International Conference

NovCare 2009

Novel Methods for Subsurface Characterization and Monitoring: From Theory to Practice

Date: **May 13-16, 2009**

Place: **Helmholtz Centre for Environmental Research - UFZ Leipzig, Germany**

Organizing Committee:

- **Georg Teutsch (Chairman) and Peter Dietrich (Helmholtz Centre for Environmental Research – UFZ)**
- **Carsten Leven (University of Tübingen)**
- **Jim Butler (Kansas Geological Survey, University of Kansas)**
- **David Hyndman and Remke van Dam (Michigan State University)**

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Welcome and Greetings

Dear participants of the NovCare Conference 2009,

I am pleased to welcome you all in Leipzig to the international conference NovCare 2009. It is a pleasure for me to support this event, as it provides a rare opportunity for researchers and practitioners from all over the world to exchange ideas and experiences on meeting the challenges of subsurface characterization and monitoring from a field perspective.

At the two national level Direct Push Workshops that have taken place recently, the participants welcomed the possibility to exchange their knowledge and discuss their experiences.

NovCare 2009 will showcase newly developed and refined methods, novel applications of existing methods, and new concepts for subsurface characterization and monitoring

I wish to all participants of this event three inspiring meeting days, interesting discussions, and new incitement.

Sincerely,

Georg Teutsch
Scientific Director
Helmholtz Centre for Environmental Research – UFZ

Some words about the UFZ:
The Helmholtz Centre for Environmental Research - UFZ was established in 1991 as the first and only centre in the Helmholtz Association of National Research Centres (Helmholtz Association) to be exclusively devoted to environmental research in a great variety of fields. At the Helmholtz Centre for Environmental Research - UFZ scientists research the causes and consequences of far-reaching environmental changes. Their task is to deliver knowledge, instruments and policies concerning the complex systems and relationships in the environment within limited timeframe for use by politicians, industry and society, in order to help them to make decisions and solve specific environmental problems. Apart from practical needs, environmental research must also meet general scientific needs. This is a two-fold challenge with the requirement that today´s environmental research dominated by natural sciences is increasingly interlinked with human and social sciences as well as environmental law.

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In the recent years the UFZ established several infrastructure platforms such as MOSAIC and TERENO. MOSAIC (Model Driven Site Assessment, Information and Control) is a new platform for research in the areas of groundwater, soil and biodiversity. The innovative mapping and monitoring technologies of MOSAIC enable high-resolution surveys of complex sub-surface structures and processes. These potentialities of subsurface characterisation are essential not only for the management and cleaning of contaminated megasites (contaminated large-scale site), whose number is estimated to be several thousand in Europe alone, but also because numerous chemical and biological processes in soils are still not completely understood. The research platform is for interdisciplinary research and technology devlopment as well as technology transfer, e.g. for establishing innovative monitoring and exploration technologies in practice and for information and training of regulators and engineering consultants.

TERENO (TERrestrial ENviromental Observatoria) is a long term operated "Global Change Observatory" for monitoring, analysing and predicting changing state variables and fluxes within environmental compartments….

Since August 2007 the Federal Ministry of Education and Research (BMBF) has been funding the project "TASK Leipzig – The Centre of Competence for Soil, Groundwater and Site Revitalisation". The main aim is to enhance innovation and technology and knowledge transfer.

Agenda

May 12, 2009

18:00-20:00	***Welcome Reception*** *(Restaurant "Auerbachs Keller"; Mädler Passage, Grimmaische Straße 2-4, Leipzig)*

May 13, 2009

8:30- 9:10	***Welcome Session***	
9:10-9:50	**Keynote Lecture** The Disconnect Between Monitoring and Models (Graham Fogg - University of California at Davis, US)	
9:55-10:35	**Session 1** **Innovative Site Characterization**	**Session 2** **Long-Term Monitoring**
10:35-11:10	***Coffee Break***	
11:10-11:50	**Keynote Lecture** Rapid Single Mobilization Solutions for High-Resolution Contaminant Flux Characterization, Network Design, and Monitoring System Deployment (Mark Kram - Groundswell Technologies, Inc., US)	
11:55-12:55	**Session 3** **Innovative Site Characterization**	**Sessions 4** **Long-Term Monitoring**
12:55-14:00	***Lunch Break***	
14:00-14:40	**Keynote Lecture** Using Tree Core Samples to Monitor Natural Attenuation and Plume Distribution of Pollutants in Groundwater (Stefan Trapp - Technical University of Denmark, Denmark)	
14:45-16:05	**Session 5** **Innovative Site Characterization**	**Sessions 6** **Long-Term Monitoring**
16:05-16:45	***Coffee Break***	
16:45-17:45	**Open Lecture** Monitoring and modeling of catchments: Lessons learned from AquaTerra (Peter Grathwohl - Center for Applied Geoscience, Tübingen University)	
17:45-18:30	***Company exhibition and demonstration***	
19:00-21:30	***Buffet*** *(Foyer Leipziger KUBUS)*	

May 14, 2009

8:30-9:10	**Keynote Lecture** Site characterization and monitoring of unstable natural slopes (Alessandro Corsini - Giorgio Cassiani, University of Padova, Italy)	
9:15-10:25	**Session 7** Innovative Site Characterization	**Session 8** Soils
10:25-11:00	***Coffee break***	
11:00-11:40	**Keynote Lecture** Hydro-geophysics: the non invasive characterization of the shallow subsurface (Giorgio Cassiani - University of Padova, Italy)	
11:45-13:05	**Session 9** Innovative Site Characterization	**Session 10** Sub-Surface Transport
13:05-14:00	***Lunch Break***	
14:00-14:40	**Keynote Lecture** Processes at and across the interface (Peter Huggenberger - University Basel, Switzerland)	
14:45-15:45	**Session 11** Innovative site characterization	**Session 12** Sub-Surface Transport
15:45-16:15	***Coffee break***	
16:15-16:55	**Keynote Lecture** Characterization of groundwater processes in riparian areas using thermal remote sensing (Steven Loheide - University of Wisconsin-Madison, US)	
17:00-17:40	**Needs and opportunities for research and technology transfer**	**Poster Exhibition/Presentation**
19:30-22:00	***Conference Dinner*** *(Bayrischer Bahnhof, need registration)*	

May 15, 2009

8:30-9:10	**Keynote Lecture** Integrated Simulations of Subsurface-Land Surface Processes at the Watershed Scale (Stefan Kollet - Bonn University, Germany)	
9:15-10:35	**Session 13** Watershed	**Session 14** Innovative Site Characterization
10:35-11:00	***Coffee break***	
11:00-12:00	**Session 15** Watershed & Stream Aquifer Interaction	**Session 16** Soils
12:00-13:15	***Lunch Break***	
13:15-14:15	**Open Lecture** **2009 Birdsall-Dreiss Distinguished Lecturer** Understanding Solute Transport in Extremely Heterogeneous Porous Media: Lessons Learned from 25 Years of Research at the MADE Site (Chunmiao Zheng - The University of Alabama, US)	
18:30-20:00	***Sightseeing tour Leipzig*** *Leipzig Downtown (Start Augustusplatz)*	

May 16, 2009

8:30-17:30	**Excursion to Freiberg (sightseeing tour, visit the silver mine "Reiche Zeche")** The transfer and sight seeing tour are included in the conference registration fee. Entrance fees need to be paid by each participant.

Detailed Program

Company Exhibition:

May 13, 2009 8:30- 21:30
May 14, 2009 8:30- 16:15

Technology Demonstration and Exhibition of larger machinery(UFZ area)

May 13, 2009 13:00-18:30
May 14, 2009 09:15-14:00

Poster Exhibition:

May 13-15, 2009

Poster Session:

May 14, 2009 17:00-17:40

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May 13, 2009

8:30- 9:10	**Welcome Session** Greetings and introduction from organization committee	
9:10-9:50	**Keynote Lecture** The Disconnect Between Monitoring and Models (Graham Fogg)	
9:55-10:35	**Session 1 (2 presentations)** Innovative Site Characterization	**Session 2 (2 presentations)** Long-Term Monitoring
9:55 -10:15	**Geophysical well logging searching for fractures having significant role for ground water flow in crystaline rocks (***Stanislav Mareš (Charles University in Prague), Josef Urik (Aquatest a.s.))*	**Development of a passive sampler for qualitative and quantitative soil air measurements: preliminary results** *(Ilse Van Keer (VITO (Fliemish Institute for Technological Research))*
10:15 -10:35	**GPR, a Method for Exploration and Monitoring of Coal Fires in China** *((Volker Gundelach (BGR))*	**Mass Flux Determination at a Tar Oil Contaminated Site Using Passive Sampling Devices** *((Norbert Hüsers (TU Dresden), Peter Börke (SMUL), Carsten Leibenath (UBV GmbH))*
10:35-11:10	*Coffee Break*	
11:10-11:50	**Keynote Lecture** Rapid Single Mobilization Solutions for High-Resolution Contaminant Flux Characterization, Network Design, and Monitoring System Deployment (Mark Kram)	
11:55-12:55	**Session 3 (3 presentations)** Innovative Site Characterization	**Sessions 4 (3 presentations)** Long-Term Monitoring
11:55 - 12:15	**LIF Sensors for in situ NAPL Characterization - Potentials and Limits** *((Michael Neuhaus (Fugro Consult GmbH))*	**Tree core sampling for site investigation and monitoring of subsurface contamination** *(Holm 0.(Technical University Berlin), Rottard W. (Technical University Berlin))*
12:15 - 12:35	**High Resolution Site Characterization with Direct Push Optical Screening Tools** *(Randy St.Germain (Dakota Technologies))*	**Membrane based measurement technology for in-situ monitoring of gases in soil** *(Detlef Lazik (UFZ))*
12:35 - 12:55	**Hydraulic Conductivity Estimates Using the Hydraulic Profiling Tool (HPT)** *(Thomas Christy (Geoprobe Systems))*	**Passive Samplers for the Measurement of VOC Mass Fluxes in Groundwater** *(Goedele Verreydt (VITO (Flemisch Institute for Technological Research)))*
12:55-14:00	*Lunch Break*	
14:00-14:40	**Keynote Lecture** Using Tree Core Samples to Monitor Natural Attenuation and Plume Distribution of Pollutants in Groundwater (Stefan Trapp)	
14:45-16:05	**Session 5 (4 presentations)** Innovative Site Characterization	**Sessions 6 (4 presentations)** Long-Term Monitoring
14:45 - 15:05	**High-Resolution Characterization of Spatial Variations in Hydraulic Conductivity with Direct-Push Technology: The MADE Site Field Assessment***(Gaisheng Liu (Kansas Geological Survey), Jim Butler (Kansas Geological Survey), Geoff Bohling (Kansas Geological Survey), Ed Reboulet (Kansas Geological Survey), Steve Knobbe (Direct-push Consultant))*	**Long-Term Groundwater Monitoring in Unconfined Rio Claro Aquifer, Brazil: a Case Study** *(Dagmar Carnier Neto (São Paulo State University), Marco Pede (ISR Rental), Hung Chang (São Paulo State University))*
15:05 - 15:25	**Determination of the hydraulic conductivity using the Direct-Push Injection Logger** *(Uwe Schneidewind (UFZ))*	**Prediction of BTEX-plume movement in Elsterwerda (Brandenburg): Application of innovative techniques for groundwater monitoring** *(D.Radny (Technical University Berlin), Scheytt Traugott (Technical University Berlin), Carsten Leven (UFZ), Peter Dietrich (UFZ))*
15:25 - 15:45	**Direct push injection logs and grain size analyses to assess aquifer heterogeneity** *(Mathias Falke (University of Greifswald, Institute of Geography and Geology), Andreas Musolff (UFZ) [speaker], Maria-Theresia Schafmeister (University of Greifswald, Institute of Geography and Geology))*	**Selected problems and solutions of quality assurance in the context of monitored natural attenuation** *(Großmann,Laudel, Müller, Beyer, Voigt, Nitsche)*
15:45 - 16:05	**Geostatistical Analysis of High-Resolution Hydraulic Conductivity Estimates Derived from Direct-Push Injection Logging at the MADE Site (***Geoffrey Bohling (Kansas Geological Survey), Gaisheng Liu (Kansas Geological Survey), James Butler (Kansas Geological Survey), Ed Reboulet (Kansas Geological Survey), Thomas Vienken (UFZ-Leipzig), Uwe Schneidewind (UFZ-Leipzig))*	**Vertical heat and mass transfer in groundwater monitoring wells due to free convection** *(Susann Berthold (DGFZ Dresdner Grundwasserforschungszentrum e.V. Frank Börner (DGFZ Dresdner Grundwasserforschungszentrum e.V.))*
16:05-16:45	*Coffee break*	
16:45-17:45	**Open Lecture:** Monitoring and Modeling of Catchments: Lessons learned from AquaTerra (Peter Grathwohl, Center for Applied Geoscience, Tübingen University)	
17:45-18:30	Company exhibition and demonstration	
19:00-21:30	*Buffet (Foyer Leipziger KUBUS)*	

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May 14, 2009	***8:30-9:10***	**Keynote Lecture** Site Characterization and Monitoring of unstable natural Slopes (Alessandro Corsini)	
	9:15-10:25	**Session 7 (4 presentations)** Innovative Site Characterization	**Session 8 (4 presentations)** Soils
	9:15 - 9:35	**Rapid characterization of subsurface contamination at extended contaminated sites – Comparison of approaches** *(Arno Rein (Technical University of Denmark) -- [speaker], Olaf Holm (Institute of Environmental Technology, Technische Universität Berlin), Steffen Popp (UFZ), Martin Bittens (UFZ))*	**Comparative study of multisensoric-spectrometry and EMI measurements** *(Tina Wunderlich (Christian-Albrechts-University of Kiel, Kiel), Anne-Kathrin Nüsch (UFZ), Fenny M. van Egmond (The Soil Company, Groningen), Andreas Kathage (Allied Associated Geophysical Ltd.))*
	9:35 - 9:55	**Opportunities and limitation of minimal invasive and tomographic methods for near surface investigation** *(Peter Dietrich (UFZ))*	**DIGISOIL: a multi-sensor system for mapping soil properties** *(G. Grandjean, O. Cerdan, K. Samyn (BRGM, Orléans))*
	9:55 - 10:15	**AACI-Log - a new borehole tool for high-resolution detection of the seal effect of clay barriers behind well casings** *(Christian Koller (Dresdner Grundwasserforschungszentrum e.V.), Frank Börner (Dresdner Grundwasserforschungszentrum e.V.), Hans Gawlik (LogIn Bohrlochmessgeräte GmbH Gommern))*	**iSOIL -Integration of geophysical technologies in measuring platforms** *(U. Werban (UFZ Helmholtz Centre for Environmental Research), A.K. Nuesch (UFZ Helmholtz Centre for Environmental Research), S. Kathage (Allied Associates Geophysical Ltd.), F.M. van Egmond (The Soil Company), T. Wunderlich (Christian-Albrechts-University of Kiel), S.A. al Hagrey (Christian-Albrechts-University of Kiel) & P. Dietrich (UFZ Helmholtz Centre for Environmental Research))*
	10:15 -10:35	**ELEMENTAL ANALYTICAL PROBE FOR ON-FIELD DEPTH PROFILING** *(Rick Comtois(Austin AI Inc, Austin/Texas, USA), Judit Jeney (GreenLab Ltd, Budapest/Hungary))*	**NMR Relaxation times and Pore size distribution: A comparison with morphological modelling** *(U. Weller(Department of Soil Physics, UFZ), S. Haber-Pohlmeier(ITMC, RWTH Aachen), A. Pohlmeier(ICG-4, Research Center Jülich))*
	10:25-11:00	*Coffee break*	
	11:00-11:40	**Keynote Lecture** Hydro-geophysics: The Non invasive Characterization of the shallow Subsurface (Giorgio Cassiani)	
	11:45-13:05	**Session 9 (4 presentations)** Innovative Site Characterization	**Session 10 (4 presentations)** Sub-Surface Transport
	11:45 -12:05	**Application of the Membrane Interphase Probe (MIP): an evaluation** *(Ilse Van Keer (VITO (Fliemish Institute for Technological Research))*	**Why do we still need tracer tests-an example by using Direct Push technology** *(Michael Dietze (TU Dresden))*
	12:05 -12:25	**Real time characterization of spatial contaminant distribution using multiple technology approach** *(Axel Oppermann (geo-log GmbH) – [speaker], Dr. Johannes Körner (geo-log GmbH), Seth Pitkin, Mike Rossi (Stone Enivronmental Inc. USA))*	**Temperature as a Tracer** *(Jürgen Dornstädter (GTC Kappelmeyer GmbH))*
	12:25 -12:45	**Site characterization with the video cone** *(Victor Hopman (Deltares))*	**Field tracer tests for characterization of local subsurface flow regimes** *(Ulf Mohrlok (University Karlsruhe), Ekkehart Bethge (University Karlsruhe))*
	12:45 -13:05	**Joint analysis of the Super-Sauze (French Alps) mudslide by Nanoseismic Monitoring and UAV-based remote sensing** *(M. Walter, U. Niethammer & M. Joswig (Institute for Geophysics, Universität Stuttgart))*	**Fully Coupled Hydrogeophysical Inversion of Salt Tracer Experiments** *(Davina Pollock (Eawag, Dübendorf, Switzerland) , Olaf Cirpka (University of Tübingen))*
	13:05-14:00	*Lunch Break*	
	14:00-14:40	**Keynote Lecture** Processes at and across the Interface (Peter Huggenberger)	
	14:45-15:45	**Session 11 (3 presentations)** Innovative site characterization	**Session 12 (3 presentations)** Sub-Surface Transport
	14:45 -15:05	**SonicSensing - a start** *(Piet Derikx (SonicSampDrill), Huug Eijkelkamp (SonicSampDrill))*	**Geophysical methods to characterize a highly heterogeneous aquifer** *(Mine Dogan (Michigan State University), David W. Hyndman (Michigan State University), Ramke L. van Dam (Michigan State University))*
	15:05 -15:25	**Use of a Heated Trunkline to Enhance Performance of the Membrane Interface Probe (MIP)** *(Thomas Christy, Geoprobe Systems)*	**Airborne and ground geophysical measurements to investigate mechanisms of salt dissolution and subsidence in abandoned mining areas** *(Yvonne Krause (Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Dienstbereich Berlin) -- [speaker],Tatyana Kerner (BGR), Bernhard Siemon (BGR), Christoph Grissemann (BGR), Markus Furche (BGR), Ursula Noell (BGR))*
	15:25 -15:45	**New developments of Direct Push probes** *(Traugott Scheytt (Technische Universitaet Berlin),Martin Asbrand (Technische Universitaet Berlin))*	**Estimation of CO2 baseline emissions of coal fires and description of coal fire driven changes of physical properties based on geophysical observations** *(Uwe Meyer (Bundesanstalt für Geowissenschaften und Rohstoffe) -- [speaker], Anja Lambrecht (Bundesanstalt für Geowissenschaften und Rohstoffe), Stefan Schlömer (Bundesanstalt für Geowissenschaften und Rohstoffe), Volker Gundelach (Bundesanstalt für Geowissenschaften und Rohstoffe))*
	15:45-16:15	*Coffee break*	
	16:15-16:55	**Keynote Lecture** Characterization of groundwater processes in riparian areas using thermal remote sensing (Steven Loheide)	
	17:00-17:40	**Needs and opportunities for research and technology transfer**	**Poster exhibition/presentations**
	17:00 -17:20	**Opportunities and limitations of large-reserach infrastructures (MOSAIC, TERENO)**	Poster exhibition/presentations
	17:20 -17:40	**How can be promoted the technology transfer: experiences of the TASK-project**	Poster exhibition/presentations
	19:30-22:00	Conference Dinner (Bayrischer Bahnhof, only for registered participants)	

