were developed and alternate remedial measures compared. The model results were used as the basis for impact analyses.

Figure 1: Model Domain Showing Topography and Discretization

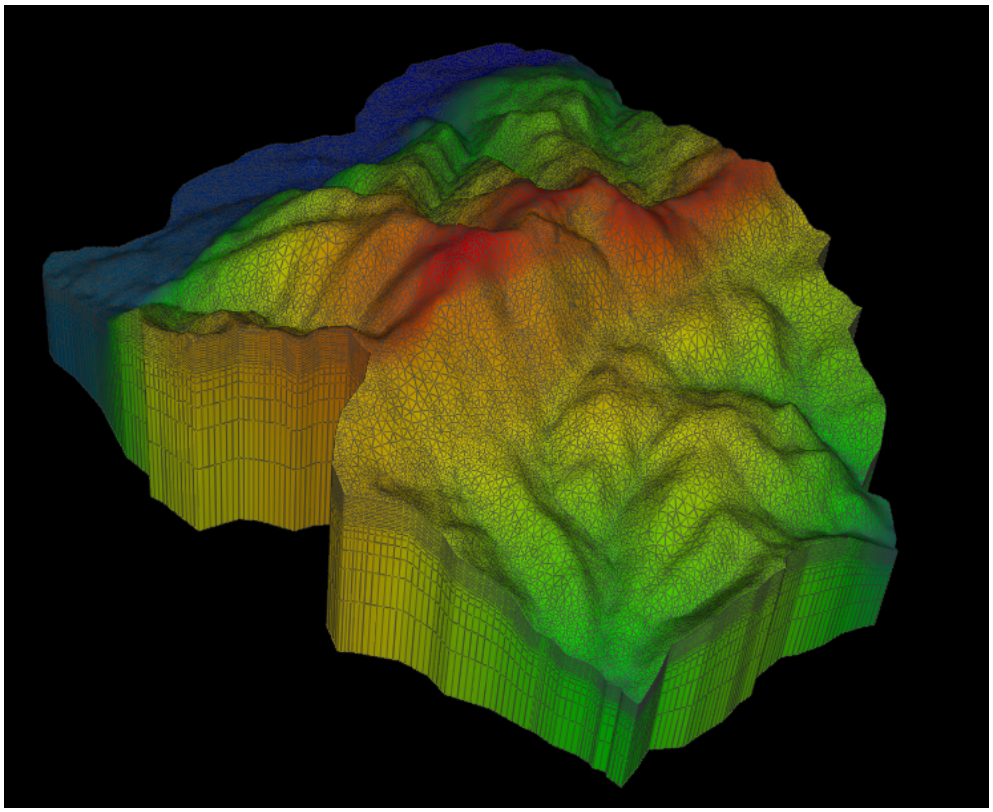
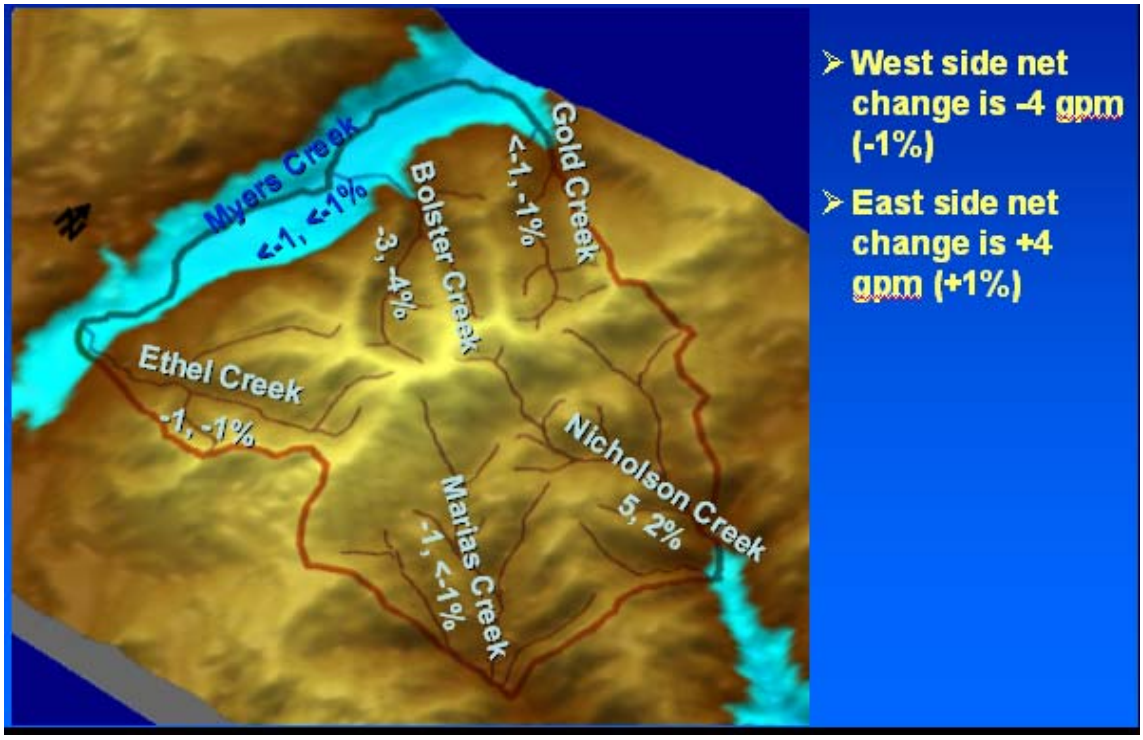


Figure 2: Predicted Baseflow Change After Mine Closure



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Conventional and Geophysical Approaches to Assess Preferential Flow Pathways Through Glacial Terrain, Mancelona, Michigan

Murray, Steven D., CPG, Lint, Robert J., CPG, and Mankowski, Leonard C., MACTEC Engineering & Consulting, Traverse City, Michigan.
Adams, Janice A., and Wagoner, Robert, Michigan Department of Environmental Quality, Remediation and Redevelopment Division, Gaylord Field Office.

Abstract

The Wickes TCE Plume extends approximately eight miles laterally from a source built on a glacial outwash plain in Mancelona, Michigan into a glacial moraine complex and impacts groundwater to depths of nearly 500 feet below grade. The Cedar River Well Field was previously constructed in a deep aquifer down gradient of the plume to replace residential and municipal supply wells and is now threatened by greater than anticipated plume expansion. Regional groundwater flow models could not account for the extent of plume migration. Conventional and geophysical methods were used to search for glacial deposits that may be acting as a preferential flow pathway.

Conventional investigation methods included rotosonic soil coring and modified rotosonic vertical aquifer sampling, groundwater sampling, and slug and pump tests. Geophysical investigation techniques included induced polarization and resistivity surveys near the source of the plume. High resolution compression and shear wave seismic surveys were performed in the distal portion of the plume.

High permeability zones that contribute to plume expansion were discovered during soil coring, slug testing, and the electromagnetic surveys. Seismic survey results coordinated with rotosonic cores and pump tests were used to map the thickness and lateral continuity of a low permeability layer that confines the top of Cedar River Well Field aquifer. Identified vertical migration risk points are being monitored with sentinel monitoring wells.

Investigation results will be presented and applied to the site-specific geologic and hydrogeologic models. Both seismic and electromagnetic studies have produced cost effective model and feasibility analysis improvements.

Geological Aspects of Contaminant Generation, Transport and Fate, Gilt Edge Mine Superfund Site, Lawrence County, South Dakota

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Fundingsland, Steve, CDM Federal Programs Inc., Denver, Colorado
Anton, Nicholas, CDM Inc., Denver, Colorado

Abstract

The Gilt Edge Mine is a superfund site located in the northern Black Hills of South Dakota. The site generates about 95 million gallons of acid drainage each year, which is collected and treated prior to discharge to prevent contamination of area surface and ground water. Remediation of acid generating mine sites is an interdisciplinary process that requires evaluation by scientists and engineers in numerous disciplines. Geological aspects of this process require consideration of lithology and mineralogy, ore mineralization, alteration, structural geology, geochemistry and hydrogeology. Contaminant generation

results from chemical weathering of pyrite and other ore minerals. Products of these oxidation reactions such as sulfate, protons, and metals react with minerals in the host rock. At Gilt Edge, this process results in formation of strongly acidic water containing high concentrations of toxic heavy metals such as cadmium, copper and zinc. The propensity for acid generation in Gilt Edge rocks is controlled by both hypogene sulfide mineralization and supergene oxidation. Permeability of the host rock is dominated by secondary permeability in the form of interconnected fractures and major fracture zones, which causes a very irregular lower boundary of supergene oxidation. Secondary permeability also controls infiltration of water through the vadose zone and migration of contaminants in ground water. The Gilt Edge mine site presents an excellent opportunity to apply numerous geological disciplines to develop important components of an overall conceptual model that describes generation, transport and fate of contaminants.

The Disappearing Geo Workforce –Another Indication of Global Warming?

Richard M. Powers, CPG, PG, BCI Engineers & Scientists, Inc, rpowers@bcieng.com

Abstract

The profession of geology, like most others, is cyclical in nature and fluctuates with our economy, society's need for natural resources, and on a more basic level "what profession is cool". Currently our profession is experiencing a "glacial retreat" and some have postulated that this is a possible indication of global warming. If one plots the recent increase in average global temperature against the declining rate of graduating US geoscientists, one might conclude that there is a profound climatic influence on those wishing to pursue a geoscience career. Whether it's too hot outside to work or math and science are "to hard", geoscientists must mobilize to increase the number of bright, motivated young people entering our profession.

The statistics are staggering: for every 350,000 undergraduates that experience a college level geology course, approximately 5500 will major in and earn a geoscience degree based on 2005 data. Of those potential 5500 geoscientists that graduate each year from US colleges and universities, inclusive of BS (4000), MS (1200) and PhD (500) degrees only 1200 will enter the geo workforce. Are our careers that dismal and boring? Is it the money? Is being an attorney, entrepreneur, of computer guru that much more appealing?

The opportunities available for geoscientists today are greater than ever before. Currently, there is 100% employment for graduating geoscientists and still the numbers of students entering our profession is small. This presentation will discuss the decline of the geo workforce and what is being done to reverse the downward trend.

Feasibility Evaluation of DNAPL Source Zone Reduction in Silty-Clay Beneath an Occupied Residential and Commercial Structure

William J. Prall, C.P.G. (wprall@grtusa.com), Nancy Posavatz, M.S. (nposavatz@grtusa.com), (Global Remediation Technologies, Inc., 1102 Cass Street, Traverse City, Michigan 49684, United States, (231) 941-8622, (231) 941-4131)

Following a thorough feasibility process, Global Remediation Technologies, Inc. (GRT) determined that use of *in situ* thermal treatment was the best available technology for source reduction at a site located in Southwestern Michigan. The site is a former manufacturing facility that had been redeveloped using

Brownfield funding to convert the property to residential living units and a public health club. Investigation activities performed following completion of the residential and commercial developments identified the presence of a mixed waste DNAPL with the primary component being trichloroethylene.

The geology at the site is primarily silty-clay and presented challenges for traditional forms of DNAPL recovery. GRT evaluated several technologies for reduction of the source zone, and determined that *in situ* thermal remediation was the best available technology for achieving desired results. Technologies screened during the feasibility process in addition to *in situ* thermal remediation included excavation and disposal (including building demolition and re-construction), *in situ* mixing with zero valent iron, *in situ* chemical oxidation, and *in situ* bioremediation.

Geochemistry of Arsenic Contamination at Deltaic Aquifer of Kolaroya, Bangladesh

Rahman Md. Tauhid-Ur[1], Mano Akira [1], Udo Keiko [1] and Ishibashi Yoshinobu [2]
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[2]Department of Civil and Environmental Engineering, Tohoku Gakuin University
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Abstract

This paper is aiming to reveal the hydro-geochemical aspect that controls the arsenic (As) mobilization at the shallow aquifer composed of deltaic sediment, at an As hot-spot, Kolaroya, Bangladesh. Geochemical analysis shows that the sampled ground water is mostly Na-Ca-HCO_3-Cl type. Multivariate data analysis illustrates that As appears to have strong positive relationships with pH, Fe, Al, Ca, HCO_3 and PO_4. However, adverse relationships are also observed with EC, depth, Na, Cu and NH_4-N. Samples having higher pH (8.10), contains elevated As concentration (154 µg/l). Large quantity of Ca (171.3 mg/l) and bicarbonate (514 mg/l) in ground-water could be an evidence of possible carbonate dissolution that might have been happening in the aquifer sediment either from calcite or dolomite. Consequently this could be one of the reasons of releasing As at a higher concentration in the ground water. High PO_4 and NH_4-N in groundwater might be from the decomposed buried peat deposit. Total organic carbon of the sediment (2.6%) also supports the presence of buried peat. Higher pH (8.98) and lower Eh (-5 mV) of sediment sample claims that the unsaturated zone is very reductive in nature where As^{3+} is dominating. Significant amount of phosphate was found in that groundwater. That can compete with As for searching of sorption sites which again could stimulate the de-sorption of As. Selective sequential extraction test presents that As available in sediment is mostly in the strong adsorbed form. Higher As was found in brown clay (34.4 mg/kg) in a shallow depth (9 m) whereas lower As was reported in coarse sand (11.2 mg/kg) in a deeper aquifer (120 m).