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May 15, 2009			
	8:30-9:10	**Keynote Lecture** Integrated Simulations of Subsurface-Land Surface Processes at the Watershed Scale (Stefan Kollet)	
	9:15-10:35	**Session 13 (4 presentations)** Watershed	**Session 14 ((4 presentations)** Innovative Site Characterization
	9:15 - 9:35	**SoilNet - A hybrid underground wireless sensor network for near real-time monitoring of hydrological processes** *(Heye Bogena (Research Center Juelich), J.A Huisman (Research Center Juelich), U. Rosenbaum (Research Center Juelich), A. Weuthen (Research Center Juelich), H. Vereecken (Research Center Juelich)))*	**Underground DC-geoelectrical and seismic surveys to investigate problem zones in salt rock formations** *(Claudia Schütze, Just A., Rücker C., Zöllner H (Leipzig University, Department for Geophysics and Geology), Matthes K. (UFZ), Schicht T. (K-UTEC Salt Technologies AG Sondershausen))*
	9:35 - 9:55	**Spatial TDR a new approach for observing 4d- soil moisture dynamics at the plot and small field scale: Promise, Progress, Problems** *(Thomas Graeff, Erwin Zehe, Stefan Schlaeger, Markus Morgner, Andreas Bauer, Rolf Becker, Axel Bronstert)*	**Combination of different seismic methods and geotechnical sounding for a rapid characterization of the near-surface ground** *(Steffen Popp, Falko Kretschmer, Thomas Vienken, Peter Dietrich (UFZ))*
	9:55 - 10:15	**Characterization and simulation of hydraulic conductivity fields using Copula based approaches** *(Andras Bardossy (Uni-Stuttgart),Sjoerd Van der Zee (Wageningen University), Li Jing (Uni-Stuttgart))*	**Using heat as a tracer in a porous aquifer: Estimation of effective flow and transport parameters** *(Carsten Leven(University of Tübingen), Tao Li (University of Tübingen) -- [speaker], Peter Dietrich (Helmholtz-Centre for Environmental Research (UFZ), Leipzig), Philipp Blum (University of Tübingen)))*
	10:15 -10:35	**PRECISE MONITORING OF UNDERGROUND WATER LEVEL VARIATIONS (Geophysical Observatory of IDG RAS "Mikhnevo")** *((Ella Gorbunova (Institute of Geospheres Dynamics of Russian Academy of Science), N.V. Kabychenko (Institute of Geospheres Dynamics of Russian Academy of Science), G.G. Kocharyan (Institute of Geospheres Dynamics of Russian Academy of Science))*	**3-D georadar and its potential in site characterization: from structural images towards petrophysical parameters** *(Jens Tronicke, Cedric Schmelzbach, Urs Böniger (Universität Potsdam))*
	10:35-11:00	*Coffee break*	
	11:00-12:00	**Session 15 (3 presentations)** Watershed & Stream Aquifer Interaction	**Session 16 (3 presentations)** Soils
	11:00-11:20	**Short- and Long-term Processes regarding Surface-Subsurface Water Interaction and Gypsum Karst Evolution** *(Jannis Epting (University of Basel))*	**Stokes'-Flow Approach to Infiltration** *(Peter Germann (Uni Basel)* **)**
	11:20-11:40	**Quantifying water and contaminant fluxes at the stream groundwater interface** *(Christian Schmidt (UFZ))*	**Full-waveform forward and inverse modeling of electromagnetic induction data for improved soil electrical conductivity estimation** *(F. André, D. Moghadas, H. Vereecken (Agrosphere (ICG-4), Forschungszentrum Jülich, Germany), S. Lambot (Agrosphere (ICG-4), Forschungszentrum Jülich, Germany; Department of Environmental Sciences and Land Use Planning, Université Catholique de Louvain))*
	11:40-12:00	**Watershed Characterization for a Water Resources Decision Support System in Honduras** *(Philip Akomiah (INST OF ADVANCED TECH, Ghana))*	**Full-Waveform Hydrogeophysical Inversion of Time-Lapse GPR Data to Infer the Unsaturated Soil Hydraulic Properties in a Digital Soil Mapping Context** *(K. Z. Jadoon(Agrosphere (ICG-4), Forschungszentrum Jülich, Germany), S. Lambot (Agrosphere (ICG-4), Forschungszentrum Jülich, Germany; Department of Environmental Sciences and Land Use Planning, Université Catholique de Louvain), E. C. Slob (Delft University of Technology, Netherlands) and H. Vereecken (Agrosphere (ICG-4), Forschungszentrum Jülich, Germany)*
	12:00-13:15	*Lunch Break*	
	13:15-14:15	**Open Lecture: 2009 Birdsall-Dreiss Distinguished Lecturer (UFZ Kolloquium)** Understanding Solute Transport in Extremely Heterogeneous Porous Media: Lessons Learned from 25 Years of Research at the MADE Site (Chunmiao Zheng)	
	18:30-20:00	Sight seeing tour Leipzig Leipzig Downtown (Start Augustusplatz)	

Open Lectures

Chunmiao Zheng
Professor of Hydrogeology and SSPA Faculty Fellow
Department of Geological Sciences
The University of Alabama, USA

2009 Birdsall-Dreiss Distinguished Lecturer

Date: May 15, 2009
Time: 13.15 – 14:15
Place: Leipziger Kubus

Understanding Solute Transport in Extremely Heterogeneous Porous Media: Lessons Learned from 25 Years of Research at the MADE Site

Field studies at well-instrumented sites have played a preeminent role in our efforts to better understand and predict contaminant transport in geologic media. In particular, field tracer tests at several well-known sites, such as those in Borden (Canada), Cape Cod (Massachusetts), and Columbus (Mississippi), have provided new insights and extensive data sets essential to development and testing of transport theories and mathematical models. This presentation focuses on the field site at the Columbus Air Force Base in Mississippi, more commonly known as the Macrodispersion Experiment (MADE) site. Since the 1980s, field data from this site have been used extensively by researchers around the world to explore complex contaminant transport phenomena in highly heterogeneous aquifers. Much recent and on-going research on contaminant transport in heterogeneous media has been motivated by findings at the MADE site.

In particular, results from field investigations have suggested the existence of small-scale preferential flow paths and relative flow barriers, which together exert a dominating control on contaminant transport and remediation. This presentation will provide an overview of the field campaigns at the MADE site over the past 25 years and discuss how the findings from these field studies have inspired various theories and models to accommodate the non-ideal transport observed in the field. The MADE site has proven to be a valuable natural observatory where continuing research efforts will lead to a stronger theoretical framework and practical tools for modeling solute transport and evaluating remedial measures in extremely heterogeneous aquifers.

Chunmiao Zheng received the B.S. degree in geology from Chengdu University of Technology (China) in 1983, and the Ph.D. degree in hydrogeology with a minor in civil & environmental engineering from the University of Wisconsin-Madison in 1988. From 1988 to 1993, he was a hydrogeologist at the environmental consulting firm S.S. Papadopulos & Associates, Inc. Since 1993, he has been a professor of hydrogeology in the Department of Geological Sciences at the University of Alabama. He is also a visiting professor and founding director of the Centre for Water Research at Peking University (China). The primary areas of his research are contaminant transport, groundwater management, and hydrologic modeling. Zheng is developer of the widely used MT3D/MT3DMS series of contaminant transport models, and co-author of the textbook Applied Contaminant Transport Modeling, Second Edition. He is currently a member of the National Academy of Sciences' Committee on Hydrologic Science and president-elect of the International Commission on Groundwater of the IAHS.

Peter Grathwohl
Center for Applied Geoscience
Tübingen University

Monitoring and modeling of catchments:
Lessons learned from AquaTerra

Date: May 13, 2009
Time: 16:45 – 17:45
Place: Leipziger Kubus

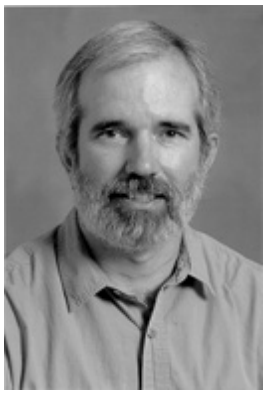
Environmental systems (e.g. the soil – groundwater - surface water – sediment system) are under pressure by large scale input of anthropogenic compounds of uncertain long-term fate as well as because of climate change. A lower availability of water through extended droughts in future climate scenarios will cause increasing pressures on water quality. Because of ongoing emissions, the persistence of many compounds and their long range global transport increasing concentrations have to be expected in the environment on large scales in time and space. Additionally, the number of compounds released into the environment continuously increases.

During the last decade understanding of fate and transport of pollutants, environmental monitoring and modeling made major progress. Many biogeochemical reactions in soils and sediments have been described in detail. For monitoring, passive sampling devices and sensor systems were developed which allow the time integrated or time resolved quantification of pollutant concentrations in air and water. With more powerful computers and parallel codes, numerical modeling not only allows to cover large catchments (> 100 km2) but also handles coupled systems such as the soil – groundwater – surface water system in 3D. Additionally, models based on the travel time concept were developed to simulate hydrology in large river basins and tributary networks.

With large scale coupled models the influence of future climate or land use scenarios on groundwater quantity and quality can be assessed. Such numerical simulations allow long-term forecasts, which may cover time periods of many decades to centuries. Like in weather forecasts the reliability of such predictions depends on the quality of the data fed into the model and of course the accuracy of the numerical codes. Data in high spatial and temporal resolution are required also for the validation of the models. For data acquisition cost-efficient monitoring strategies are needed such as sensor devices and passive sampling networks. Natural and anthropogenic compounds as well as isotopes can be utilized as tracers for the elucidation of origin and transport pathways of pollutants. The large amount of data needs to be processed using innovative data assimilation techniques. Finally, massive parallel codes and new modeling approaches have to be developed which can simulate reactive transport at the catchment scale for time periods of centuries (including supercomputing).

After graduating with a degree in geology from the University of Tübingen in 1985, Prof. Grathwohl continued his studies to gain a Ph.D. over volatile chlorinated hydrocarbons in soils. On completion of his Ph.D. he was awarded a 15 month research scholarship at Stanford University, USA, in the field of subsurface remediation using vapour phase extraction of volatile contaminants. From 1990 to 1996 he was active as an assistant at the University of Tübingen, specialising in the area of groundwater contamination with organic compounds. Since 1993 he has led the hydrogeochemical section of the Chair of Applied Geology, University of Tübingen. He is the scientific-technical coordinator of AquaTerra (www.eu-aquaterra.de); Member of the Commission for Soil Protection (KBU) at the Federal EPA (UBA); Member of the senate and granting committee for graduate colleges by the DFG (German Research Association); President of the Section Hydrogeology of the German Society for Geosciences (www.fh-dgg.de); Editor-in-chief: Journal of Contaminant Hydrology (-Dec. 2006); Member of governing board of the European Environment Observation (Monitoring), and the DFG "Wasserkommission" and "Geokommission". In 2004 he received the Award for Applied Geosciences from the Alfred-Wegener Foundation (Heitfeld-Preis).

Keynote Speakers – 13th May



Graham E. Fogg
Hydrology Program, Department of Land, Air and Water Resources
Department of Geology
Chair, Hydrologic Sciences Graduate Group
University of California, Davis

The Disconnect Between Monitoring and Models

Date: May 13, 2009
Time: 09.10 – 09:50

Subsurface scientists and engineers commonly monitor solute or isotopic concentrations to draw conclusions about transport and fate. There is particularly strong interest in the development and use of monitoring approaches to detect evidence of biodegradation and to estimate groundwater age. Underpinning such pursuits is the notion that success depends mainly on effectiveness of the monitoring network and of the particular compounds or environmental tracers. Through several examples I will show that regardless of the monitoring network and measured indicators, one should expect limited success unless a suitable transport model is also used to facilitate interpretation of the data. The main reason is that both physical processes and biochemical processes can cause the same spatiotemporal trends in solute concentrations and in some isotopic ratios. These concepts and the role of modeling are illustrated for (a) simple monitoring of solute concentrations in a heterogeneous system where apparent decreases in concentration and plume length can be misconstrued as biodegradation, (b) monitoring for MTBE biodegradation through the use of compound specific isotope ratios, where both biodegradation and diffusion across aquifer-aquitard interfaces can give rise to the same degrees of isotopic fractionation, and (c) use of the tritium- helium method of estimating groundwater age, where differential rates of aquitard diffusion of tritium and helium can confound interpretation of groundwater age. The bottom line is that there are no short-cuts – physical and biochemical scientists must work together using all the available tools, including models, to adequately characterize subsurface processes.

Graham E. Fogg received a B.S. in Hydrology from the University of New Hampshire, an M.S. in Hydrology and Water Resources from the University of Arizona, and a Ph.D. in Geology from The University of Texas at Austin. He has more than 30 yrs experience researching and teaching about subsurface water flow and pollutant transport processes and water resource sustainability. Graham's research interests include characterization and modeling of subsurface complexity, groundwater quality sustainability, response of hydrologic systems to climate change, and hydrogeologic processes in ecosystems, among others. He teaches courses at UC Davis in groundwater hydrology, groundwater modeling, applied geostatistics, and water resources. He served as Chair of the Hydrologic Sciences Graduate Group from 1993 to 1998 and 2006-present, and Chair of the Hydrology Program from 1998 to 2001. He was the 2002 Geological Society of America Birdsall-Dreiss Distinguished Lecturer. Dr. Fogg is a Fellow in the Geological Society of America.

Mark Kram
Groundswell Technologies, Inc.
Santa Barbara, CA, USA

Rapid Single Mobilization Solutions for High-Resolution Contaminant Flux Characterization, Network Design, and Monitoring System Deployment

Date: May 13, 2009
Time: 11.10 – 11:50

For the first time ever, groundwater contaminant characterization, remediation design, and remediation performance monitoring systems can be implemented in a single field mobilization. Direct push chemical and hydrogeologic assessment tools allow for rapid high-resolution characterization, model development, monitoring well network design, implementation of optimized remediation strategies and deployment of automated performance evaluation systems. The high-resolution piezocone direct push sensor probe can be used to determine direction and rate of groundwater flow in three dimensions, while other direct push probes can be deployed to collect essential contaminant concentration distribution information. Field hydraulic measurements are used to determine seepage velocity distributions through interpolation methods recently incorporated into modeling platforms. Following chemical concentration data collection, innovative data processing and modeling approaches allow for the determination of mass flux distributions at resolutions and spatial configurations never before available. Co-located soil type information allows for monitoring well network design and installation. Single mobilization field efforts comprised of data collection, interpolation, modeling, long-term monitoring network design and automated remediation performance evaluation system implementation will be discussed.

Dr. Mark Kram is the Founder and President of Groundswell Technologies, Inc., a group specializing in automated monitoring and modeling of environmental and homeland security sensor networks. Dr. Kram earned his Ph.D. in Environmental Science and Management from the University of California at Santa Barbara, a M.S. degree in Geology from San Diego State University, and his B.S. degree in Chemistry from the University of California at Santa Barbara. He has over 25 years of experience using innovative environmental assessment techniques and has authored papers, national standards, articles and book chapters on the subject. Dr. Kram has been instrumental in the areas of sensor development and implementation, innovative GIS applications, dense non-aqueous phase liquid (DNAPL) site characterization, chemical field screening and monitoring well design, and holds several patents for hydrogeologic and chemical characterization tools and automated environmental monitoring approaches. Dr. Kram is also an active member of NGWA, ASTM (Subcommittee D18.21), and ITRC (SCM and Bio-DNAPL Teams), and is currently preparing national guidance for expedited characterization and mass flux.

Stefan Trapp
Department of Environmental Engineering
Technical University of Denmark

Using Tree Core Samples to Monitor Natural Attenuation and Plume Distribution of Pollutants in Groundwater

Date: May 13, 2009
Time: 14:00 – 14:40

The lecture will report about the potential of using tree core samples to detect and monitor natural attenuation of chemicals in groundwater. As example, the case of a PCE-contaminated site in CZ is shown. In the area of the known plume, cores were collected from tree trunks at a height of about 1 m above ground surface. Tree sampling of the site was completed in under six hours. Chlorinated ethenes were analyzed by headspace GC/MS. PCE and natural attenuation products, TCE and c-DCE, were detected in tree cores. 1,1-dichloroethene and vinyl chloride were not detected, corresponding to very low concentrations in the groundwater. The contaminant plume was mapped from the concentrations measured in trees, which delineated a probable hot spot area that had been undetected in decades of traditional groundwater monitoring. Natural attenuation products in tree cores increased with distance from the known source area. Concentrations of PCE and reductive dechlorination products in tree cores were correlated with the corresponding groundwater concentrations. Within a range of limitations, tree-core sampling provides a rapid, reliable and inexpensive method to investigate the extent of shallow contamination by chlorinated ethenes in soil and groundwater. The lecture will go beyond this case and discuss other potential indicator chemicals which could be found in tree trunks.