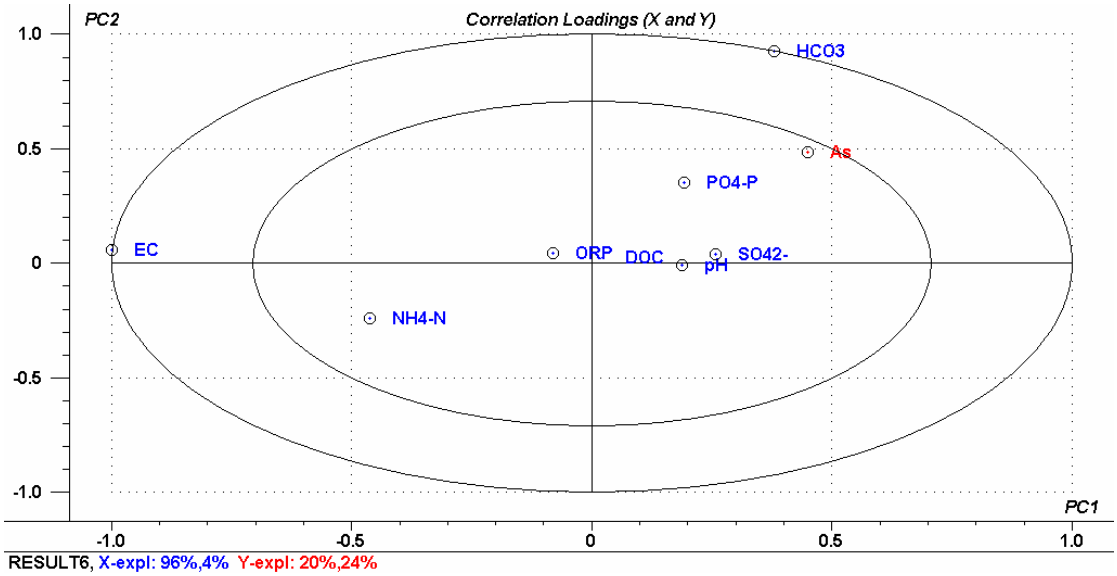

Figure1: Loading plot of Multivariate data analysis showing the relationship of As with other anions

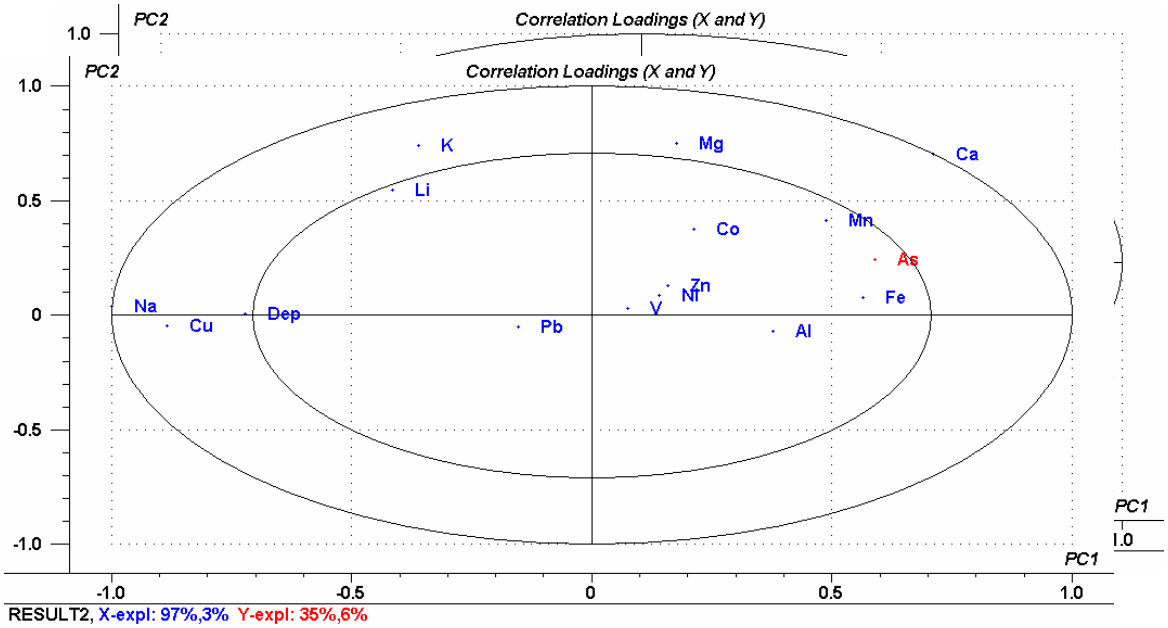

Figure 2: Loading plot showing relationship of As with other accompanying heavy metals

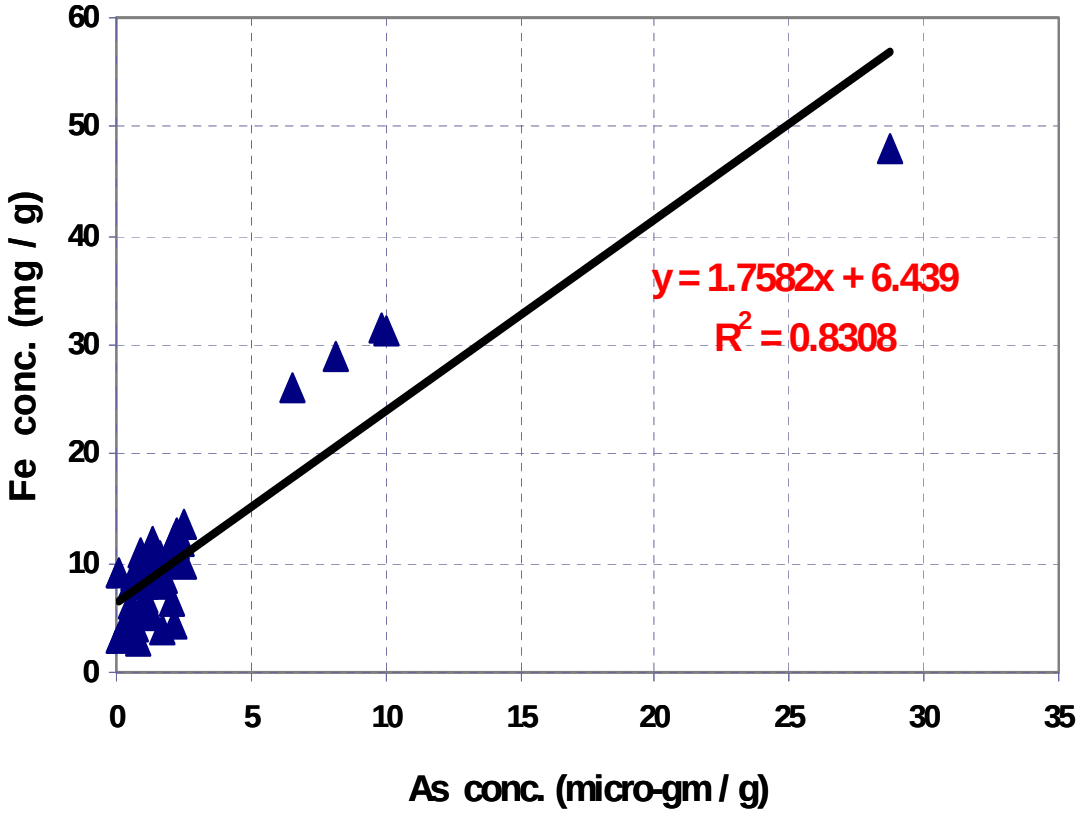

Figure 3: As and Fe relationship in Aquifer Sediment

Observed Ground-Water-Level Response to the Shut Down of a Ten Million Gallon per Day Ground-Water Withdrawal, Monroe County, Michigan, USA

Reeves, H.W. and Nicholas, J.R., USGS Michigan Water Science Center, 6520 Mercantile Way, Suite 5, Lansing, Michigan 48911

Abstract

In December, 2002, an aggregate quarry in Monroe County, Michigan, ceased operations. Prior to shut down, approximately ten million gallons of water per day was removed from the sump within the quarry. Data from both USGS monitoring wells and private-sector monitoring wells will be presented and discussed. The regional recovery in water levels is quite extensive. Approximately fifteen feet of recovery is observed in wells over seven miles away from the quarry. The observations will be contrasted to standard radius-of-influence calculations performed using data only from nearby wells. These calculations indicate that the quarry should have very little impact on water levels beyond one or two miles.

Quarry-Induced Potentiometric Rebound in Southeastern Michigan: 2003-2007

David P. Regalbuto, CPG and Sean C. Paulsen, Golder Associates Inc., Wixom, Michigan

Abstract

Most of southeastern Michigan is underlain by Silurian and Devonian carbonate formations that are commonly covered by less than 100 feet of glacial overburden. Due to their accessibility, these bedrock formations are a valuable resource from which aggregate is produced for construction, ballast, and the manufacture of cement. In some areas, quarrying has been active for over 100 years. Because bedrock quarrying in this part of the state necessarily entails dewatering, water levels in areas surrounding the quarries have experienced declines.

The glacial deposits in this part of the state (i.e., Monroe, Wayne, and extreme southeastern Washtenaw Counties) are predominantly comprised of glacio-lacustrine clay that is frequently underlain by dense clay-rich glacial till. Where the glacial clay is of a sufficient thickness and low enough permeability to act as an aquitard, Michigan solid waste disposal statues and rules permit the construction of landfill cells to depths below the potentiometric elevation in the clay, provided that: a) a prescribed vertical isolation is maintained above the uppermost aquifer; and b) uplift pressures will not result in failure of cell bottoms prior to waste disposal.

In November 2002, the former London Aggregates quarry, located in north-central Monroe County, ceased operations. Consistent with U.S. Geologic Survey data, Golder Associates has observed the rebound of water levels in the detection monitor well systems at several landfills located within a 10- to 15-mile radius of the quarry. The rebound began during early 2003 and continues to the present. The rate and magnitude of increase in groundwater levels is more pronounced in wells that are completed in the bedrock than in the overlying glacial deposits. At some locations, the rebound has exceeded 20 feet within a 4-year span. This magnitude of increase has the potential to: a) alter the direction and magnitude of hydraulic gradients at disposal facilities with detection monitoring systems; b) affect the geochemistry of groundwater samples that are used to determine whether a statistically significant difference in groundwater chemistry has occurred; and c) impact stability where landfill cells are to be excavated into clay below the potentiometric surface, but where construction may occur long after permit issuance.

Setting Yourself Apart with Brownfield Professional Certification

Richardson, Donald W., C.P.G., R.B.P., Kleinfelder, Inc. Hamilton, NJ

Abstract

Established in 2004, the Institute of Brownfield Professionals is an educational organization whose mission is to:

- provide a forum for discussion of business, regulatory, and technical issues of common interest;
- represent members in regulatory matters;
- provide educational and training media and fora to advance members' knowledge and capabilities;
- certify the apparent capabilities of environmental professionals; and
- promote members' availability to serve those who need the services of environmental professionals.

Institute President-Elect Donald W. Richardson, C. P.G., R.B.P. will discuss the founding of the IBP and its development of the Registered Brownfield Professional (R.B.P.) designation. The designation is intended to recognize environmental professionals who have the qualifications to design and conduct brownfields studies and develop remediation plans effectively, in accordance with the U.S. Environmental Protection Agency's All Appropriate Inquiry regulations. In this session, he will address the federal government's "environmental professional" criteria, how it differs from R.B.P. criteria, the benefits becoming an R.B.P. creates for individuals and the companies that employ them, and how to become an R.B.P.

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Predicting Groundwater Flow and Transport Using Michigan's Statewide Wellogic Database

Andreanne Simard, Ph.D., Golder Associates Inc., Lansing, Michigan

Abstract

One of the most significant challenges in groundwater investigations is data limitation. The fact that the subsurface environment is inherently heterogeneous makes the data limitation problem particularly acute. Among the various data often needed for groundwater investigations, the most critical components are water level and hydraulic conductivity data. The collection of these data through traditional means (e.g., installing monitoring wells, collecting monitoring data, performing aquifer tests…etc) can be expensive and time prohibitive. In this study, we present a new source of data for mapping groundwater levels and generating estimates of hydraulic conductivity that are accurate across multiple spatial scales. In particular, we propose integrating and making systematic use of a massive amount of rarely-used, but highly valuable static water level (SWL) data collected by drillers and accumulated over the past several decades (publicly available through the Wellogic System). Although these measurements can be relatively crude, they are available extensively and at a high spatial resolution, which continues to increases with time. Many prior investigations have concluded that these data may be too noisy for most practical hydrogeologic applications; however, our systematic analysis shows that, if properly processed, the SWL data from the Wellogic System can be extremely useful, enabling surprisingly accurate predictions of spatially-detailed and temporally representative groundwater flow patterns. In addition, these data can be used to provide solid estimates of hydraulic conductivity, which can be used to further estimate regional or local groundwater flow rates. This tool may have significant implications and application for a number of groundwater research and professional investigations.

Glaciotectonic and Associated Features in Detroit Metropolitan Area

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Abstract

In the Detroit Metro Area, a range of glaciotectonic and associated glacial geology features occur which can be observed in excavations. Three examples are described.

Near Franklin two thin clay-boulder moraines occur that are overlaid by sheet sands with a thin basal conglomerate. Deformed sand clasts occur in a complex layer between the moraines might suggest a deformable layer under the former glacier. Sand-gravel wedges extend vertically trough the lower till, do not show compressed margins and are not due to ice wedging. Perhaps they opened up under other glacier derived stresses.

At the Clarkston Post Office a gravelly soil horizon, water-laid gravels and sands overlay a clay-boulder moraine. A glaciotectonic structure occurs that is 90 feet long, shows distinct compressive and extension zones and thrust surfaces that vary from horizontal to nearly 30 degrees from the horizontal.