The research of Stefan Trapp is mainly on behavior and fate of organic pollutants in the environment, with a focus on the soil/plant system and on mathematical modeling. Together with scientists from all over the world, Dr. Trapp developed the current theory for uptake of chemicals into vegetation. Activities are in chemical risk assessment (REACH), environmental biotechnology (phytoremediation), impact assessment (contaminated sites) and water pollution. Stefan Trapp has about 150 scientific publications, hereof more than 50 ISI papers (25 of them in the last 5 years), 5 books and 4 patents. Stefan Trapp is working at the Institute of Environment & Resources (E&R) in the research groups "Contaminated Sites" and "Environmental Chemistry & Ecotoxicology". He is course coordinator of the 10-credit-points-course 12233 Water Pollution.

Keynote Speakers – 14th May

Alessandro Corsini
University di Modena e Reggio Emilia, Italy

Site characterization and monitoring of unstable natural slopes

Date: May 14, 2009
Time: 08:30 – 09:10

Natural slopes can be unstable as a result of the action of seismic or meteorological triggers, due to inherited geologic, hydro-geologic, climatic and topographic causal factors. Unstable slopes are a major problem in many engineering projects and are often the cause of natural risk, thus requiring costly structural or non-structural mitigation measures.

Slope instability creates, over time, landslide bodies that display heterogeneous geotechnical and hydrologic characteristics. In case of large scale landslides, this is often associated with a complex displacement behavior in space and time. The larger the landslide, the more difficult and costly is to collect significant reference data for parameters and variables that rule slope movement. Crucial is the determination of the depth and shape of failure surfaces, of shear strength and visco-elasto-plastic properties, of hydraulic properties, of pore pressure regime and of displacement in space and time.

A broad range of characterization and monitoring techniques is nowadays available for estimating these parameters and variables. However, available techniques do not always allow for their precise determination. It is the case, for instance, of geotechnical parameters, whose assessment is made difficult by the heterogeneous nature of landslide materials, by the limited reliability of borehole tests, by the problems in collecting undisturbed and representative samples and by scale effects that cannot be fully accounted for in laboratory tests. At the same time, technological advancements in the last decade have made common practice the usage of continuous monitoring techniques that allow tracking in time the relationships between pore□pressure regime and displacement, so that numerical models, simulating slope instability on a geotechnical basis, can be validated even in absence of “true” values of geotechnical and hydrological parameters.

The speech will overview the topic by presenting field investigation and testing techniques that can profitably be used in conjunction with innovative monitoring systems in order to achieve a full characterization of landslides. Special reference will be made to complex large scale earth slides and earth flows that are commonly affecting weak rocks such as clayey mélanges and flysch, and that are widespread in the Alps, in the Appennines and in the many other collisional mountain ranges of the world.

PhD in Geology (2000), Dr. Corsini is currently Senior Researcher in Engineering Geology at the University of Modena and Reggio Emilia. His research activity covers different topics of engineering geology, but it is prevalently aimed at monitoring, assessment and mitigation of risks related to large-scale mass movements. His activity has been mainly focused on areas of the northern Appennines and eastern Alps of Italy. He's author or co-author of about 50 papers, many in peer-reviewed journals.

Dr. Corsini has been involved in research projects of the Vth and VIth FWP of the European Commission and in National and Regional research projects. He is currently involved in international projects such as Interreg IIIB Cadses project MONITOR 2006-08: Hazard Monitoring for Risk Assessment and Risk Evaluation (in the role of external consultant for the Autonomous Province of Bozen - South Tyrol); Marie Curie Training network MOUNTAIN RISKS: 2006-2010 Mountain risks: from prediction to management and governance (in the role of Tutor of an early stage researcher PhD work); Program VIGONI 2007-08 (CRUI-DAAD) Numerical modeling of slopes for evaluating efficiency of structural mitigation (in the role of Leader of the Italian team). Furthermore, in National and local research Dr. Corsini took part in various projects financed by the Ministry of Research and by the National Research Council.

Giorgio Cassiani
University of Padova, Italy

Hydro-geophysics: the non invasive characterization of the shallow subsurface

Date: May 14, 2009
Time: 11:00 – 11:40

The characterization of the shallow subsurface in terms of its hydraulic and mechanical properties is a key step towards the solution of real-life problems in hydrology, hydrogeology, soil science and geotechnics. In particular, the presence and motion of water in the subsurface controls a number of phenomena of great environmental interests, such as contamination of water resources, catchment hydrology, floods and slope stability. The traditional characterization methods are inherently invasive (drilling and sampling) and in most cases do not allow for the space and time resolution needed for the monitoring of hydrological and environmental processes. For this reason, non invasive – geophysical – methods have been increasingly used to support the invasive techniques and fill the knowledge gap in space and time. This approach is conceptually similar to the one adopted for many years in the petroleum industry, with considerable success. However, the shallow subsurface requires specific investigation techniques that are not suitable for deeper applications. The development of such techniques has been very rapid over the past couple of decades. Ground-penetrating radar (GPR), electrical resistivity tomography (ERT) and spectral induced polarization (SIP) have seen the most widespread use to date. Of particular importance are the abilities of geophysical methods to describe two aspects of the shallow subsurface:
(a) static aspects, which *do not* change over time, principally related to physical and chemical properties of the geological medium; (b) *dynamic* aspects, which *do* change over time in response to changes in fluid saturations and water chemistry.

The successful use of geophysical data for hydrologic, environmental and geotechnical investigations requires (1) that the collected geophysical data have a clear, identifiable and quantitative petrophysical relationship to environmental variables of interest; (2) that the resolution and sensitivity of geophysical methods in space and time is fully understood and is appropriate to constrain the process of interest; (3) that indirect measurements be incorporated into hydrologic models in the most effective way, e.g. as means to calibrate predictive models. In this talk, the general conceptual will be presented, together with specific applications to vadose zone and saturated zone characterization in both plain and mountain regions.

Giorgio Cassiani is Associate Professor in Applied Geophysics at the Department of Geoscience, University of Padua, Italy. He graduated in Mining Engineering from the University of Trieste (1991), has been awarded a PhD in Applied Geophysics from the same university (1996), a M.Sc.(1995) and a Ph.D. (1997) in Civil and Environmental Engineering from Duke University, USA. He worked at OGS Trieste and at ENI-Agip in San Donato Milanese (Milan) as an Environmental Specialist. From 1999 to 2001 he was Lecturer in Contaminant Hydrogeology at Lancaster University, UK, where he taught courses in Hydrogeology, Environmental Management and Contaminated Land Remediation for undergraduate and graduate students in Environmental Science. From 2001 to 2006 he was lecturer in Applied Geophysics at the Department of Geological Sciences and Geotechnology at University of Milan-Bicocca, Italy.

His main research interests include (1) Geophysical methods for environmental applications, focus on the characterization of contaminated sites from the geological, hydrological and contamination viewpoints. Methods of choice are Electrical Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR), especially in borehole and cross-borehole configuration. Novel Spectral Induced Polarization (SIP) methods are currently under development. (2) Geophysical methods for the geotechnical characterization of sites. Methods of choice are seismic methods – especially Surface Wave methods (SWM). (3)Integration of invasive and non-invasive techniques for site characterization, with particular reference to geostatistical techniques.(4)Integration of hydrological modeling with evidence from geophysical methods and from classical hydrological measurements, both in the vadose zone and in the saturated zone, with the aim of calibrating the hydraulic and hydrological parameters of relevant geological formations. He has authored about 30 scientific papers in international refereed journals and about 60 papers and talks for scientific conferences. He is member of the American Geophysical Union (AGU) Hydrogeophysics Technical Committee and associate editor for the journals Near Surface Geophysics and SERRA.

Peter Huggenberger
University Basel, Switzerland

Processes at and across the interface

Date: May 14, 2009
Time: 14.00 – 14:40

Canalization of many rivers in the 19th century strongly influenced the economic development and urbanization of most European countries. Together with technical developments in agriculture, a series of environmental problems such as flooding, groundwater pollution and ecological changes, including the decrease of characteristic habitats of riverine landscapes, were created. Most of the river valleys are important groundwater reservoirs, in particular in central Europe. These reservoirs are often highly endangered due to intense agricultural and industrial activities and a dense network of urban areas connected by numerous traffic lines. Additionally, the high permeability of fluvial sediments (esp. fluviatile shaped aquifer types of alpine type), the frequently observed lack of a thick protective cover layer and the exchange processes with surface waters result in a high vulnerability of groundwater resources.

Formulated goals for a sustainable development of water resources guide mitigation strategies and consider defined standards, i.e. natural composition of surface waters. Major efforts for future transdisciplinary research, with respect to hydrological regimes (low and high flow) or groundwater flow regimes, will concentrate on the knowledge of the structural dynamics of the river and related groundwater systems. To identify hydrological and hydrogeological system profiles, methodologies to quantify and control these profiles must be developed and applied. This can be achieved by the implementation of management systems that include observation systems and the development of numerical models combined with specific field experiments and scenario development. The integral of changes in river structures in the catchment (i.e. lack of retention space) has already demonstrated serious consequences during major floods. Due to the experience gained from the hazardous flood events in the last twenty years, the pollution problems and the loss of characteristic riverine landscapes, most countries have adopted a more comprehensive view of rivers. It is recognized that the consideration of processes of river-groundwater interactions are important, which significantly differ for natural and channelized states.

Within this context, positive and negative aspects of river-groundwater interaction for channelized and non-channelized surface waters are investigated. The interaction of surface and subsurface waters is subject to continuous dynamics involving water budgets, water quality and flow patterns. When considering quantitative hydrological aspects of river-groundwater interaction, the transient character of riverbed permeability is an essential factor. Sediment erosion as well as transport and deposition processes are influenced by rivers that are able to exert their natural dynamics. As a consequence, the variance of the riverbed permeability is increased temporarily, influencing infiltration rates and groundwater mixing ratios, as well as residence times for groundwater from different provenance.

To understand the dynamics of river-groundwater interaction, our investigations focus on: (1) the evaluation of transient hydraulic boundary conditions, including the transient character of riverbed permeability and (2) qualitative aspects of surface waters and groundwater. Results from experiments of selected river-reaches are presented, including: (1) adequate observation systems that facilitate the measurement of groundwater parameters at different depths, as well as the definition of sampling strategies, (2) non-destructive geophysical methods (Georadar, Geoelectrics) within the river bed and the riparian zone, as well as (3) subsequent high resolution groundwater flow and transport modeling, including scenario techniques, model calibration and sensitivity analyses. Interaction processes are studied at a regional and a local scale (e.g. Upper Rhine Graben, individual catchment areas, riverreaches and capture zones of extraction wells).

Prof. Dr. P. Huggenberger is head of the Applied and Environmental Geology research group at the Department of Environmental Sciences of the University of Basel and in charge of the Geological Survey of Basel-Stadt and Basel-Landschaft, Switzerland. He's research includes topics in the domains of river-groundwater interaction, groundwater-management, fluvial sedimentology, contaminant transport and hydrogeophysics. He is leading several projects in the domain of urban hydrogeology and groundwater resource management in the Basel area. He has experience in structural geology and tectonics (ETH Zürich, University of Geneva) and in acquisition and processing of geophysical data on fluvioglacial deposits. Dr. Huggenberger gave major contributions in the process of understanding the relationships between surface processes (horizontal sections) and the interpretation of ancient gravel sequences in vertical sections (facies models). He also has experiences on the guidance and realization of multidisciplinary projects in the domain of riparian ecology.

Steven Loheide
Civil & Environmental Engineering
University of Wisconsin-Madison, US

Characterization of groundwater processes in riparian areas using thermal remote sensing

Date: May 14, 2009
Time: 16.15 – 16:55

Characterization of hyporheic exchange and groundwater discharge to streams is critical for understanding ecosystem function, yet quantification of spatially-variable, surface-groundwater interactions remains a challenge at scales ranging from the point measurement to the watershed.

Thermal remote sensing offers an opportunity for detecting both diffuse and focused groundwater discharge to streams and for mapping groundwater levels along streambanks. Surface water temperature varies over a relatively large range on both diurnal and annual time scales when compared with groundwater, which maintains a more constant temperature year round. Because of this difference between groundwater and stream temperature, groundwater discharge has a measurable effect on the thermal regime of the stream and streambank that can be detected with airborne and land-based thermal remote sensing.

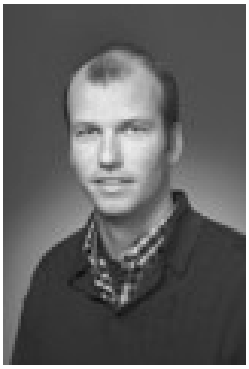
First, airborne thermal imagery will be used to demonstrate that: 1) springs and seeps can be identified with thermal remote sensing, 2) stream-aquifer interactions exert control on observed stream temperature regimes at the watershed scale, and 3) the resulting stream thermal signal can be used to quantify hyporheic exchange and baseflow. Using remotely-sensed stream temperature data and insitu stream temperature records, numerical modeling of the heat fluxes to/from the stream can be used to quantify the spatially variable rate of groundwater discharge. The use of this methodology can be made more cost effective and widespread by employing unmanned aerial vehicles as an alternative to traditional methods using helicopters.

Second, ground-based thermal imaging of seepage faces will be shown to provide a means of imaging groundwater flux at the centimeter scale. The methodology we developed enables us to 1) create fine-scale maps of groundwater discharge along a stream bank seepage face and 2) locate the water table position along this boundary. Variations in groundwater discharge appear as anomalies in the thermal signature of the seepage face boundary. Because groundwater is relatively cool in the summer and warm in the winter compared with surface temperatures (in the upper Midwest, USA), regions of high discharge caused by heterogeneity and/or macropores, appear as cool anomalies in the summer and warm anomalies in the winter. Furthermore, the diel temperature fluctuation of the soil/water matrix is an indicator of the degree of saturation. Saturated regions have a higher heat capacity, which results in a higher thermal inertia and a lower amplitude of diel temperature fluctuations. This characteristic enables us to detect the position of the water table either by collecting time-lapse imagery or by collecting snapshot thermal images at thermal maxima in the summer or thermal minima in the winter. The work employs new, transferable, non-invasive methods that use heat as a natural tracer to image spatially variable groundwater flow processes and distinguish between focused and diffuse groundwater discharge to the surface.

Steven Loheides research focuses on the interactions between ecological and hydrological processes in natural and built systems. His approaches use a combination of field data, remote sensing, and numerical modeling to understand the feedbacks between vegetation patterning, vegetative water use, soil moisture availability, groundwater regimes, and stream-aquifer interactions. This work is focused on improving the scientific basis for stream, floodplain, and wetland restoration efforts under current and future climatic conditions.

Keynote Speakers – 15th May

Stefan Kollet
Meteorological Institute
Bonn University



Integrated Simulations of Subsurface-L and Surface Processes at the Watershed Scale

Date: May 15, 2009
Time: 08:30 – 09:10

Land surface models parameterize important soil-vegetation-atmosphere transfer processes and have been commonly used in atmospheric models as lower boundary conditions and, recently, as upper boundary conditions in subsurface flow models. The resulting integrated simulation platforms (ISPs) have great potential in conjunction with measured data for watershed characterization. However, it is important to emphasize that in these ISPs, applied physical parameterizations are based on simplifying assumptions that may limit their usefulness and require additional research.

In this study, results from detailed simulations of a 1400km2 watershed using a parallel ISP are presented and utilized to discuss some of these assumptions related to subsurface heat and moisture transport, root water uptake, and bare soil evaporation. In these models, an additional problem constitutes the application of a lateral spatial resolution on the order of 101m. Technically (numerically) this does not constitute a major problem, except an increase in computation time. However, in land surface models, the atmospheric transfer schemes, which are based on dimensional analysis, break down conceptually at spatial resolutions <102m. Thus, moving from land surface scales (>102m) to scales that are interesting to hydrologists (<102m) requires novel theoretical approaches for watershed characterization, which are discussed also.

Professional career
since July 2007, Scientist, Meteorological Institute, Bonn University, Germany
June 2005 – June 2007, Physicist, Atmospheric, Earth, and Energy Sciences Department, Lawrence Livermore National Laboratory, USA
January, 2004 – June 2005, Postdoctoral Researcher, Environmental Science Division, Lawrence Livermore National Laboratory, USA

Awards, grants, and scholarships
− Research Grant, Lawrence Livermore National Laboratory, Co-PI, 2005-2006.
− Outstanding Student Paper Award, Hydrology Section, American Geophysical Union, 2001 Fall Meeting
− Student Travel Grant, Geological Society of America North-Central Section, Annual Meeting Boston, 2001
− HSP3 Graduate Scholarship, German Academic Exchange Service, 8/1999-7/2000
− Research Grant, Central Platte Natural Resources District, Nebraska, 1999-2003

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ
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Company Exhibition

The company exhibition and demonstration will take place on May 13-14. There will be several information booths in the Foyer of the Conference Hall-KUBUS. Technology demonstration and exhibition of larger machinery will be at the UFZ area (Please follow the signs).

Information booths:	May 13, 2009 May 14, 2009	8:30- 21:30 8:30- 16:15

1. Allied Associates Geophysical Ltd.
2. Dresdner Grundwasserforschungszentrum e.V.
3. Eijkelkamp Agrisearch Equipment
4. FUGRO
5. GTC Kappelmeyer GmbH
6. Basin Studies Laboratory (LEBAC) at the Institute of Geosciences and Exact Sciences of the São Paulo State University
7. imw - Innovative Messtechnik Dr. Weiss
8. MPBF Mess- und Probenahmetechnik GbR
9. UIT GmbH Dresden

Exhibition of larger machinery/Technology demonstrations (UFZ area)	May 13, 2009 May 14, 2009	13:00-18:30 09:15-14:00

1. Geotechnik Heiligenstadt gmbh Beratende Ingenieure VBI
2. Röhrenwerk Kupferdreh Carl Hamm GmBH
3. SonicSampDrill
4. Geoprobe Environmental Technologies S.A.

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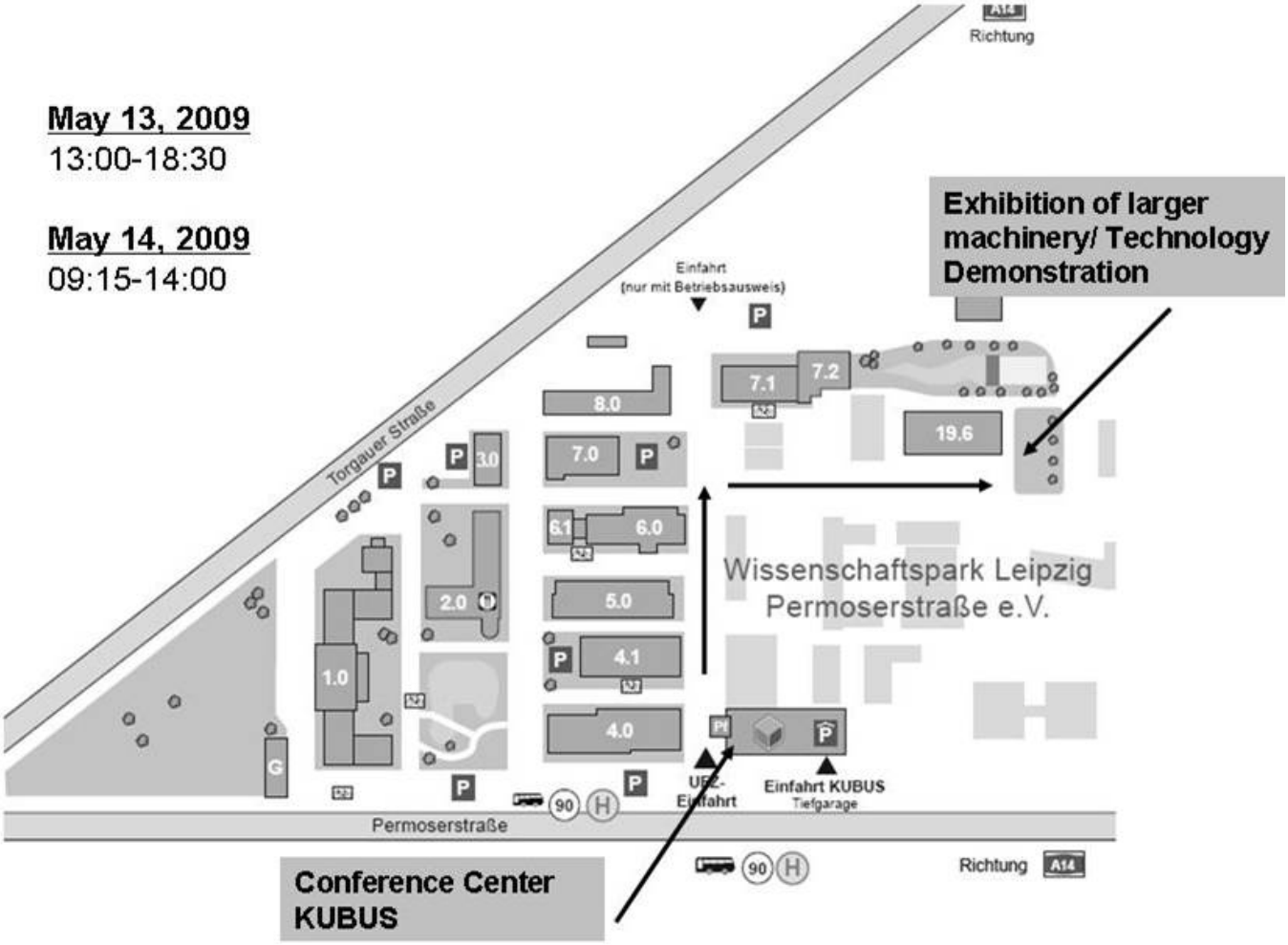
May 13, 2009
13:00-18:30
May 14, 2009
09:15-14:00
Exhibition of larger machinery/ Technology Demonstration
Richtung
Einfahrt
(nur mit Betriebsausweis)
Torgauer Straße
8.0
7.1
7.2
19.6
7.0
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6.0
2.0
5.0
1.0
4.1
4.0
Wissenschaftspark Leipzig
Permoserstraße e.V.
UFZ-
Einfahrt
Einfahrt KUBUS
Tiefgarage
Permoserstraße
90
Richtung
A14
Conference Center
KUBUS

Allied Associated Geophysical Ltd.

Allied Associates Geophysical Ltd. (AAGL) is recognised as the foremost rental, repair and support company for geophysical, geotechnical as well as non-destructive equipment and techniques throughout Europe, the Middle East, Africa and the Far East.

Allied Associates Geophysical Ltd. (AAGL) was founded in 1989. With nearly **20 years of experience**, Allied Associates now owns offices located in the **United Kingdom, Belgium and Germany.**

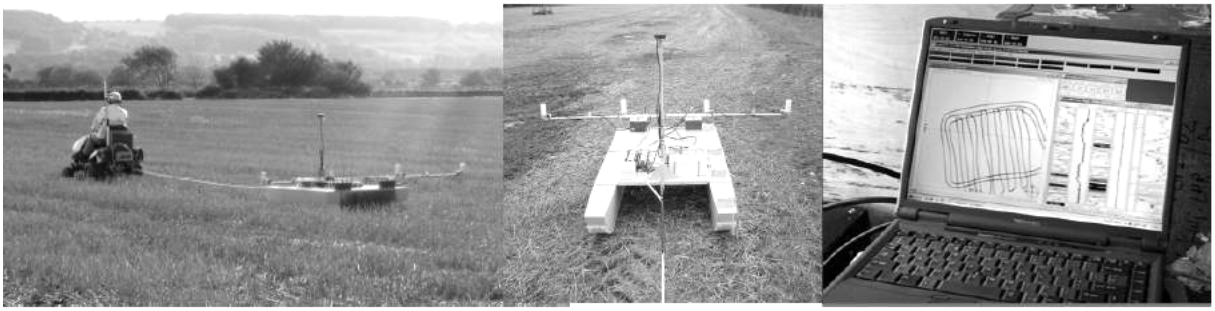
The company's objectives include the **sale and rental of a wide range of sophisticated instrumentation** for the acquisition of geophysical and geotechnical data. Moreover AAGL is providing dedicated instrument development and system design for GPR, Seismic as well as Resistivity sensors. AAGL, as manufacturer of resistivity equipment, has proven to produce tailored solutions for the individual customer requirements.

AAGL's staff consists of a mix of **highly experienced geophysicists and engineers** who together possess intricate knowledge of the latest instrumentation and applications of geophysical and Non-Destructive Testing technology.

Full training facilities are provided for all types of geophysical instrumentation including GSSI approved courses in Ground Penetrating Radar (GPR). In addition to the equipment available for rental (a full list of the rental equipment is available on request), AAGL also supply **spare parts, and consumables** for a vast range of geophysical instruments.

Allied Associates will present the new **GEEP multisensor** approach which increases the efficiency of any geophysical survey incl.:

- Logging of different sensor techniques in variable combinations simultaneously (e.g. Magnetics, FD-EM, TD-EM, OhmMapper, Gamma Spectrometer)
- Real-time data display incl. GPS position
- On-site processing of datasets



Dresdner Grundwasserforschungszentrum e.V. (DGFZ)

DGFZ
Dresdner Grundwasserforschungs-zentrum e.V.

The DGFZ e.V. is an incorporated non-profit society which conducts:

- concept development for soil and groundwater management and protection;
- realization and promotion of continuing education and conferences; and
- strategy and method development for the in-situ remediation of contaminated soil and aquifers.

It provides pilot plant stations, an accredited test laboratory, and a sampling team with the required modern equipment for a certified sampling of groundwater, surface water, soil, and bedrock.

A focal point is the promotion of capable young researchers. E.g., since 1995 about 20 doctoral theses were finished with excellent success.

Innovative prototyps of groundwater sampling and well logging devices resulted from various research projects:

The patented **non-adulterating groundwater sampling system** enables a depth-oriented and isobar retrieval of unadulterated groundwater samples.

A special **groundwater sampling system** combines **well logging** and water sampling. Pressure, temperature, and salinity of the water sample are monitored until its transfer into a laboratory.

Using the **AACI-Log**, the sealing behind a well casing can be checked for fissures allowing unwanted vertical transport of water and contaminants**.**

Eijkelkamp Agrisearch Equipment

Eijkelkamp Agrisearch Equipment BV is an international organisation that supplies all types of equipment in the area of environmental and agricultural research. The range of products that Eijkelkamp has to offer can best be described as equipment used for researching soil, water, earth monitoring and sludge & slurry. And this all is for the benefit of agricultural, hydrologic and environment-related studies.

Eijkelkamp also has a modern Education and Training Centre that offers a range of courses, training sessions and workshops.

Product ranges includes equipment for:

Soil:	soil drilling/sampling and soil physical research
Water:	water quality & quantity monitoring, (Ground-)water sampling/analysis
Sludge & Slurry:	samplers
Earth monitoring:	meteorological instruments, dataloggers, sensors and measuring stations, e-SENSE, plant physiology

e-SENSE®: measuring and monitoring that crosses boundaries

Measuring and control devices increasingly need to be used at a (greater) distance. Adjusting settings, reading data followed by taking appropriate action, if necessary, from a location of your own choice are possibilities that are now very much part of the standard package of requirements. With the use of e-SENSE, taking measurements of data via intelligent sensors such as the e+ sensors from Eijkelkamp Agrisearch Equipment or the Diver® from Schlumberger Water Services has become more than just measuring. Intelligent sensors measure data in the field and store these internally. The e-SENSE field modem makes it possible to then transmit your data or alarms to a data base which is located either on your own computer (e-SENSE direct) or at a central database.

FUGRO

Fugro Consult GmbH provides high quality environmental and geotechnical services to national and international clients. Main activities are focused on environmental consultancy, environmental and geotechnical data collection, geological and hydrological data management, environmental impact assessment, regional planning and infrastructure projects, design advice, civil engineering, groundwater investigation, groundwater modeling, raw material exploration and assessment of deposits, coastal engineering and protection. The company employs geologists, geographers, geophysicists, biologists, landscape architects, chemists and civil engineers.

Fugro Consult GmbH is a member of the Fugro Group of Companies with approximately 10,000 staff in over 50 countries worldwide. Fugro Headquarters are in Leidschendam, the Netherlands. Fugro Consult GmbH was established in 1997 as a merger of separate Fugro consulting firms and is looking back to over 40 years experience in geological, hydrological and natural resources engineering.

Geoprobe

Since 1987, GEOPROBE® designs and manufactures direct push machines, equipment, and tooling for the environmental and geotechnical industries.

GEOPROBE® direct push machines are hydraulically-powered and use static weight/dynamic percussion force to advance small-diameter tools into the subsurface.

GEOPROBE® brand tooling includes soil core, groundwater, and soil gas sampling tools; equipment for performing hydraulic conductivity testing, Standard Penetration Tests, and Cone Penetration Tests; electrical conductivity and MIP logging equipment; high-pressure grouting and injection systems; augering systems; and prepacked screens for installing monitoring wells.

Geotechnik Heiligenstadt GmbH

ADVICE - PLANNING - REPORT – SUPERVISION

The engineering company Geotechnik Heiligenstadt GmbH was founded now 14 years ago.

We are specialised in geotechnical engineering and soil exploration and has grown in a subsequent decade into a renowned engineering consultancy in soil mechanics, environment, water and sustainable energy disciplines.

The company is certified by the ISO 9001:2000 standard and specialised in
• Geotechnical field studies
• Geotechnical consultancy
• Environmental soil and groundwater exploration with own equipment of drilling and CPT (registered as an Acknowledged Drilling- and Draining company certified by the DVGW W120 standard)
• Environmental consultancy
• Geohydrological consultancy
• Laboratory analysis and tests (certified by the RAP-Stra, BAST, VMPA standard)
• Geothermal prospecting / geothermal energy
• Explosives analysis
• Special tests
• Experts in the field of Geohydrologics and Geotechnical and renders the services with 35 employees from engineers and technicians.

All performances from the first planning of the environmental soil and groundwater exploration up to the handing over of an engineered project are carried out from one hand.

The managing general director, Mr. graduate engineer Elmar Dräger, is an public order and sworn expert for soil and traffic way building, soil and ground foundations as well as environmental and rock mechanics and is engaged by courts for the compilation of specialist reports.

GTC Kappelmeyer GmbH

GTC Kappelmeyer GmbH is an engineering and service company and specialized in the sensitive detection of seepage in embankment dams and of flow phenomena in the subsurface. The Temperature Sounding Method, a direct push technique for measuring soil temperatures was developed by GTC and is applied worldwide in hydraulic structures, downstream of landfill sites and along pipeline systems. More than 40.000 temperature soundings have been carried out since 1991. Furthermore, GTC tests all kind of sealing elements as e.g. jet grouting, diaphragm, sheet pile and slurry trench walls. Leakage detection is provided for cut-off walls and sealed excavation pits.

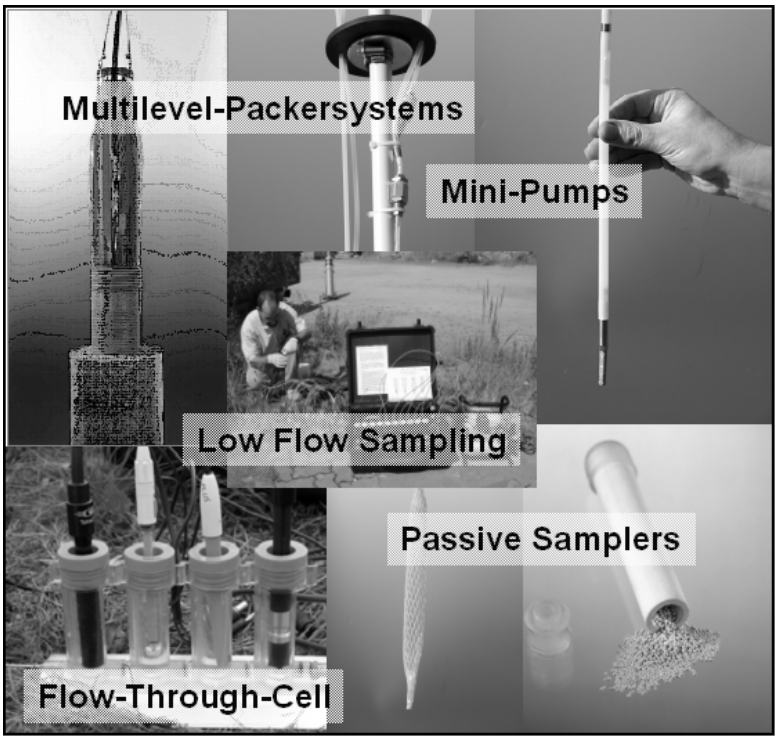
Basin Studies Laboratory (LEBAC) at the Institute of Geosciences and Exact Sciences of the São Paulo State University- UNESP

The Basin Studies Laboratory (LEBAC) at the Institute of Geosciences and Exact Sciences of the São Paulo State University-UNESP is located in the city of Rio Claro, São Paulo, Brazil. The laboratory carries out scientific studies in groundwater exploration and remediation. To support these activities it has dedicated part of the efforts on software development and design of automation devices for groundwater hydrodynamic tests (slug and pumping tests), aquifer monitoring, sensor network and telemetry.

The automated system for slug test is composed of probe for water-column measurement, microcontrolled metering device and software (WinSlug). The probe is connected to the meter, which is powered by and communicates with a computer using an USB port. The software integrates in a single package all the steps for performing a slug test, from the data acquisition of the water column variation through data processing and finally to the interpretation of the test, using the Hvorslev and Bouwer & Rice methods. During data acquisition is possible to check the slug test quality through the ongoing measurements in real time, and changes made at interpretation phase are showed instantaneously, without losing the original files. User can export the results and plots for utilization in other programs such as electronic spreadsheets and text editors. Thanks to the automation kit, the results obtained are accurate and trustworthy, making WinSlug a useful “field-and-office” software tool that provides greater productivity in less time and at lower costs.

Innovative Messtechnik Dr.Weiss –imw

The company imw – Innovative Messtechnik Dr. Weiss, Tübingen Germany provides innovative sampling and measurement technologies to monitor the quality of ground- and surfacewater. The up to date know-how is a result of a permanent technology transfer and ongoing cooperation with leading research institutions in the field of applied environmental geosciences. We act as an interface between applied research and industry in order to put new and sufficient tested measuring and sampling technologies into the market. Our range of innovative products includes different kinds of semi-permanent Multilevel Packer Systems for depth-determined groundwater sampling, as well as different equilibrium and non-equilibrium passive sampling systems for time-integrated sampling of different organic chemicals dissolved in water (ground-, surface water and effluents). We also provide different kinds and sampling equipment for direct-push wells. As a general agency of Solinst, Canada, Waterra, UK and Proactive Pumps, US we can offer a broad range of innovative and practical equipment for site characterizations, spill investigations, and long-term ground water monitoring, used by both hydrogeologists and hydrologists.