Southwest of Mt. Clemens is a several hundred foot-long deformed section that consists of a succession that includes a clay-rich moraine overlain by sands, an ice laid gravel layer with oriented striations which is succeeded by laminated sands. The orientation of the striations on the gravel is parallel the length of the mapped moraine and the associated erosion surface truncates the deformed section horizontally.

Carbon Dioxide Enhanced Hydrocarbon Recovery in the Michigan Basin

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Abstract

Opportunities exist in the Michigan Basin for using carbon dioxide for the enhanced recovery of hydrocarbons and sequestration of carbon dioxide. In addition to the value of the recovery of additional hydrocarbons, utilizing carbon dioxide for enhanced hydrocarbon production would provide a market for carbon dioxide that would mitigate some of the costs of carbon capture and sequestration.

Michigan has produced over 1.3 billion barrels of oil since oil was discovered in the state. Since traditional oil field recovery practices only recover about 25% to 40% of the oil in place, large volumes of oil remain that could be recovered by injecting carbon dioxide into old oil fields.

Not all oil reservoirs are equally suited for enhanced oil recovery utilizing carbon dioxide. Michigan stratagraphic units that have been studied are: Trenton / Black River in southern Michigan; Dundee, Richfield, and Detroit River in central Michigan; and Niagaran reefs in northern Michigan.

The Antrim Shale of northern Michigan is an attractive target for enhanced natural gas production and carbon dioxide sequestration. Demonstration work indicates that additional natural gas can be released from organic materials in coals and shales with the injection of carbon dioxide.

In addition to the evaluation of the hydrocarbon reservoir, integrity of existing wells, existence of suitable field unitization, and the feasibility of delivery of carbon dioxide all need to be considered in evaluating carbon dioxide enhanced recovery opportunities.

Use of Glacial Geology for Mineral Exploration

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Abstract

Glaciers erode, transport, and deposit debris systematically, and by applying this basic tenet, geologists use glacial geology as a prospecting tool, a concept commonly known as "drift prospecting," to search for aggregate resources, industrial minerals, base metals, precious metals, and gems. Drift prospecting is commonly unavoidable in glaciated terrain that lacks significant bedrock outcrop, such as the Canadian Shield. Plumes of ore minerals can be found in a variety of glacial deposits and landforms, including till, glaciofluvial sediment, moraines, and eskers. The key to tracing the plumes upglacier to the source lies in carefully delimiting the size and shape of the plume, and through the provenance of the indicator boulders and minerals, identifying the lithology of the bedrock target. Field techniques include air photo interpretation, mapping glacial deposits and landforms, lithologic tracking of large clasts ("boulder tracing") and indicator minerals, and geochemical analysis of specific size fractions of selected soil horizons. Airborne and ground geophysical surveys may provide useful supplementary information. These techniques have resulted in the discovery of base metal and precious metal deposits, and in the early 1990s, the world-class diamond deposits in kimberlites of Nunavut (northern Canada). Other examples to be presented include gold and barite mineralization (Matachewan, Ontario), kimberlites (Northern Michigan), and uranium (Nunavut, Canada).

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Effective Public Policy in Mitigation of Oil Pollution Legacy Problems – Cooperative Use of Federal and State Funding Mechanisms to Remedy Oil Pollution Risks

By John Valkenburg, The Adventus Group (DeWitt, Michigan), Jeffrey D. Spruit, Michigan Department of Environmental Quality (Kalamazoo, Michigan), and Chris Englert, Malcolm Pirnie (Detroit, Michigan)

Abstract

Federal Oil Pollution Act (OPA) funding (Figure 1) is available to State agencies to mitigate many oil pollution problems in Michigan. Although the use criteria for this funding mechanism appear fairly broad, there are cases where the applicability of this funding mechanism is not obvious. Funding mechanism applicability is discussed relative to two cases – mitigation of an abandoned crude oil pipeline in Kalamazoo County, Michigan, and a former great lakes refueling facility. The pipeline decommissioning project (Figure 2) demonstrates a highly successful example of interagency cooperation and obvious OPA applicability, and the great lakes refueling facility highlights a case where OPA applicability was not as clear-cut.

The pipeline decommissioning project prevented a potentially catastrophic release of crude oil to numerous environmentally sensitive areas, satisfied the "Due Care" obligations of the property owners, improved local property values, improved development potential and presented the Michigan Department of Environmental Quality (MDEQ) with the opportunity to recover the vast majority of project costs.

The great lakes refueling facility was considered for funding, including an on-site meeting with relevant funding agency representatives. Funding applicability was somewhat ambiguous, and was not pursued further.

Figure 1. Oil Pollution Act Funding

Figure 2. Example Photo of Crude Oil Pipelline Decommissioning

BIOGRAPHICAL SKETCHES

Mr. John Valkenburg, MS, PE

John Valkenburg, Senior Engineer, The Adventus Group, 1493 West Pratt Road, DeWitt, Michigan, 48820, John.Valkenburg@AdventusGroup.com. John has more than 20 years of industry experience, including 5 years as an environmental chemist and over 15 years in environmental sciences. John has worked on a broad array of environmental assessment, construction, and remediation projects for both industrial and governmental clients. His areas of technical expertise and proficiency include: Environmental Remedial Investigations and Feasibility Analyses; Construction document and specification preparation; and Construction administration. A 1991 graduate of the University of Illinois, Valkenburg holds a M.S. in Environmental Engineering. He is also a licensed professional engineer in Michigan, and certified by the Construction Specifications Institute as both a Construction Document Technologist (CDT) and a Certified Construction Specifier (CCS).

Mr. Jeffrey D. Spruit

Jeffrey D. Spruit, Project Manager, Michigan Department of Environmental Quality, 7953 Adobe Road, Kalamazoo, Michigan, spruitj@michigan.gov. Mr. Spruit has over 24 years experience as a geologist and project manager. Jeff has worked on a broad array of contaminated sites and environmental issues. He currently manages complex and controversial state-funded,and privately-funded remedial actions and Brownfield Redevelopment clean-ups. Additionally, he provides geological support to district staff and project managers on Part 201 and Part 213 remedial actions and enforcement staff on district enforcement cases. Jeff received a BS in Geology from Grand Valley State University in 1975 and a MS in Geology from Western Michigan University in 1981.

Mr. Chris Englert, PE

Chris Englert, Associate, Malcolm Pirnie, Inc., 645 Griswold, Suite 1950, Detroit Michigan 48226, cenglert@pirnie.com. Mr. Englert has more than 25 years of environmental consulting experience. Chris has worked on a broad range of environmental projects including: remedial design and construction, wastewater treatment; and brownfields projects for both industrial and municipal clients. His areas of technical expertise include: Environmental Remedial Investigations and Feasibility Analyses; Remedial Design; Construction Administration; and wastewater treatment. Mr. Englert received a B.S. in Environmental Engineering in 1982 from the University of Michigan. He is also a licensed professional engineer in Michigan.