- **Multilevelsystems**
  - Sockpacker
  - Washerpacker
  - CMT-Systems
- **Groundwater Pumps**
  - Micro and Mini Double Valve Pumps
  - Bladder-Pumps
  - Footvalves
- **Peristaltic-Pumps**
- **Bailers**
  - Disposable Bailers
  - Discrete Interval Samplers
- **Passive Samplers**
  - Ceramic-Dosimeter
  - PDB-Sampler
  - DM-Sampler
- **Direct-Push Wells**
  - Lost Pumps
  - Multilevel-Wells
- **Interface Meters**
- **Water Level Meters**
- **Dataloggers**

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

MPBF Mess- und Probenahmetechnik GbR

At MPBF we have committed ourselves to direct-push technology. This includes the development of products and measuring instrumentation that have particularly been designed and optimized for the application with direct-push machines. Our main focus lies on the minimization of the size of our products, in order to make them suitable for the use in standardized direct-push rods. Our products can be applied with manually- or machine-operated systems and can be designed to fit nearly all direct-push systems, manufacturer-independent. At the moment, our assortment includes instrumentation for the logging of various physical parameters like electric or hydraulic conductivity or for taking groundwater samples. We also provide a selection of materials and options regarding the installation of 1 inch wells or multi-level micro-wells.

Aside from our products we offer certain services related to direct-push. These services include but are not limited to:

Development of new measuring instrumentation
In cooperation with research institutes and universities we develop measuring devices to record geological field data

Planning, project management and development of field measuring vehicles
We provide our customers with our know-how when it comes to planning, equipment and configuration of all types of geological measuring vehicles.

Feasibility studies regarding the applicability of direct-push technology
Regarding the applicability of direct-push technology we can give you advice and answers to your questions – either by means of field tests or by applying our vast theoretical knowledge.

Product range

- MGA1 - geoelectric logger
- MST1 - slug test kit
- MIL1 - injection logging device
- Electric conductivity probes with 2 and 4 pins
- DVP - double valve pump
- MPS – pneumatic control for DVP
- Inertial pump
- 1 inch double packer system
- Different well material

Röhrenwerk Kupferdreh Carl Hamm GmbH

Röhrenwerk Kupferdreh Carl Hamm GmbH
Rohrleitungsbau & Geotechnik

Quality as a tradition

In April 1929 the pipe mill Röhrenwerk Kupferdreh was founded by Mr Carl Hamm at the present company headquarters in Essen, Germany. In the meantime the company is in the guiding hands of the family's third generation.

Over the years the pipe mill could also establish its knowhow in industries not specific to mining.

For example, Kupferdreh clientele today includes utilities, the engineering industries, and general pipeline engineers.

Carl Hamm Geotechnics

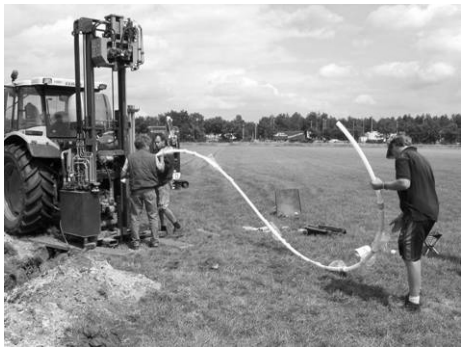
The founding of the geotechnics division in 1989 was a step in an all new field of operations. Since then the geotechnics division has been successfully producing and selling geological exploration equipment and test systems for engineering geology, the building industry, and institutes of higher education.

Sales of geotechnical products were extended to all of Europe, Africa, and South America.

In the meantime our high-quality test systems are acclaimed and utilised all over the world.

SonicSampDrill

SonicSampDrill is an innovative producer of sonic drilling rigs and tooling. Sonic rigs utilize high-frequency (180 Hz) vibrations to penetrate the soil. This intense vibration causes a very thin layer of soil particles directly surrounding the casing to loose structure. Instead of a stiff obstinate mass, the soil behaves like a fluid powder in the unsaturated zone, or as a slurry or paste in the saturated zone. This fluidization, or liquefaction, dramatically reduces friction between the casing and the surrounding soil, allowing very rapid penetration. The stagnant soil, compared to the high speed moving casing, prevents soil from sticking to the wall of the casing or in- and outside of the sampler. The liquefaction and inertia effects enable collection of long undisturbed samples (up to 4 meters).



Main advantages of such drilling are:

- High productivity – on average 100 m per day of continues sampling and 300 m per day of installation works
- Drilling in all formations
- Dry drilling in alluvial formations
- No cuttings above the ground in alluvial formations
- Perfect for environmental drilling – no cross-contamination occurs while drilling
- Well installation is done through the casing using our exclusive LostCone method.
- High sample recovery in all formations

Our company produces 4 types of drill heads:

CompactSonic (can go up to 30 meters with 115 mm ∅);
CompactRotoSonic (can go up to 45 meters with 115 mm in all formations);
MidSonic (can go up to 100 meters with 180 mm in all formations);

LargeSonic (can go up to 200 meterts with 300mm ∅).

Besides drilling rigs our company also produces sonic-proof tooling. We have a complete range of tooling for various applications. To mention: Lost and fixed cones (soft/medium soil), rock coring bits, full face rock bits for water- or air assisted drilling, lost plate rock bits for rock drilling combined with simultaneous well, seismic explosives or geothermal loop installation. Smearing over layers is extremely low. Extra casing can be used to fully isolate overburden from a layer below.

Besides producing Sonic drilling rigs SonicSampDrill is an exclusive distributor for AMS – an American producer of high quality direct push rigs. We have several models of direct-push rigs which can be used in both environmental and geotechnical fields.

AMS positions itself on the direct push market as a producer of a very high quality machines for an affordable price

SSD delivers all AMS machinery with CE and training!

Umwelt- und Ingenieurtechnik GmbH Dresden (UIT)

Since its foundation in 1990, the Umwelt- and Ingenieurtechnik GmbH Dresden has been standing for competence and innovative solutions for the benefit of our environment. A professional team of natural scientists, engineers and technicians unites comprehensive competences in the fields of environmental monitoring and water technologies.

In the field of environmental monitoring, UIT offers integrated solutions for complex and fully automatic monitoring networks well as a broad range of advanced hydrological sensors, gauges and data loggers. Our monitoring systems unite state of the art communication technologies and latest scientific methods.

UIT is offering single and multiparameter instruments, integrated systems, and accessories for most unattended monitoring, water quality sampling, profiling and logging applications. Most of our sensors and loggers are Internet enabled and have wireless data transfer systems already onboard.

The business activities in the field of water technologies comprise the whole range of water treatment: development of remediation concepts, development of water treatment technologies, engineering services, construction and planning of facilities and turnkey solutions. Our services are completed by scientifically funded modelling services and concepts for process optimisation of existing facilities.

Business Activities

- Hydrological monitoring systems for surface, ground and waste water quality monitoring, sampling, water level and flow rate as well as precipitation
- Dynamical modelling of environmental systems (geochemical, geo-hydrological, microbiological) as well as modelling of water treatments
- Planning, design and construction of water treatment facilities
- Water technology: Design, plant construction, automation, project management

Milestones – business area environmental monitoring

- Internet enabled and web based ground water monitoring network for the city of Dresden and many other sites and selected research institutes
- Radiological monitoring networks in Romania
- Hydrological monitoring network in Bulgaria
- Monitoring network, consisting of CTD-probes, water quality probes incl. data transfer for the Federal Institute for Geosciences and Natural Resources (BGR) in Hannover
- Environmental and early warning monitoring network for Singapore
- Early warning system for the detection of water pollution caused by oil leaking from pipelines in Azerbaijanian
- Several fully automatic hydrological monitoring stations in Serbia, Spain, Czech Republic, Germany, Austria etc.

Participants

(registered by May 4, 2009)

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Schwede	*Ronnie*	Germany	University of Tübingen
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Spence	*Michael*	United Kingdom	Shell Global Solutions
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Sponsors

HIGRADE

The Helmholtz Interdisciplinary Graduate School for Environmental Research (HIGRADE) is a roof organization for all PhD students of the Helmholtz Centre for Environmental Research – UFZ and joint scholarship holders at six partner universities. HIGRADE aims to provide profound disciplinary knowledge, problem-oriented, interdisciplinary thinking as well as Soft Skills. HIGRADE highly supports networking and provides access to a unique infrastructure.

The educational program of HIGRADE consists of four modules with core curricula in the following fields of research:

- Environmental Toxicology
- Environmental Biogeochemistry and Environmental Technology
- Water Resources and Aquatic Ecosystems Analyses
- Biodiversity and Ecosystem Functions
- Environmental Health
- Society and Environment
- Environmental Modeling and Informatics

The individual PhD students collect credit points from Introductory, Advanced, Transfer-to-Practice and Soft Skill Modules with emphasis on interdisciplinarity. They are highly encouraged to conduct research visits and to present their own research on international conferences with travel funding. Each student has a personal supervision team of 3-4 representatives who support the elaboration of a personal Career Development Plan.
HIGRADE intends to optimally prepare the PhD students for a future career as decision-makers in environmental research, management, technology development, policy or education.

www.higrade.ufz.de

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

FH-DGG

The technical section hydrogeology wants to encourage the communication and collaboration between experts from different disciplines devoted to the exploration and practical utilization of ground water resources. The technical section Hydrogeology conceives itself as a forum for science and practice of hydrogeology.

Tasks of the technical section Hydrogeology include:

- the implementation and promotion of conferences and training courses related to hydrogeology and neighbouring geoscientific sub-disciplines;
- the dissemination of technical information, in particular the publication of the scientific journal "Grundwasser";
- collaboration with related national and international professional associations; working on hydrogeological relevant standards, rules, and working materials.

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FH-DGG

Helmholtz Centre for Environmental Research - UFZ

The **Helmholtz Centre for Environmental Research - UFZ** was established in 1991 as the first and only centre in the Helmholtz Association of National Research Centres (Helmholtz Association) to be exclusively devoted to environmental research in a great variety of fields. It currently employs around 950 people studying the complex interrelationships between humans and the environment and develops tools and strategic concepts for policy makers, the economy and society. They aim to contribute to creating a balance between economical and societal development and long-term protection of our natural resources. The UFZ has a strong focus on interdisciplinary research involving ecologists, social and legal scientists, and economists.

Michigan State University

Michigan State University (MSU) was founded in 1855 and has over 46,000 students and 10,000 employees. The Hydrogeophysics research group at MSU focuses on data acquisition and physical models for subsurface parameter estimation, in particular related to hydrology, geological hazards, and geotechnical and lithological properties. This group also evaluates the influence of human activities on the water cycle through changes in climate and land use, develops novel methods to characterize the aquifers that store and transmit water supplies critical to human and ecological health, and helps develop methods to clean contaminated aquifers using emerging technologies such as bioremediation. Much of the group's research has been done in interdisciplinary teams that span areas of hydrogeology, geochemistry, microbiology, geophysics, civil engineering, and ecology.

Kansas Geological Survey, University of Kansas

The Kansas Geological Survey is a research and service division of The University of Kansas. Created in 1889, the Survey studies the geology of Kansas, develops new techniques for exploring and analyzing geologic data, and produces maps, reports, and scientific papers. The Survey currently employs more than 80 researchers and technicians engaged in a variety of geosciences-related activities. The Geohydrology Section of the Survey conducts both fundamental and applied research on hydrologic and hydrogeochemical systems ranging in scale from site-specific to the river basin and regional aquifer level. Present areas of research include: physical, stratigraphic, and geochemical characterization of sedimentary aquifer systems; surface-water/ground-water interactions; ecohydrology of riparian corridors; spatial data analysis/geostatistics; assessment of recharge and sustainable yields in complex hydrologic systems; simulation of aquifer dynamics; technology for subsurface characterization; and contaminant transport and source identification.

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

MOSAIC

Research Platform MOSAIC (Model-Driven Site Assessment, Information & Control)

For different environmental and hydrogeological problems, a detailed knowledge of subsurface structures (including geometry and relevant parameters) and processes is an important prerequisite for the understanding and the solution of the specific problem. Problem examples are the management of water resources, the management of contaminated megasites and the evaluation of building grounds.

Commonly, boreholes and geophysical surface measurements are used for subsurface investigations. In case of boreholes, information can be obtained from cores and geophysical logging. Typically, borehole data have high vertical resolutions, but suffer from a lack of information in lateral directions between the boreholes. This gap can be bridged by the application of geophysical surface measurements which can provide horizontally continuous information. However, due to physical reasons the vertical resolution of surface methods decreases with depth. A further possibility for the exploration of sites is the use of Direct Push (DP) technology (also known as “cone penetration testing” or “direct drive technology”). This technology refers to a growing family of tools used for performing subsurface investigation by pushing and/or hammering small-diameter hollow steel rods into the ground and delivers vertical profiles with a high resolution up to depth of 50 m. For a satisfying geological and/or geotechnical, cost-effective exploration of the subsurface, a combination of the different methods is necessary.

With the aim to combine the different methods for a problem oriented, rapid site characterisation, the UFZ Centre for Environmental Research creates the new research platform MOSAIC (**Mo**del-Driven **S**ite **A**ssessment, **I**nformation & **C**ontrol). The platform comprises a mobile and modular data acquisition and evaluation unit for adaptive and modeling-based field investigations. It contains vehicles equipped with direct push drilling devices in combination with geophysical measuring techniques, borehole logging equipment, equipment for hydrogeological and geotechnical investigations as well as a GIS-based data visualization and communication unit. MOSAIC should be applicable for the high resolution 3D near surface (approx. 50 deep) characterization of sites with a size of up to square kilometres. With this aim and the instrumentation, MOSAIC offers new possibilities for research on exploration and monitoring techniques. Examples are the combination of methods with different spatial resolution and dimension of investigation, development and evaluation of adaptive problem oriented site investigation strategies as well as of new exploration/monitoring methods, optimization of environmental monitoring networks and the development of effective methods for the determination of site specific rock parameter relationships.

Contact: Peter Dietrich - mosaic@ufz.de

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

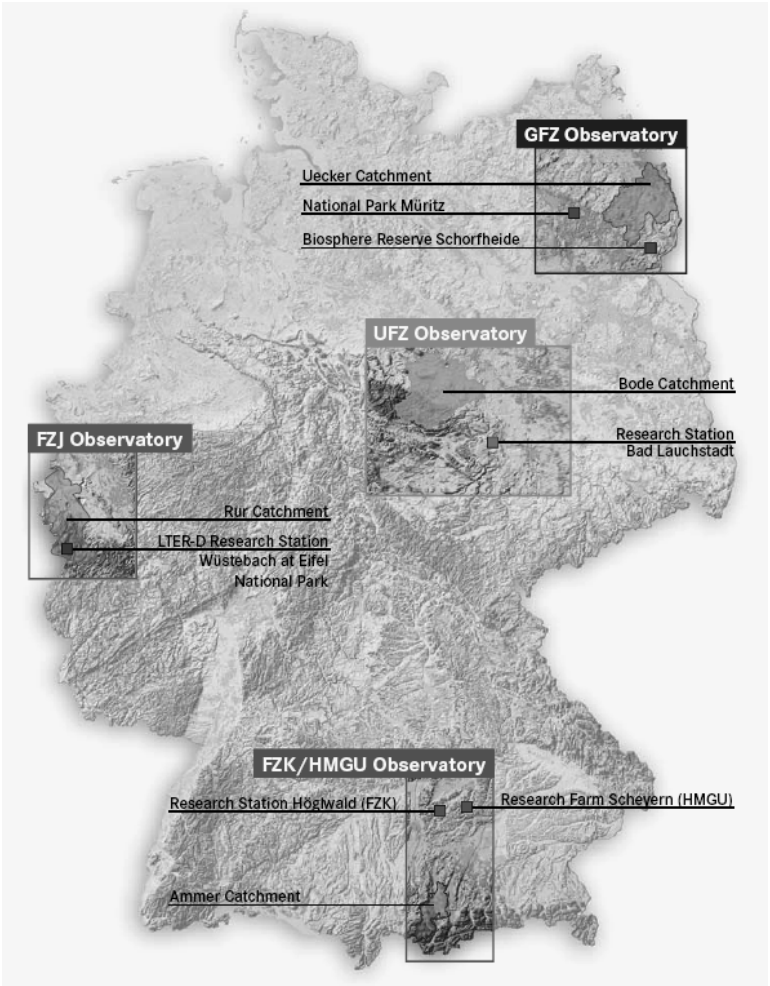
FH-DGG

HIGRADE

TERENO

(TERrestrial ENvironmental Observatories)

Climate change and land use changes are key factors of global environmental change which have to be managed by the society in the next decades. Global changes in terrestrial systems take place on different spatial and temporal scales. The challenges for environmental research are immense. Therefore, long-term operated “Global Change Observatories” for monitoring, analysing and predicting changing state variables and flues within different environmental compartments are of special importance. The infrastructure activity TERENO, a research initiative of the Helmholtz Association, aims to establish an observation platform linking observatories in different climate and managent sensitive regions.



- Studying the long-term influence of land use changes, climate changes, socioeconomic developments and human interventions in terrestrial systems
- Providing long-term environmental data in a multi-scale and multi-temporal mode
- Multi-scale analysis of interactions and reactions between the environmental compartments soil, vegetation and atmosphere
- Development of new model concepts and scaling methods for the evaluation of effective parameters, fluxes and state variables for different scales.
- Bridging the scale discrepancy between measurement, model and management

http://www.tereno.net
Contact: Steffen Zacharias
tereno@ufz.de

“What makes TERENO so special is its observatory overarching coordination of approaches and analysis of results – from local to regional level.”
Peter Haschberger (DLR)

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

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HIGRADE

MADE

THE MADE SITE – A NATURAL OBSERVATORY for transport studies

Field studies at well-instrumented sites have played a preeminent role in our efforts to better understand and characterize solute transport processes in geologic media. In particular, several field tracer tests conducted at well-known sites, such as the Borden site in Ontario, Canada, the Cape Cod site near Boston, Massachusetts, and the MADE site in Columbus, Mississippi, have provided essential insights and extensive data sets for development and testing of transport theories and mathematical models. Of these sites, the one that is continuing to perplex and inspire the groundwater transport community is the site located in Columbus, Mississippi, commonly known as the Macro-Dispersion Experiment (MADE) site. Since the mid-80s, the data collected at the MADE site has been extensively used by numerous researchers around the world to gain new insights into transport processes in highly heterogeneous aquifers. It has also served as a catalyst for development of new and improved theories and computer models to enable more accurate description and prediction of contaminant transport and remediation. Several research projects are currently on-going at the MADE site to achieve more fundamental understanding of transport processes controlled by preferential flow paths processes and to develop new characterization and parameterization approaches.

SAFIRA II

In the framework of **SAFIRA II** research programme, lead-managed by the UFZ, scientists develop technical solutions and management concepts for the revitalisation of megasites. Based on a step-by-step approach, innovative technologies and large-scale technical devices are applied to investigate extensive and complex contaminated areas. Acquired data is fed into a conceptual site model that shows the three dimensional distribution of contaminants in the sub-surface. Thus the decision on the need of remedial actions and the determination of appropriate measures can be facilitated. Over the years UFZ researchers refined a number of different remediation methods, such as using radio waves to heat the soil or the use of enhanced natural attenuation processes. Eventually, it is important that the performance of remediation measures and their result are monitored. For that purpose there is a number of different integrated and high resolution monitoring methods available.

Contact: Prof. Dr. Holger Weiß - holger.weiss@ufz.de

TASK

TASK Leipzig – The Centre of Competence for Soil, Groundwater and Contaminated Site Revitalisation

The TASK initiative (Terra-, Aqua- & Site Remediation Competence Centre and Network) was funded in 2007 under the direction of the Helmholtz Centre for Environmental Research - UFZ and the German Ministry of Science and Education (BMBF) within the scope of supporting the widespread use of emerging knowledge and new technologies in contaminated land management. TASK intends to establish itself as an international focal point in the field of soil & groundwater remediation and land revitalisation and endeavours to disseminate existing national and international knowledge and experience. TASK consists of an UFZ-based competence and coordination centre and a network of internationally accepted experts in the field of soil and groundwater remediation technologies.

Based on an analysis of already funded research products (concepts and technologies), as well as the situation at the market, TASK identifies research products of high innovation potential. Such products are for example: methods and technologies, models, software tools, management strategies, guidelines and standards. Supported by the network of experts (i.e. experienced scientists and representatives of industry and administration), TASK will then conduct technology transfer measures for selected technology lines and concepts. These measures include:

(i) Exhibition of technologies at annual product fairs;

(ii) Organisation of workshops and expert panels;

(iii) Set-up of recommendations for policy makers;

(iv) Networking and teaching activities as well as;

(v) Product demonstrations at field sites.

The planning and implementation of the work packages is conducted by the expert teams under the direction of the TASK coordination office. In most cases, subcontractors such as engineers, technicians, product developers and representatives of administration will support the TASK office during the implementation of the supporting measures. Measures are implemented according to previously developed business plans. Recommendations from the TASK scientific-technical advisory body (WTB) are considered. A focus of the TASK project will also be on eastern European countries. About 8 to 10 expert teams (and thus, product lines) are going to be appointed each year.

Contact: Martin Bittens - kontakt@task-leipzig.info

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

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HIGRADE

Social Program

Welcome Reception

Date: May 12, 2009
Time: 18:00-20:00
Place: Restaurant "Auerbachs Keller" Leipzig.

The Welcome Reception is open to all conference participants and gives you the opportunity to meet the other conference participants at a very famous location in Leipzig, the ***"Auerbachs Keller".*** The Auerbachs Keller is the best known and second oldest restaurant in Leipzig, well recognized thanks to Wolfgang von **Goethe** who mentioned this restaurant in his play Faust I.

At the reception you will receive your conference materials, drinks and some fingerfood. The reception is an informal and highly interactive environment that gives participants the opportunity to engage with one another in discussions about relevant, ongoing work and critical issues in key areas.

The welcome reception is included in the conference registration fee.

Further information: http://www.auerbachs-keller-leipzig.de/

Buffet

Date: May 13, 2009
Time: 19:00-21:30
Place: *Foyer Leipziger KUBUS (Free of charge)*

Conference Dinner

Date: May 14, 2009
Time: 19:30-22:00
Place: *Bayrischer Bahnhof*

The **Bayerische Bahnhof** was built in 1842 and thus being the world's oldest terminus has been the starting point for a flourishing trade in the region.

Today again the Bayerische Bahnhof is worth visiting: a place of unforgettable gastronomic and culinary delights and a brewery home for Leipzig's original beer specialty, the Gose.

Fee: €30 Euros. Registration is required.
Further information: http://www.bayerischer-bahnhof.de/old/index.php4?target=english

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

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HIGRADE

Excursion to Freiberg
Reiche Zeche and Terra Mineralia

Date: May 16, 2009
Time: 8:30 – 17:30

The transfer and sightseeing tour are included in the conference registration fee.
Entrance fees need to be paid by each participant.

Freiberg is considered to be one of the "secret jewels" of the region.

The ***Reiche Zeche*** mine at Freiberg it a part of a mining complex called "Himmelfahrt Fundgrube" that dates from the 14th and 16th centuries. The whole complex is estimated to be 100 km long, but only 14 km on four levels and up to 230m deep have been explored. During the last mining period from 1950 to 1969 the shaft Reiche Zeche (Rich Pit) was used to lift the ores and the shaft Alte Elisabeth was used for ventilation. The surface around Alte Elisabeth shows a large complex of mining buildings from the 18th century. There are several routes through the mine. One tour shows the mining of the 19th and 20th century at a depth of 150 metres. Another tour shows the mining of the 14th to 16th century. The passages in this part were mined mainly by hand. On the surface at the Reiche Zeche is a mining museum with machinery, tools, and an impressive mineral collection.

Today, Freiberg holds the oldest university of mining and metallurgy in the world (1765): the TU Bergakademie Freiberg and the mine is still used as an experimental mine for its students in the areas of mining, surveying, geophysics, geology, mineralogy among others.

The inauguration of the exposition **"*Terra Mineralia*"** in October 2008 in the Freudenstein Castle located in the heart of the historic centre got an enormous interest of the national and international media. "Terra Mineralia" – this sounds as it must have something to do with minerals and stones and in fact it is true in the wider sense. But what one can see there are impressive masterpieces of nature.

In Freiberg you find the greatest and probably the most beautiful collection of mineral samples in the whole world. Experience more than 5000 miracles of nature: minerals, jewels and meteorites, shown in a unique atmosphere of a historic castle awake from a state of hibernation.

Welcome to Leipzig

Media, Trade Fair and University City!

Sightseeing tour

Date: May 15, 2009
Time: 18:30 – 20:00
Meeting point: Leipzig Tourist Information Center
(Richard-Wagner-Str. 1, opposite site of Leipzig Central Station)

Leipzig is one of the biggest cities in Central Germany and with its 512,000 inhabitants the biggest city of Saxony. Officially founded in 1165, Leipzig is internationally acknowledged for its trade fairs, which have been organized since medieval times. The city is also home of **one of Europe's oldest universities**, founded in 1409. Some of the most famous Germans are affiliated with the University like the writers **Goethe and Lessing**, the philosophers **Leibniz** (also a famous mathematician) and **Nietzsche** or the scientists **Heisenberg and Hertz**. Fine arts, especially music have a very important place in the city's culture and history. Besides the University of **Music and Theatre** founded by Mendelssohn and the **Gewandhaus**, the gothic-style, **St. Thomas Church** is one of the most important musical centres of the city, as it was a place of inspiration to the composer **Bach** for several decades. In the course of history Leipzig has been a place of many important events. It played an important role during the Reformation, the Napoleonic wars and during the German reunification. The city was home to the first daily newspaper published in Modern Europe (1650) and many **publishing houses.**

Noteworthy sights:

***Battle of Nations Monument** was built to commemorate a victory against Napoleonic troops*

***St. Thomas Church** was a place of inspiration to Johann Sebastian Bach*

***St. Nicolas Church** was the starting point of peaceful demonstrations for a reunited Germany*

German Federal administrative court

*Old and new **city hall***

Opera house** and **Gewandhaus

*Leipzig **Central Station** is one of Europe's largest stub terminals*

***City houses** in Wilhelminian-style architecture.*

Animal Park

*Central **Stadium** and sports complex*

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

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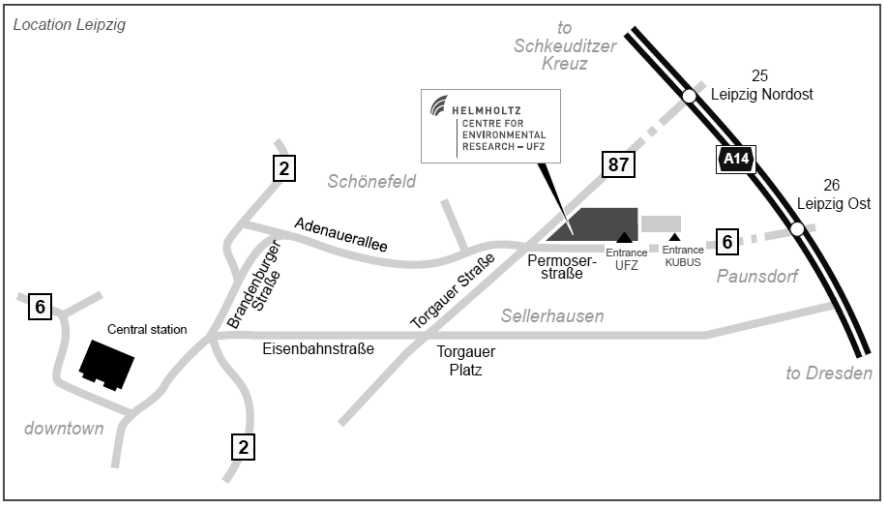
Important information for your stay

How to reach UFZ Leipzig

Helmholtz Centre for Environmental Research (UFZ)
Permoserstraße 15
D-04318 Leipzig,
Germany



By bus

From Leipzig Central Station to UFZ: please take tram no. 13 (direction "Taucha") or no. 3 (direction “Sommerfeld”) till stop “Permoserstraße/Torgauer Straße" (about 12 min, 7th stop).

By taxi

A taxi from Leipzig Central Station to the UFZ will cost about €10.
The fare from Leipzig-Halle Airport is about €30.

How to move in Leipzig

Public transport

Public transport is operated by LVB (www.lvb.de), which runs an information kiosk (8am-8pm Mon-Fri, 8am-4pm Sat) outside the Main Train Station (Hauptbahnhof). The central tram station is here as well. The S-Bahn circles the city’s outer suburbs. Single tickets cost €1.40 for up to four stops and €2.00 for longer trips; day passes are €5.20. Recommended is to buy a 4 journey-ticket €7.60.

The sale of tickets for buses and trams are available from ticket machines. ***Important:*** ticket machines on buses and trams can only be operated by coins. Please remember you have to ”punch” your ticket in a time-stamp/ticket-cancelling machine (”Entwerter”) at bus stops or on board buses or trams.

Taxi

Funktaxi (0341.600 500) and Löwen Taxi (0341.98 22 22) are the main local firms. There is a €1.90 km-rate (1. und 2. km) and then it’s €1.25 per kilometre (day rate).

Others

Medical services

After-hours emergencies (0341.192 92; 7pm-7am)
Klinikum St Georg (0341.9090; Delitzscher Strasse 141) Take tram 16 to this hospital.
Universitätsklinikum Leipzig (0341.971 7300; Liebigstrasse 20) Hospital and clinic.

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ
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Abstracts - Oral Presentations

Session 1: Innovative Site Characterization *(May 13, 9:55- 10:35)*

Title: Geophysical well logging searching for fractures having significant role for ground water flow in crystalline rocks

Author(s): S. Mareš[1], M. Kobr[1], J. Urik[2], J. Lukeš[2], J.H. Williams [3]

Institution(s):
[1]Charles University in Prague
[2] Aquatest a.s., Division of logging
[3] U.S. Geological Survey

Abstract
For identification of individual fractures as well as fracture zones in the borehole profile, following logging methods can be used: formation resistivity logs (fractured zone are indicated by low resistivity values in the range decades or hundreds of Ωm), formation density log (fractured zones are indicated by low density values), neutron porosity log (fractured zones are indicated by higher Hydrogen index) and acoustic or ultrasonic log (fractures indicated by lower values and higher attenuation of elastic waves). For estimation of hydraulic properties (hydraulic head and transmissivity) of individual fractured zones in single wells, it is necessary to measure vertical flow rates in the well under two different hydraulic conditions, e.g. a) under natural ambient conditions and b) under the pumping test in the steady state flow conditions. Down hole impeller flowmeters have the threshold sensitivity limit W = 2 mm/s, corresponding to vertical flow rate Q' > 0.01 l/s in boreholes with diameter d = 0.1 m. If vertical flow rates are below this limit, it is necessary to use the tracer technique, i.e. to measure a series of fluid logs after the tracer application in different time intervals from the start of the hydraulic test. In that case, it is possible to estimate vertical flow rates as low as 10–3 to 10 – 4 l/s. Logging of a single borehole offers valuable information on the formation medium (fractures frequency and hydraulic parameters) in the near to borehole space with the radial extent not exceeding first meters (Le Borgne et al., 2006).

The tendency to get information on hydraulic properties and the structure of the fracture zone from a wider region around the borehole (e.g. decades of meters) needs to verify the fracture zone by two or more boreholes. The recent procedures are based on a special tracer test organized between the boreholes. In one of the boreholes, water containing the tracer is injected into the selected fracture zone (separated from the total borehole space by packers), in the second borehole the entry of traced water is estimated using a logging tool sensitive to the tracer concentration (Lukeš 2005). In such a test, the direct connection of the fracture systems between both these two boreholes is documented. These techniques are time consuming and very expensive, especially if greater number of insulated fractures or fracture zones is present in the studied depth interval.

From that reason, Paillet (1998) proposed a more appropriate approach to the determination of hydraulic properties (hydraulic head, transmissivity, storage) of fracture zones. It is based on special test in the couple of boreholes; i.e. a short hydraulic test (20 to 40 minutes) in one of the boreholes and documentation of the flow response (induced water flow) in the second (monitoring) borehole using high resolution flowmeters. This approach has been checked and successfully verified at two localities (Williams and Paillet, 2002; Le Borgne et al., 2006). We are presenting the application of this technique in a couple of bore holes, situated in fractured granitic massif of the Bohemian–Moravian Highland, where also the packer test has been realized (Lukeš, 2005). The pulse heat flowmeter has been used with the aim to document the induced water flow (transient flow response) in selected depths of the monitoring borehole during short hydraulic tests in the pumped borehole. The proposed methodology has great practical advantage, no expensive pressure test and special sealing technique (packers) is necessary what saves time and money.

Title: GPR, a Method for Exploration and Monitoring of Coal Fires in China

Author(s): V. Gundelach

Institution(s): Federal Institute for Geosciences and Natural Resources

Abstract
Due to the climate change it is a global task to fight against gas emission of coal fires. In China exists many burning coal seams which should be extinguished. A Chinese-German initiative tries to find new technologies and solutions to control these fires. Most of the fires are close to the surface in arid areas. In that case GPR is a possible geophysical method to get detailed information about the structure of the soil. Mining activities and the burning coal are leaving voids which collapse or still exist as dangerous areas. With GPR it is possible to detect voids and clefts. Crevices are potential paths for oxygen transport from the surface to the fire. The knowledge of these structures would help to extinguish the fire. The heat of the burning coal changes the permittivity and the conductivity of the rock. This affects the radar signal and makes it possible to separate burning zones from intact zones. Monitoring of the burning zones helps to find optimal solutions for fire extinguishing strategies.

In the years 2007 and 2008 three field campaigns were made in China. The first campaign was in the province Xinjiang with a 50 MHz system from Mala on a steep dipping coal seam. The other campaigns were in the province Inner Mongolia with 40 MHz to 200 MHz antennae from GSSI on shallow dipping coal seams. The experiences from these measurements will be shown. The surveys were collected in rough terrain. The data from the unshielded antennae contained a lot of effects coming through the air. The limits of detecting crevices with GPR will be demonstrated. Some parts of the measurements over burning coal were influenced by strong anomalies of the magnetization. Modeling of the radar signal helps at the interpretation. Parts of the interpretation from the surveys can be validated by the outcrop of the investigated structures. The border of the fire line can be determined. A spatial visualization of the results is the basis for discussions.

Session 2: Long-Term Monitoring *(May 13, 9:55- 10:35)*

Title: Development of a passive sampler for qualitative and quantitative soil air measurements: preliminary results

Author(s): I.Van Keer, E. Goelen, J. Bronders, M. Spruyt, M. Stranger, A. Borburgh, D. Poelmans & J. Provoost.

Institution(s): VITO (Fliemish Institute for Technological Research

Abstract
Soil gas sampling, a screening tool to rapidly and cost effectively identify and delineate VOCs in the subsurface, involves the collection of gas samples at shallow depths (50-150 metre below ground surface). Although passive sampling has several advantages compared to active sampling (e.g. time integrated measurements, identification of broad range of contaminants, effectiveness in wet and low permeable soils), it can only be used for qualitative measurements. Within the soil there are no convective fluxes which guarantee a constant uptake rate of contaminants. As a consequence, results obtained by passive sampling devices cannot be used in risk assessment studies.

To get quantitative data using a passive soil sampler, the patent pending VITO sampler on ambient and indoor air has been adapted in such a way that soil gas can be sampled at reduced uptake rates and zero face velocity.

According to a feasibility study it is possible to measure reproducible concentrations of toluene with a reduced uptake rate, when there is no face velocity over the samplers membrane. With zero face velocity and toluene concentrations ranging between 3-64 mg/m³ a reduction of 20-30% of the uptake rate was observed in comparison to the original configuration of the passive sampler (i.e. without reduced uptake rate and a face velocity of 40 cm/s). Thus, theoretically it would be possible to use the adapted VITO passive sampler for the measurements of toluene in soils.