The Use of Sediment Pore Water Sampling as an Economic and Effective Tool to Investigate Groundwater Plumes Discharging to Surface Water Bodies

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Abstract

Various remedial investigation activities have been conducted at a facility located in northeastern Michigan which is primarily contaminated with perchloroethylene, hexavalent chromium and a brine solution. Groundwater has been impacted to a depth of 160 ft below grade, and discharges into a stream 1/2 mile away.

Investigations performed by MACTEC and the Michigan Department of Environmental Quality included site characterization through soil coring, vertical aquifer sampling, hydraulic push, hollow-stem-auger, sonic drilling techniques, and various seismic surveys. Other media investigated included surface waters, sediment, sediment pore water and macroinvertebrates of the stream.

Recently, Michigan Department of Environmental Quality staff performed pore water investigations in the valley bottom where contaminated groundwater was suspected to discharge in order to better determine the contaminant location and magnitude. Pore water samples were collected from the sediments along the stream course. Sampling was conducted utilizing stainless steel mini-piezometers. Laboratory and field analysis indicated areas that were affected by the discharge. Sampling indicated that the uppermost portion of the aquifer (containing perchloroethylene) discharges directly through the stream bottom, and deeper portions of the plume containing hexavalent chromium and brine, discharges beyond the present stream-course. There are indications that this portion of the plume expression discharges to the stream through hyporheic flow, converging to stream flow (Henry and Veenstra, 2007).

The pore water investigation yielded some of the more valuable data regarding definition of impact to the stream and its associated hyporheic zone and community, and did so at a relatively low cost compared to other investigation components.

AN INTRODUCTION TO THE POWERWAVE™ PROCESS FOR IMPROVED WATERFLOODING

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Abstract

The oil and gas industry as a whole is undergoing profound change: there is a production decline in most oil operations worldwide, there is growing worldwide demand for oil that is outstripping supply, and there remain few new exploration and development basins to exploit. To bridge the gap between supply and demand companies must look to, and institute new technologies to aid in the exploitation of remaining reserves.

Wavefront's patented Powerwave™ Process is an injection technology that allows users to improve the flow of fluids in geological materials. The major applications of Powerwave include improved oil recovery and the remediation of contaminated groundwater by increasing the performance of existing systems.

Powerwave can trace its roots back to seismic research conducted in the 1950s when earthquakes were observed to affect fluid levels in oil wells by creating enhanced flow. The inventors of Powerwave undertook further research into seismic wave theory to uncover the reason behind this occurrence and found that, for many different geological environments, an energy wave, having specific characteristics, would stimulate flow throughout the area affected by the wave. This, in turn, would increase fluid flow, such as the production of oil, similar to the increases that were observed by earthquake seismic stimulation.

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A Hydrostratigraphic Approach for 3D Modeling of Aquifer Architecture

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Abstract

Detailed aquifer characterization is fundamental to development of effective remedial strategies. Without an understanding of the complex, three-dimensional hydrostratigraphic architecture, remedial system

design can overlook significant heterogeneities that influence contaminant transport. Geostatistical techniques like geologic indicator kriging (GIK) have been successfully employed when a wealth of data exist. This approach was used at an industrial site in western Michigan, where data have been collected from nearly 200 boreholes. The site is adjacent to the Grand River, and is underlain by sequences of post-glacial fluvial sediments. Simplified "layer-cake" stratigraphy fails to represent the complex facies patterns that are present. Geologic data from the site were imported to CTech's Environmental Visualization System (EVS), a program designed for 3D analysis of environmental data, and 3D GIK routines were applied. Results demonstrate the importance of approaching aquifer characterization from a depositional environment framework.

Hydrogeology of the Yellow Dog Plains, Marquette County, Michigan: Testing Segerstrom's Conceptual Model of "Beheading" the Yellow Dog River with Real Data.

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Abstract

In 1964, Kenneth Segerstrom (USGS) published a paper (1) that presented a conceptual model of the Quaternary hydrologeological evolution of the Yellow Dog Plains of northern Marquette County, Michigan. Based on watershed drainage patterns and quaternary depositional models, his model concluded that much of the upper reaches of the Yellow Dog River would inevitably be "beheaded", or captured, by the continual increase in drainage basin size by the headward cutting of the Salmon Trout River into the Yellow Dog plains from the north. This erosional progression of drainage basin development on the Yellow Dog Plains has been in action since the start of post-glacial drainage, following a period of glacial deposition and glacial lake drainage that previously dominated the hydrology of the area and created the surficial geology of the Yellow Dog Plains as it exists today.

Since 2002, the hydrogeology of the Yellow Dog Plains has been studied intensively as part of baseline environmental studies for a proposed non-ferrous metallic mining project. These studies have resulted in a testing of Segerstrom's hypothesis with significant stream flow, groundwater flow, and hydrogeochemical data and groundwater/surface water flow modeling. These data strongly support the conceptual model offered by Segerstrom and currently the groundwater basin associated with the Salmon Trout River extends well south of the surface watershed divide between the two rivers that is defined based on land surface topography.

Segerstrom, K., 1964, Negaunee Moraine and the Capture of the Yellow Dog River, Marquette County, Michigan, Geological Survey Research, U.S. Geological Survey Professional Paper 501-C, Pages C126-C129.

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STUDENT ABSTRACTS

A Paleoenvironmental Cross Compression of the Arkadelphia and Navesink Formations

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Abstract

Both the Arkadelphia and Navesink formations are well known in paleontology as fossiliferous units given that each of these fossils is representative of an animal that once lived in the environment represented by the marl of the corresponding formation. Using the known environmental niches of these organisms it is possible to narrow the environment of deposition for these formations thereby resulting in a better paleoenvironmental interpretation. The outcrops of the Arkadelphia used in this study are located in southwest Arkansas and parts of Louisiana and Texas. Outcrops of the Navesink are located in the Cretaceous outcrop belt of New Jersey (specifically Monmouth County). The premise of this study is simply to compare and contrast these two formations in the areas of geology and paleontology in order to yield information concerning the paleoenvironment of these two important areas. Background research on this problem has proven very fruitful yielding stratigraphic sections and paleontological information. This study will add to the overall understanding of the biomechanics at work in these two localities.