Title: Mass Flux Determination at a Tar Oil Contaminated Site Using Passive Sampling Devices

Author(s): Norbert Hüsers[1], Peter Börke[2], Carsten Leibenath[3], Peter Werner[1]

Institution(s):
[1] TU Dresden, Institute of Waste Management and Contaminated Site Treatment
[2] Saxon State Ministry of the Environment and Agriculture
[3] Umweltbüro GmbH Vogtland

Abstract
The concept of control planes for quantification of natural attenuation (NA) processes at contaminated sites has been lately intensively discussed. These control planes are used to determine the mass fluxes of contaminants in the subsurface at different locations along the plume, hence a minimum of two planes required. Furthermore, information needed include geological settings, ground water flow direction and distribution of contaminants. Usually these data can be obtained from standard site investigation including ground water monitoring. Unfortunately, it was not possible to apply this approach to a tar oil contaminated site located in Saxony, Germany. The concentration of PAHs and other substances presented high variations over time at several monitoring wells of the site which is typical of tar oil contaminated sites. This makes it difficult to obtain consistent data for mass flux calculation. Therefore, usually further investigations for mass flux calculations are necessary.

Two different types of single-borehole tests were performed to determine the groundwater flow velocities at the site. The Groundwater-Flow-Visualization (GFV) system (Phrealog, Germany) allows continuous monitoring of groundwater flow velocity and direction of flow within single wells without any artificial flow markers. The flow velocity has been additionally obtained by fluid logging using a salt tracer. The collected data showed a highly complex hydraulic system with a watershed down gradient the source area. As a consequence, not only the flow velocity but also the flow direction has been highly influenced by the groundwater level. It was obvious that this had a huge effect on the distribution of contaminants within the plume.

The problem with the fluctuating concentration of contaminants has been overcome by installing non-equilibrium passive sampling devices (ceramic dosimeter and a new developed "mass flux meter"). These devices were left in several monitoring wells for weeks and even months and they collected organic substances by adsorption without reaching apparent equilibrium. As a result one could quantify the mass of contaminant passing along the respective monitoring well.
Financial support for this study was provided by German Federal Ministry of Education and Research, BMBF (project: KORA; 02WN0364 and 02WN0365).

Session 3: Innovative Site Characterization *(May 13, 11:55- 12:55)*

Title: LIF Sensors for in situ NAPL Characterization - Potentials and Limits

Author(s): M. Neuhaus

Institution(s): Fugro Consult GmbH

Abstract
Currently available LIF sensors like ROST, UVOST and TarGOST will be presented and monotonic or non-monotonic signal behaviour towards different contaminant types will be discussed.

Title High Resolution Site Characterization with Direct Push Optical Screening Tools

Author(s): Randy St.Germain

Institution(s): Dakota Technologies

Title: Hydraulic Conductivity Estimates Using the Hydraulic Profiling Tool (HPT)

Author(s): T. Christy and W. McCall

Institution(s): Geoprobe Systems

Abstract
The Hydraulic Profiling Tool (HPT) is a simple direct push logging tool developed by Geoprobe Systems (Kansas, USA). The main purpose of the tool is hydrostratigraphic profiling in unconsolidated soils. The HPT uses a down-hole transducer to measure the pressure required to inject a constant flow of water through a wire mesh orifice in the side of a percussion driven probe. Typical flows during logging are 200 to 400 ml/m and injection pressures can range as high as 690 KPa. In present practice, the injection pressure log from an HPT sounding is used by site investigators to determine relative permeability; high injection pressures are indicative of fine grained zones and low injection pressures indicate zones of high permeability that would serve as contaminant transport pathways. The problem is that while it relatively easy to use HPT logs to visually identify potential transport pathways and differentiate these from zones of low hydraulic conductivity, no numerical estimate of hydraulic conductivity can presently be made from HPT logs.

This presentation will describe work by the authors to develop numerical methods to estimate formation hydraulic conductivity from HPT injection pressures and flows. To do this data is examined from multiple sites where HPT logging was performed adjacent to slug test measurements over discrete intervals. In addition, several logs and offset slug test measurements were performed for the specific purpose of developing a hydraulic conductivity correlation for the HPT tool.

Results of this study indicate a positive correlation between the HPT Q/P ratio and K determined from the discrete interval slug tests. A general model will be presented which allows for order-of-magnitude estimates of K based on the Q/P ratio. Strengths and limitations of this model will be discussed.

Session 4: Long-Term Monitoring *(May 13, 11:55- 12:55)*

Title: Tree core sampling for site investigation and monitoring of subsurface contamination

Author(s): O. Holm, W. Rotard

Institution(s): Institute of Environmental Technology, Technische Universität Berlin, Germany

Abstract
Tree coring may offer a rapid and cost-effective possibility for screening investigations at contaminated sites. Respective methods, i.e. using tree core samples to screen and monitor groundwater contamination, were tested at a former military site near Berlin, Germany, which is contaminated mainly with chlorinated solvents and fuel contaminants.

Preliminary investigations at the site and adjacent wetlands proved the existence of trichloroethylene (TCE) and the metabolic product cis-1,2-dichloroethylene (cDCE) in plant tissue of reed and different trees species. Thus, tree coring revealed appropriate for monitoring these contaminants in groundwater at the studied site, which is characterised by shallow aquifers. However, various factors were found to significantly influence the observation of contaminants in trees, such as sampling location within the stem, weather and day time. Due to low variation of water content and nearly constant dry weight of taken plant samples, a semi-quantitative scale referred to analysed peak areas was preferred to point out contaminant distributions.

Tree coring was then carried out along a wide-meshed grid (100 x 100 m) covering the whole site of approx. 120 ha, and in adjacent wetlands. Samples were analysed in laboratory using gas chromatography/mass spectrometry (GC/MS) in combination with Solid-Phase-Microextraction (SPME). Areas of TCE and cDCE contamination could be identified in correspondence to a Direct-Push-based groundwater sampling campaign performed in parallel, showing a good correlation for moderate and high concentrations. Furthermore, contaminant distribution in the adjacent wetlands (inaccessible for DP equipment) could be delineated by tree core sampling. The observed distribution patterns of TCE and cDCE in the wetlands reflects microbial degradation activity in plume fringes, where cDCE is dominating over TCE.

Title: Membrane based measurement technology for in-situ monitoring of gases in soil

Author(s): D. Lazik, S. Ebert, J. Hagenau and H. Geistlinger

Institution(s): Helmholtz Centre for Environmental Research – UFZ, Halle, Germany

Abstract
The representative measurement of gas concentration and fluxes in heterogeneous soils is one of the current challenges when analysing the interactions of biogeochemical processes in soils and global change. Therefore, a measurement method based on selective permeation of gases through tubular membranes has been developed. Combining the element-specific diffusion rates for a membrane set and Dalton's principle, the gas concentration (or its partial pressure) can be determined by the measurement of physical quantities (pressure or volume) only. Due to the comparatively small diffusion constants of the used membranes, the influence of the sensor to its surrounding can be neglected. The design of the sensor membranes can be optimized scale-dependently for the representative measurement from bench scale to landscape scale. Furthermore, a continuous time-averaged measurement is possible where the time constancy for averaging corresponds simply to the wall-thickness of the membrane used.

The measuring method is demonstrated for continuous monitoring of O_2 and CO_2 inside of a sand filled Lysimeter. Using three monitoring planes which were installed normal to the gas flow direction and a reference measurement system, we demonstrate the precise in-situ gas-detection for different flux-based boundary conditions.

Title: Passive Samplers for the Measurement of VOC Mass Fluxes in Groundwater

Author(s): G. Verreydt[1,2,3], J. Bronders[1], I. Van Keer[1], L. Diels[1,2], P. Vanderauwera[3]

Institution(s):
[1]VITO (Flemish Institute for Technological Research)
[2]University of Antwerp
[3]Artesis University College of Antwerp

Abstract
The measurement and interpretation of mass fluxes instead of concentrations is gaining more and more importance, especially in the frame of large scale groundwater contamination. Traditional methods for estimating contaminant fluxes and discharges involve individual measurements /estimations of the Darcy water flux and the contaminant concentrations. However, under spatially and temporally varying hydrologic conditions in complex, heterogeneous aquifers, significant uncertainty is propagated from such indirect estimation of contaminant fluxes. Therefore, recent studies are focused to the direct measurement of mass flux using passive sampling devices.

To evaluate the prospects and limitations of direct flux measurement with passive samplers, a research project has started at VITO (Flemish Institute for Technological Research) since January 2008. The goal of the project is:

- to investigate the performance of a selection of passive samplers available on the market and that are considered to be eligible for the (in)direct capture of mass fluxes;
- to implement the results in the larger context of groundwater management.

Chlorinated solvents are chosen as the target compounds because of the large scale and the complexity of groundwater pollutions with these contaminants.

A first screening of existing passive samplers, potentially applicable for the measurement of VOC mass fluxes in groundwater, has been made. This resulted in the selection of the Passive Fluxmeter, the Ceramic Dosimeter, the Sorbisampler and the MESCO sampler for a lab-scale performance screening. The Passive Fluxmeter, a permeation-based passive sampler, is the only passive sampler that allows direct measurement of cumulative mass fluxes. Concerning the other samplers, mostly diffusion-based, the impact of the groundwater flow rate on the contaminant uptake rate should be precisely investigated. In case of a linear influence within the natural variations of the groundwater flow rate, a mass flux may be derived.

Session 5: Innovative Site Characterization *(May 13, 14:45- 16:05)*

Title: High-Resolution Characterization of Spatial Variations in Hydraulic Conductivity with Direct-Push Technology: The MADE Site Field Assessment

Author(s): G. Liu[1], J. J. Butler[1], Jr., G. C. Bohling[1], E. Reboulet[1] and S.Knobbe[2]

Institution(s): [1] Kansas Geological Survey, University of Kansas, Lawrence, KS
[2] Direct-push consultant, Salina, KS

Abstract
Previous field and modeling investigations have demonstrated the promise of the direct-push permeameter (DPP) and the direct-push injection logger (DPIL) for high-resolution characterization of the vertical distribution of hydraulic conductivity (K) in shallow unconsolidated aquifers. The DPP is a small-diameter tool with a short cylindrical screen and two pressure transducers incorporated into a direct-push rod. The tool allows for rapid performance of a series of short-term injection tests at a given depth in an aquifer. The K estimate for that depth can be obtained through analytical or numerical analyses of the injection tests. The sensitivity of a DPP test is focused very strongly on the material in the immediate vicinity of the tool, leading to significant uncertainty regarding K variations between test depths. In addition, due to limitations of the tool design, the prototype DPP tool cannot resolve heterogeneous features smaller than the interval between the injection screen and the most-distant transducer (36 cm). Although the DPP is much more time efficient and accurate in comparison to other approaches for characterization of vertical variations in K (e.g., slug testing), each test sequence does require 10-15 minutes for a reliable K estimate to be obtained in a relatively permeable interval.

The DPIL is a simpler tool consisting of a short screen element mounted on a direct-push rod. Water is injected through the screen while the pressure response is monitored either behind the screen or at the surface. The injection logging process can be conducted continuously as the tool is advanced or in a discontinuous mode involving halt of advancement for a brief period during which the injection rate is varied. The injection-induced pressure profile, normalized by the injection rate, reflects the vertical variation in K. The DPIL approach in the continuous-advancement mode provides very rapid and highly detailed information on K (typically less than 30 minutes for a 10-m profile at 0.015-m depth increments). However, site-specific relations must be developed to transform the DPIL flow/pressure ratios into actual K estimates.

In this presentation, we explore the power of coupling the DPP and DPIL into a single tool. This new tool, which has the outward appearance of the original DPP, enables water to be injected through both transducer ports and the injection screen. During advancement the injection rates and pressure responses are monitored continuously at both transducers, i.e. the tool functions in a continuous DPIL mode. Upon reaching a desired depth, advancement ceases and injection tests are performed as with the original DPP tool. Using a numerical procedure, the DPP test data is used to condition the highly detailed DPIL flow/pressure ratios measured at the transducer ports to develop a relationship for transforming the high-resolution DPIL information into K estimates. As part of a multi-institutional research project directed at the development of new technology for the high-resolution characterization of extremely heterogeneous formations, a total of 11 coupled DPP/DPIL profiles were obtained recently at the extensively studied MADE site on Columbus Air Force Base in the state of Mississippi. Despite the extreme heterogeneity at the site, a single power relation can be used across the site to transform the DPIL flow/pressure ratios into K estimates at a 0.015-m resolution. Results indicate that, through the coupling of the DPP and DPIL techniques, hydraulic conductivity information can potentially be obtained at an unprecedented high resolution and speed under extremely heterogeneous site conditions.

Title: Determination of the hydraulic conductivity using the Direct-Push Injection Logger

Author(s): U. Schneidewind[1], S. Lessoff[2], P. Blum[3], C. Leven-Pfister[3], P. Dietrich[1],

Institution(s):

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[3] University of Tübingen, Centre for Applied Geoscience (ZAG), Tübingen, Germany

Abstract
The hydraulic conductivity K is one of the parameters of main interest and the basis for describing flow and transport in aquifers. In many cases a level of detail is required regarding K that can hardly be achieved with conventional hydrogeological tests. Over the last 15 years, the Direct-Push (DP) technology has been developed for shallow unconsolidated aquifers as a means of rapidly obtaining information on aquifer parameters in the absence of classical monitoring wells. Some of those techniques such as the Direct-Push slug test (DPST) provide absolute hydraulic conductivity values, however are time-consuming. Other techniques such as the Direct-Push injection logger (DPIL) are much faster and allow for a higher subsurface resolution, but only provide relative hydraulic conductivity values (Kr) that have to be transformed into absolute ones. In this work DPIL data was gathered for the unconfined heterogeneous aquifer at Lauswiesen test site in Southern Germany near the city of Tübingen. It was found that the aquifer consists of two zones of different heterogeneity and hydraulic conductivity. In order to gain more information on the hydraulic conductivity, relative K-values from DPIL measurements were correlated with K-values from DPST assuming a linear relationship giving a coefficient of determination of R2 = 0.67. Variogram analysis provide a vertical integral scale of 0.25-0.35 m and a horizontal integral scale of 1.5-3.0 m for ln(Kr) values. Nevertheless, additional work still remains to be done to address the problem of different support scales of the DPST (30-60 cm) and DPIL (2.5 cm) methods.

Title: Direct push injection logs and grain size analyses to assess aquifer heterogeneity

Author(s):A. Musolff[1], M. Falke[2] & M. Schafmeister[2]

Institution(s):
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[2] University of Greifswald, Institute of Geography and Geology, Applied Geology/ Hydrogeology

Abstract
For a numerical transport model within the city of Leipzig, an accurate picture of the aquifers hydraulic conductivity was needed. The study sites fluvial Quaternary aquifer has a mean thickness of 7.5 m. The hydrogeological setup was investigated by the use of ram sounding. From the cores, samples were taken and investigated by sieve analysis. From the grain size-distribution of each sample, the hydraulic conductivity was estimated. Moreover, direct push injection logs (DPIL) were operated. By the use of regression, results were related to the values of the conductivity from the sieve analyses. Two resulting dataset were compared: 1) hydraulic conductivity from the sieve analysis and 2) from the sieve analysis combined with the DPIL-results. We used sequential Gaussian simulations to derive continuous grids of hydraulic conductivity and implemented the results in a groundwater flow model. Results of the sieve analysis revealed a bimodal grain size distribution with middle sands and middle gravels. The hydraulic conductivity ranges from 2*10-5 m s-1 to 9*10-2 m s-1 (mean 8*10-4 m s-1). As a result of the regression, both conductivity datasets are characterized by comparable probability distributions. Nevertheless, different spatially resolved conditioning data yielded different simulated grids. Simulated hydraulic heads were comparable for 1) and 2). On the other hand, breakthrough curves based on conservative particle tracking (from a virtual contamination to a well in a distance of 52 m), varied significantly. While in model 2) breakthrough of first particle was fasted (21 days; d50 65 days), particle in model 1) took much longer (56 days; d50 23.5 days). Although based on the same probability distribution of the hydraulic conductivity, the spatially higher resolved DPIL-dataset revealed a different pattern in particle transport. We hypothesize that the DPIL-technique is more capable to map zones of higher conductivity and connectivity than conventional methods.

Title: Geostatistical Analysis of High-Resolution Hydraulic Conductivity Estimates Derived from Direct-Push Injection Logging at the MADE Site

Author(s): G.C.Bohling[1], G. Liu[1], J. J. Butler[1], Jr. E. Reboulet[1], T. Vienken[2], U. Schneidewind[2]

Institution(s):
[1] Kansas Geological Survey, Lawrence, KS
[2] UFZ, Leipzig, Germany

Abstract
A related presentation (Liu et al.) describes the combined use of the direct-push permeameter (DPP) and the continuous direct-push injection logger (continuous DPIL, also known by the trade name "HPT") to obtain profiles of estimated hydraulic conductivity at a very high resolution. We have applied this technique to obtain K profiles at a 0.015-meter vertical spacing from 11 DPP/DPIL profiles performed at the MADE site in November 2008. These profiles are located in two different areas that are the focus of intensive investigation, a 25- x 25-meter area in the south (Data Cube 1), closer to the injection site for earlier tracer tests, and a 12- x 12-meter area approximately 100 meters to the north of the first one (Data Cube 2). Analysis of 20 additional DPIL-only profiles is in progress. Preliminary analysis of all 11 DPP/DPIL profiles indicates K values ranging over seven orders of magnitude, from about 7 x 10^{-9} to 5 x 10^{-2} cm/s, with a natural log variance of 8.9. Considered alone, the values in Data Cube 2 range from 7 x 10^{-7} cm/s to 5 x 10^{-2} cm/s with a log variance of 6.3. Considered alone, the Data Cube 1 profiles show a log K variance of 11.5. However, the variation in Data Cube 1 is dominated by a strong contrast between low K sediments (~10^{-8} to 10^{-5} cm/s) in the lower portions of the profiles (roughly 10.5 to 12 meters below land surface) and very high K sediments in the upper portions of the profiles. There is strong evidence that the DPIL-based K estimates are truncated at the upper end, especially in the upper portions of Data Cube 1, due to our inability to produce a measurable pressure response in intervals of very high K. The DPP tests performed in those intervals suggest that K values at some levels could exceed 1 cm/s. In addition, there is uncertainty about some of the DPIL-based K estimates at the lower end of the range because these estimates fall outside the span of K values associated with the DPP pressure responses used in the calibration of the DPIL curves. Nevertheless, the DPIL-based K profiles indicate that the MADE site is considerably more heterogeneous than previous investigations have indicated (e.g., an estimate of a log K variance of 4.5 based on analysis of flowmeter profiles across the site). We will also present variogram analysis of the 31 DPP/DPIL profiles obtained in the November 2008 field campaign at the MADE Site, along with more detailed comparisons with the earlier flowmeter data.