Evaluation of Asmari Reservoir Caprock Keybeds (Miocene), Pazanan Oil Field, Zagros, Iran

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Abstract

The Pazanan oil field located at South West of Iran with 60Km long and 4-6 Km wide. This reservoir is one of the largest condensate gas reservoirs in Iran that has an economical oil column. The caprock of this oil field (Miocene age), were evaluated using well-logs (Gamma Ray and Sonic) SEM, optical petrography, isotopic analyses and Geochemical data. The caprock type is mainly consisting of Mudstone. On the basis of our investigations, the caprock can be divided into six keybeds: A,B,C,D,E,F. Sonic and Gamma-Ray well logs were used to determine lithological changes. The observed textures of Anhydrite are microlitic, spherolite, porphyroblast, satin-spar and granular. Bituminous Shale sample was analysis geochemically. The analytical data of Bitumen`s biomarkers belong to member 1 of Gachsaran Formation applied to evaluate sedimentary basin and maturity evaluation of probable source rocks in the caprock. The presence of Tricyclic Terpanes, Bisnorhopane and low quantity of Gammacrane index is subsidiary of low salinity. Some organic geochemical indicators of caprock are also indicating marine-terrestrial environment. Maturity analyses showed that bituminous shale of keybed B is immature. $\delta^{13}C$ in extracted saturate and aromatic parts of bitumen is -25.1 and -22.8‰ respectively. Carbon isotope value ($\delta^{13}C$) of carbonate samples is -20.7. The value $\delta^{34}S$ of anhydrite varies from 16.6 -16.8 to 20.8-21.1‰. These data are indicating marine to non-marine source and relate the presence of two fluids: diagenetic (brackish) and primary sea water. These data and lithological variations verify a Sabkha-lagoonal environment. The hot-wet and hot-dry climate can be concluded.

A Geophysical Study of Glaciotectonic Deformation, Ludington Ridge, Michigan

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Abstract

Late Wisconsin glaciotectonic processes have resulted in large deformation structures, which are visible in a 1.5km long section of cliff face along the eastern shore of Lake Michigan south of Ludington, Michigan. Several apparent clay diapirs rise from below beach level to near the top of the ~50m high cliff. The clay was deposited in a proglacial lake environment, while overlying sands and gravels were deposited as

glacial outwash during ice re-advancement. The sequence is topped by areas of eolian dune sand. On the surface there are springs and gullies, indicating a preferred pattern of groundwater drainage and past landslides. Characterization of this system will improve understanding of the glacial history of west Michigan and the effects of this deformation on the local hydrology. In order to study the inland extent and orientation of these structures we used a suite of geophysical methods and stratigraphic interpretations. The primary method of study was electrical resistivity, which utilizes the strong electrical contrast between the clay and the overlying sands and gravel. A series of constant spread traverses (Wenner array with a-spacings of 30 and 90m) was performed along parallel transects perpendicular to the expected orientation of the clay deformation structures. Data interpretation was aided by 1D soundings and stratigraphy from well logs. Further investigation to gather higher resolution data on areas of interest was performed using ground-penetrating radar and multi-electrode roll-along Wenner surveys with a-spacings ranging from 6 to 162m.

The Sediment Record of Productivity from Oligotrophic Lakes: A Multi-element Approach

Lori N. Babcock, David T. Long, Matthew J. Parsons

Abstract

Lake sediment records of nutrients are often used to understand changes in productivity within the lake and land use in the watershed. Oligotrophic lake-watershed systems can provide insight into the cycling of nitrogen and other nutrients in a more natural environment compared to eutrophic or mesotrophic systems. Torch and Mullett lakes, located in the northern Lower Peninsula of Michigan, are oligotrophic lakes that vary in their land use histories and physical attributes (e.g., watershed size). The aim of this study was to interpet the environmental record (i.e., changes in productivity), as recorded in ^{210}Pb dated sediment cores, of these lakes using a multi-element approach. Total nitrogen and total carbon were analyzed using a Perkin Elmer CHN Analyzer; all other elements were analyzed using inductively coupled plasma mass spectrometry with hexapole technology. Compared to literature environmental records Torch and Mullett lakes had low concentrations of total nitrogen (TN). Sediment nutrients concentrations from Mullett Lake were increasing in the top section of the core, suggesting increased primary productivity. Trends of nitrogen and phosphorus from Torch Lake are conflicting; nitrogen concentrations are increasing in more recent sediments whereas phosphorus concentrations are decreasing. This implies a source of nitrogen independent of phosphorus. Although Torch Lake may be an geochemical end-member, the results suggest that the nitrogen record alone may not provide enough information to determine past changes in productivity.

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A Geophysical study to locate grave sites at the Maple Ridge Cemetery, Sault Ste. Marie, MI

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Maple Ridge Cemetery, located in Sault Sainte Marie, MI operated during the 1800s as a municipal and catholic burial site. Many of the cemetery records were burned in a fire and several events of headstone and burial relocation leave the location of many buried sites unidentified. As part of restoring the cemetery, the city of Sault Ste. Marie plans to erect a decorative fence around the cemetery. We conducted a geophysics

survey implementing Ground Penetrating Radar and Electrical Resistivity techniques. Our goal was to identify a fence location, avoiding existing graves and to determine burial plot locations and dimensions.

Ground Penetrating Radar suggests grave depths of 3.5 feet, consistent with recorded burial depths of approximately 3-4 feet. Due to the lateral resolution of resistivity data, exact locations of buried remains rely primarily on Ground Penetrating Radar data with its better horizontal resolution. Analysis of Ground Penetrating Radar suggests the municipal and catholic burial sites have different plot dimensions. Good data quality for the municipal section provides a high degree of confidence for plots 16 x 16 feet, consistent with historical records. A plot layout of 20 x 20 feet is likely for the catholic portion of the cemetery based solely on the Ground Penetrating Radar data. A distance of 3-5 feet from the sidewalk is likely the best fence location. Additional Ground Penetrating Radar surveying is suggested to delineate the catholic plot layouts and to further restore the historical Maple Ridge Cemetery.

Using Non-Intrusive Geophysical Techniques to Identify Potential Hazards at the Decommissioned Camp Lucas Military Facility in Sault Ste. Marie, MI

Churchill, Kim M. and Paul R. Kelso. Lake Superior State University, Sault Ste. Marie, Michigan

Camp Lucas is a decommissioned military facility located in the northeastern part of Michigan's Upper Peninsula in the town of Sault Ste. Marie. There are concerns that defense department materials remain buried at the site. The primary objective of this geophysical investigation was to identify potential underground hazards at the site.

This investigation utilized magnetic, electromagnetic, electrical resistivity and ground penetrating radar techniques in order to detect the presence of subsurface materials. The geophysical survey suggests that multiple bodies with varying characteristics are buried at the site. Models created for the magnetic anomalies were consistent with the susceptibility of ferrous materials and had dimensions of two meters or less. These sizes indicate that the most likely cause for the large anomalies is due to targets such as pits or trenches with various ferrous materials.

The geophysical methods used provided coverage of the survey area in a short period of time and were non-intrusive. The results obtained from the different techniques were complimentary and indicate caution should be exercised when developing the area. Further investigation is necessary to determine if the buried materials are hazardous to the environment.

Characterization of a Volcaniclastic Formation from Idaho's Eastern Snake River Plain as an Analog to Martian Sediments

Freeman, Emily D.; Xu, Huifang; Konishi, Hiromi; Blöthe, Marco; and Roden, Eric E.

Samples taken from an iron-rich, weathered basalt formation in Box Canyon in Idaho's volcanic eastern Snake River Plain were analyzed as an analog to Martian sediments. The material was concluded to be primarily comprised of nontronite, an Fe(III)-rich smectite, and nano-crystals of maghemite, a cubic mineral that has a structure very similar to that of magnetite. Analysis of total iron concentration using citrate-bicarbonate-dithionite extraction yielded a mean weight percent Fe(II) of 2.86%. The surface area of the strongly magnetic portion of the sample was found to be 110 m^2/g and the majority of the pores fell within a range of 2 – 15 nm. X-ray diffraction (XRD) and X-ray energy dispersive spectroscopy (EDS) data indicate that the sample also contains quartz, feldspar, and phillipsite (a potassium-rich zeolite). Transmission electron microscope (TEM) images revealed remarkably uniform nano-sized crystals of maghemite with an average size of approximately 5-10 nm, along with larger crystals of phillipsite and nontronite.

The composition of the sample suggests this portion of the unit experienced chemically stable, low temperature, hydrous conditions as it altered from basaltic volcanic glass to the present mineral assemblage. The presence of maghemite indicates that a reducing environment, necessary for the formation of precursor materials such as magnetite or green rust, once existed. Low-temperature, reducing environments are common in modern systems which sustain microbial activity. Subsequent oxidizing conditions may have resulted in the transformation of precursor material into maghemite. It has been proposed that nanoporous maghemite is a result of the oxidation of nanoporous, biogenic magnetite (Chen et al., 2005). Recent fieldwork in the area may add insight to our understanding of the environment of formation. This study represents a collaboration between the University of Wisconsin's Biogeochemistry and Nanogeoscience labs, as part of a partnership with NASA's Astrobiology Institute.

GRADUATE STUDENT POSTER
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Paleoenvironmental Reconstrution of Cambrian Sandstones, Central Wisconsin

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Abstract

Cambrian sandstones in Wisconsin are the deposits of marine and non-marine sedimentary environments, discerned in part by fossil content, sedimentary structures and facies associations. An absence of fossils in Knuteson Quarry renders their origin less certain. Observed sedimentary facies characteristics (mineral composition, grain size, sedimentary structures) and subsurface correlation records indicate these rocks are likely equivalent to lower lithofacies of the Mt. Simon Formation farther west. Paleocurrent azimuths at this quarry, however, do not fit data patterns reported from elsewhere in the Mt. Simon Formation. This discrepancy is interpreted to have resulted from localized deflection of paleocurrents due to paleotopographic features close to the ancient shoreline of the Wisconsin Arch.

Predicting the spatial distribution of groundwater recharge at regional scales with the Integrated Landscape Hydrology Model (ILHM)

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Abstract

Forecast changes in climate and land use are expected to alter the amount and distribution of groundwater recharge in the Great Lakes region. To understand how these changes will affect water resources, predictive tools capable of explicitly describing changes to individual processes of the hydrologic cycle are required. Quantifying groundwater recharge at regional scales, either through baseflow separation techniques or watershed modeling, typically requires lumping hydrologic processes in a way that limits the predictive capability of these methods.

To address these limitations we developed a comprehensive watershed/subsurface modeling environment called the Integrated Landscape Hydrology Model (ILHM). This code combines established numerical modeling tools including MODFLOW and hydrologic process models from literature, with a few novel codes. These routines were selected for their suitability to both fine-scales (~100 m, ~1 hr) and large-domains (>10,000 km, >20 year).

We have applied the ILHM to predict groundwater recharge, evapotranspiration, and stream discharge across the Muskegon River Watershed in northern lower Michigan for the period of 1980-2006. The results

demonstrate that ILHM is suitable to predict both inter- and intra-annual variability in these processes. Year-to-year variation in recharge can be 50% or more, and seasonal variability even higher, irrespective of fluctuations in precipitation. The results also reveal significant changes in groundwater recharge induced by variations in climate, land use, and soil type. Importantly, the results differ considerably from empirically-derived estimates currently in use by state and local planning agencies.

SUBSURFACE STRATIGRAPHY OF THE DEVONIAN DUNDEE FORMATION, MICHIGAN BASIN, USA - A LOG BASED APPROACH

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A distinct hard ground surface separates two disparate facies tracts in numerous Middle Devonian, Dundee Formation cores in the Michigan basin subsurface. This sharp stratigraphic contact is distinguished by scour and/or dissolution of a partially lithified surface, which is commonly bored and/or eroded, and overlain by rip up clasts. This contact probably represents both subaerial and subaqueous exposure surfaces and a subsequent period of slow sediment accumulation. Diverse supratidal to shallow marine, shoal-water carbonate facies occur below this contact, basin wide. More lithologically homogeneous, fossiliferous, mudstone-wackestone facies overlie the hard ground surface in core and are indicative of transgression to more distal, open marine conditions.

Analysis of hundreds of wireline logs throughout the basin reveals a widespread gamma ray marker (grm) coincident with the hard ground/marine flooding surface observed in core. Although present across much of the basin, the grm does not always occur apparently due to local variability of carbonate lithofacies, especially in more open marine Dundee successions in the eastern basin. A corresponding sharp decrease in porosity, inferred from lithodensity logs, commonly coincides with the grm and is typically present even when the grm is not.

Formal basin lithostratigraphy does not subdivide the Dundee Formation. This investigation supports the idea that the Rogers City Limestone, recognized in outcrop, is actually a laterally extensive unit that can be differentiated from the underlying Dundee (aka "Reed City equivalent") Formation throughout the Michigan basin subsurface. Log-based, stratigraphic subdivision of the Rogers City - Dundee succession is important in understanding the primary depositional history, genesis, and distribution of highly productive, secondary dolomite reservoirs in the Rogers City.

Monitoring the Effect of Land Use on Seasonal Changes in Soil Moisture Using Electrical Resistivity Soundings across a Mid-Michigan Ecotone

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In recent years, electrical resistivity has been increasingly used to study spatial and temporal changes in vadose zone soil moisture. Many of these studies, however, involved controlled injection or infiltration experiments. In this study, we examine the influence of climate and vegetation characteristics on seasonal variations in vadose zone soil moisture using analysis of repeated electrical resistivity soundings in a deciduous forest and grassland. The field site, located in glacial till near East Lansing, Michigan, has been permanently instrumented with an electrode array (a-spacing 1.5m) crossing the vegetation boundary and multiple sensors for monitoring soil moisture and temperature. Data have been collected in Wenner mode on a bi-weekly average over a 1-year period that started in October 2006. Apparent resistivity data have been inverted using a three to four layer geometry and corrected for temperature. The resistivity changes correlate well with precipitation events and changes in vegetation characteristics. Seasonal soil moisture

patterns differ significantly under the two vegetation types, which we attribute to varying root zone depth and evapotranspiration rates.

UNDERGRADUATE POSTER