Session 6: Long-Term Monitoring *(May 13, 14:45- 16:05)*

Title: Long-Term Groundwater Monitoring in Unconfined Rio Claro Aquifer, Brazil: a Case Study

Author(s): Chang, Hung Kiang [1], Dagmar Carnier Neto [2] and Marco Aurélio Zequim Pede[3]

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Abstract
Groundwater monitoring constitutes an important tool for aquifer management, providing information about the current state and trends of monitored parameters, as well as recording responses to anthropic influences and natural phenomena. Moreover, it makes possible the continued and systematic monitoring of groundwater volume fluctuations, thus allowing a rational management of this resource. Understanding mechanisms that cause water level variation and the ability to monitor this level are critical in recharge quantification studies, whether on the aquifer scale for assessment of water resources and management in general or on the local evaluation and remediation of contaminated groundwater.

This presentation shows the results of six years (2002 to 2008) of detailed monitoring (sampling interval of five seconds) of the water level of the Rio Claro Aquifer in observation wells drilled on the campus of the São Paulo State University in the city of Rio Claro, SP, Brazil. Methods of time-series analysis - Fourier Analysis and Cross-Correlation - were used to verify the natural periodic fluctuations in water level, specifically those resulting from seasonal cycles and earth-tides, and to analyze the temporal relation of rainfall to aquifer recharge, estimating the average time required for infiltration and consequently the average hydraulic conductivity of the non-saturated zone for the area, that can be difficult to obtain owing to its inherent non-linear behavior.

Results show that a detailed monitoring process provides valuable information contributing to a more complete understanding of the aquifer characteristics as well as contaminant distribution. This knowledge should be of direct help in planning for the remediation of contaminated areas, in particular when NAPL are involved.

Title: Prediction of BTEX-plume movement in Elsterwerda (Brandenburg): Application of innovative techniques for groundwater monitoring

Author(s): D. Radny[1], T. Scheytt[1], C. Leven[3], P. Dietrich[2],

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[3]University of Tübingen, Center for Applied Geoscience

Abstract
A railway accident in southern Brandenburg (Germany) in 1997 led to a spill of about 470 t of unleaded fuel and a quaternary aquifer was contaminated with BTEX. Soil excavation and soil vapor extraction, which were conducted immediately after the accident, and pump & treat yielded a recovery of NAPL of about 260 t within the last 9 years. Due to very low recovery rates of NAPL by pump & treat, laboratory researches estimated the site-specific potential for natural attenuation of BTEX as alternative treatment technique. In April 2006, the pumping activity was stopped at the field site. The aim of the shut-off of pump & treat is to determine sorption- and biodegradation-rates under natural conditions.

At the field site, there are 55 2” observation wells with filter screens between 2 and 4 m, which are used for the conventional groundwater monitoring. To evaluate Natural Attenuation processes and to balance electron acceptors and donators at several cross sections, depth oriented hydrochemical information is needed. Therefore, 2 direct-push-campaigns were conducted and 60 depth oriented groundwater samples were obtained by low-flow-sampling. Several 1” observation wells and one CMT (Continous Multichannel Tubing) were constructed. In 4 1” observation wells so called online sondes were installed, which measure water level, temperature and electrical conductivity. The measured data can be retrieved via internet. Additionally, ceramic dosimeters were installed in some of the existing 2” observation wells. This passive sampling technique gives the possibility of long-term, time-integrated monitoring of organic pollutants without changing concentration gradients.
In the presentation we will show results of the different innovative sampling techniques and how these results correlate with the conventional sampling.

Title: Selected problems and solutions of quality assurance in the context of monitored natural attenuation

Author(s): Großmann, J., Laudel, G., Müller, K. , Beyer, M., Voigt H.-J., B. Harpke and C. Nitsche

Institution(s): BGD Boden- und Grundwasserlabor GmbH

Abstract
Monitored Natural Attenuation (MNA) of contaminants in the groundwater zone requires a change from information-oriented to decision-oriented groundwater monitoring, based on a detailed hydrogeological exploration and prediction. Therefore, MNA expands on classic groundwater monitoring through process-related interpretation of data. MNA has to be considered as a process control and not as a system state control. This means that the quality assurance methods, developed and applied for classic groundwater monitoring in order to get repeatable and definitive groundwater samples, have to be enlarged.

MNA always requires a model-based prediction of groundwater quality. As a result of a confidential prediction, it has to be decided whether the natural contaminant degradation is sufficient to prevent risks or if a temporarily contaminant migration is declining and tolerable within defined spaces of time. Based on this prediction, a model-based design with type, number and placement of groundwater monitoring wells, as well as the time interval of sampling and analytical program have to be defined. In addition to the system state parameters, process parameters also have to be measured.

Therefore, MNA needs object-related, authoritative migration parameters for model-based prediction of groundwater quality. This requires an objective-related set-up of a system and parameter model, for which the corresponding parameters have to be determined. It is essential that the degradation parameters are only valid for the process conditions for which they are determined. They can only be used as prediction tools whose reaction approaches are consistent with the boundary conditions of the parameter determination. Furthermore, a sensitivity analysis of the different migration parameters is essential in order to identify particular sensitive NA parameters.

Conditional on partial complex groundwater contamination and matrix effects, migration parameters from literature are of very limited use, mostly for an initial estimation of migration behavior of contaminants in the groundwater zone. Therefore, additional methods were developed and applied, such as isotope fractioning or inverse parameter identification using field test results. In order to prove these results, expected parameters are needed. This deficit of quality assurance can be corrected using process-related laboratory tests. The advantage of these laboratory tests exists in a purposeful selection and balancing of migration processes. This assumes a consequence model based up scaling.
The achieved state of process related laboratory tests in the context of a model-based up scaling in comparison with literature values and results of an isotope fractioning will be presented and discussed on an example of a mega-site.

Title: Vertical heat and mass transfer in groundwater monitoring wells due to free convection

Author(s): S. Berthold, F. Börner

Institution(s): DGFZ Dresdner Grundwasserforschungszentrum e.V.

Abstract
Groundwater monitoring wells locally distort the natural flow field and create a path that opens up an (additional) possibility of heat and mass transfer between aquifer, surrounding and atmosphere. Among the processes that cause such heat and mass transfer, vertical convection plays an important roll. This study focuses on free convection that is caused by density differences. The resulting convection cells allow for a distinctively increased transport compared to common temperature conduction or molecular diffusion.

Experimental investigations and in-situ measurements revealed significant free convective flow in groundwater monitoring wells. Using a medium-scale testing facility, its occurrence could be verified for temperature gradients from 2 K/m down to 0.1 K/m. Temperature gradients in that order exist in many monitoring wells - the higher ones especially in the near surface zone influenced by seasonal temperature variations. Flow velocities ranged from 7 to 95 m/d and increased with destabilizing temperature gradient. Free convective flow in monitoring wells can consequently exceed natural groundwater flow. Further experimental investigations and measurements in monitoring wells proved that free convection leads to significant transport of dissolved matter, e.g. oxygen from atmospheric input. Mass transport increased with increasing destabilizing temperature gradient.

That means, in conventional monitoring wells, in-situ measurements (e.g. with passive samplers or well logging) can be used only very restrictively to derive information about the well surroundings. When convective flow reaches the well screen, horizontal through flow may cause an input of the transported matter into the aquifer, possibly leading to the development of a geochemically altered zone downstream the well. Consequently, a representative groundwater sample is not reliably obtainable with standard sampling techniques in a monitoring well with an environment impacted that way.

Session 7: Innovative Site Characterization *(May 14, 09:15- 10:25)*

Title: Rapid characterization of subsurface contamination at extended contaminated sites – Comparison of approaches

Author(s): A. Rein [1], O. Holm [2], S. Popp [3], M. Bittens [3], W. Rotard [2], P. Dietrich [2]

Institution(s):
[1] Department of Environmental Engineering, Technical University of Denmark
[2] Institute of Environmental Technology, Technische Universität Berlin, Germany
[3] Helmholtz Centre for Environmental Research - UFZ, Germany

Abstract
Approaches for the characterization of subsurface contamination need to be reliable and cost-effective, particularly for extended and remote areas aimed at being redeveloped. At a former military site near Berlin, Germany, adaptive strategies and technologies for a risk-based site characterization and monitoring were developed and applied and compared to conventional techniques. Direct-push (DP)-based groundwater screening and tree core sampling, i.e. considering contaminant uptake into trees as an indirect indication of organic pollutions in the subsurface, were performed along a wide-meshed grid covering the whole site of approx. 120 hectares. Tree core sampling also covered the downstream area of the site, which is characterized by wetlands that are not accessible for DP, in order to investigate the plume extension.

The DP-based groundwater screening was performed within a short time period, i.e. less than three weeks, at significantly lower costs compared to investigations based upon conventional groundwater wells (which characterized areas of suspected contamination, only). Findings of monitoring at the conventional wells could be confirmed, and new and unexpected areas of groundwater contamination at the site were identified. Results of groundwater sampling were in a good accordance to results of the tree core sampling campaign. Consequently, this novel investigation method could be identified as appropriate and economically effective for the screening of large scale areas characterized by dense tree populations and low depths to the groundwater level. Tree core sampling in the northern downstream area, which is characterized by wetlands inaccessible for DP equipment, enabled the delineation of the contaminant plume discharging from the site. The investigated screening methods are also appropriate tools for monitoring tasks, as they are low-invasive, comparatively fast and cost-effective.

Title: Opportunities and limitation of minimal invasive and tomographic methods for near surface investigation

Author(s): P. Dietrich

Institution(s):
Helmholtz Centre for Environmental Research - UFZ, Department Monitoring and Exploration Technologies

Abstract
Nowadays there is an increasing need to observe and investigate natural and anthropogenic-influenced systems. Challenges for monitoring- and exploration technologies in environmental research are among others the identification and parameterization of system relevant physical-chemical-biological processes as well as the interaction between different scales. These challenges require high resolution methods.

In particular, cost-effective methods of minimal destructive nature and rapid application are taken into consideration. Methods for near surface investigation are direct-push (DP) technologies, borehole based as well as tomographic methods. Classical borehole based methods as well logging and sampling can deliver a high vertical resolution. But beside their high cost related to the drilling efforts, they suffer from a lack of information in lateral direction, i.e. between the boreholes. Other borehole based method as tracer and pumping tests can give information on the space between the boreholes, but the spatial resolution is very low. Another option to get vertical profile information with high resolution is the use of DP technologies. These technologies can be used for a cost-effective characterization of the subsurface in terms of (geological) structure, distribution of contaminants as well as for the installation of sampling and monitoring equipment. The applicability of these technologies strongly depends on the geotechnical / mechanical characteristics of the subsurface material. Also if the application of DP technology allows for the same cost the measurement of much more profiles as compared to boreholes, it still suffers from the lack of spatial coverage in lateral directions. An alternative approach to compensate the poor lateral resolution is the application of tomographic methods (i.e. p- and s-waves seismic, DC-geoelectric, radar and hydraulic) using boreholes and/or DP. They deliver spatial continuous information and have a better resolution in deeper parts of the investigated area as only surface based measurements. But it should be taken into account that the spatial and parameter resolution strongly depends on the configuration of tomographic surveys.

Title: AACI-Log - a new borehole tool for high-resolution detection of the seal effect of clay barriers behind well casings.

Author(s): C. Koller[1], F. Börner[1] and H. Gawlik [2]

Institution(s):
[1] Dresdner Grundwasserforschungszentrum e.V
[2] LogIn Bohrlochmessgeräte GmbH Gommern

Abstract
Clay barriers behind the casing of groundwater monitoring wells must completely fill the annular space between two screens or above the top screen to ensure that no vertical movement of fluids occurs. If the annular space behind the casing is not properly sealed, the annular space provides a potential channel for vertical movement of water and contaminants. There are several undesirable potential pathways for water flow in any casing of a groundwater monitoring well.

The provocative question is that the voids for the potential vertical water movement must be detected through the casing material. The seal effect of clay barriers is evaluated beside hydraulic tests particularly with borehole geophysics. Hydraulic tests – to detect voids in improperly installed annular seal materials – are complex and difficult. For these two reasons hydraulic tests are very cost-intensive. Most geophysical borehole logging systems measure an integral value over the whole circumference of the borehole (360°) at a defined depth. An azimuthal differentiation of the annulus is not possible. Azimuthal measuring probes are known, for instance, for formation evaluation at hydrocarbon exploration.

The target of this FuE- Research project is the development and the construction of an azimuthal measuring borehole probe. This borehole probe must be able to declare questions about the technical efficiency of groundwater monitoring wells regard to the sealing behind well casing and it must be capable of series productions. Currently the activity is focused on the test phase of the prototype “Azimuthal-Annulus-Convection-Identification-Log” (AACI-Log). LogIn Bohrlochmessgeräte GmbH Gommern is a partner in this research project.

The three-dimensional detection of voids and vertical flows are methodical solved by the combination of (1) an azimuthal Gamma- or Gamma-Gamma-Density-Log with (2) an azimuthal Temperature-Log. The technical realisation of the AACI-Log occurs by a geophysical borehole log, which has got four measuring arms. These four measuring arms are moved around 90° and are pressed elastic against the wall. Through this a horizontal measuring plane can be azimuthal measured. First test phases of the AACI-Log show the functional capability of the system in real groundwater monitoring wells. The evaluation of formation dip in open holes is prepared.

Title: Elemental Analytical Probe for On-Field Depth profiling

Author(s): Rick Comtois[1], Judit Jeney[2]

Institution(s):
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Abstract
This presentation will discuss the development and application of a cone-tipped penetrometer (CP) for in situ elemental analysis of soil or sediment by energy dispersive x-ray fluorescence spectroscopy (EDXRF). Intended to provide field screening data complementary to existing physical property testing probes and molecular spectroscopy probes (for the identification of organic compounds); the EDXRF CP is engineered to deliver elemental analysis on a wide range of soil and sediment contaiminants.

Rather than using a radioactive source as in previous designs, a miniature x-ray tube is powered by a filament isolation transformer located inside the penetrometer pipe which has an outside diameter of > 50 mm. The x-rays pass out through a special x-ray transmissive window, such as a low metal impurity-containing high strength boron carbide, into the soil or sediment below the surface. The resulting x-rays from the metals in the soil or sediment return through the window to a detector. The signal is transmitted back up to the surface where the x-rays are quantitatively analyzed to determine the concentration of metals in the soil. This real-time in situ x-ray fluorescence spectroscopy of soil or sediment samples permits field analysis of hazardous waste sites and other underground soil and underwater sediments.

Included in the presentation will be discussions of applications in the field of environmental characterization and remediation. Data will be presented on actual field deployment-based data as well as recovery vis a vis SRM's. Other applications include mining; petroleum, petrochemical and chemical processing; and agronomy.

Session 8: Soils *(May 14, 09:15- 10:25)*

Title: Comparative study of multisensoric γ-spectrometry and EMI measurements

Author(s): Wunderlich, T.* [1], Nüsch, A.-K. [2], van Egmond, F.M. [3], Kathage, A. [4], al Hagrey, S.A. [1], Rabbel, W. [1]

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[3] The Soil Company B.V.,Groningen, The Netherlands
[4] Geohires International Ltd., Borken, Germany

Abstract
The EU project iSOIL (Interactions between soil related science – Linking geophysics, soil science and digital soil mapping) deals with improving fast and reliable mapping of soil properties, soil functions and soil degradation threats.

Data collection with commercially available individual sensors is well proven and numerically described. However the reliability of measurements with combined sensors mounted on mobile platforms and the interference between them are yet not quite investigated.

This study will show some results concerning γ-spectrometry, EMI/EMR and geoelectrical methods of the first measurements within this project. The survey was conducted on an area in Rosslau, Germany, by four project partners. Among others two EM38DD, two γ-spectrometers with a NaI-crystal and one γ-spectrometer with a CsI-crystal were used. These sensors were mounted on several platforms towed by tractors. The measurement aimed at testing and comparing the results of the single sensors and platforms with respect to each other. For this purpose we mounted the sensors in several setups and drove in different velocities. To quantify the repeatability of the measurements and to test for interference between the sensors or between the sensors and the tractor we calculated correlation coefficients for different setups and sensors. Regarding the apparent electrical soil conductivity (σ_a) measured by EM38, the results are relatively insensitive concerning the velocity. Comparison of the concentrations of K, U and Th as well as dose rate measured by different γ-spectrometers was complicated by diverse units applied in the different sensors. The overall comparison of the resulting single geophysical attributes shows a good qualitative and partly quantitative similarity in resolution.

Title: DIGISOIL: a multi-sensor system for mapping soil properties

Author(s): G. Grandjean, O. Cerdan, K. Samyn[1], G. Richard[2], I. Cousin, J. Thiesson[2], B. Van Wesemael[3], S. Lambot[3], F. Carré[4], R. Maftei[5], T. Hermann[6], T. Thörnelöf [7], L. Chiarantini[8], S. Moretti[9]

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Abstract
The purposes of the multidisciplinary DIGISOIL project are the integration and improvement of *in situ* and proximal measurement technologies for the assessment of soil properties and soil degradation indicators, going from the sensing technologies to their integration and their application in (digital) soil mapping (DSM).

In order to assess and prevent soil degradation and to benefit from the different ecological, economical and historical functions of the soil in a sustainable way, high resolution and accurate maps of soil properties are needed. The core objective of the project is to explore and exploit new capabilities of advanced geophysical technologies for answering this societal demand. To this aim, DIGISOIL addresses four issues covering technological, soil science and economic aspects (**Fehler! Verweisquelle konnte nicht gefunden werden.**): (i) the validation of geophysical (in situ, proximal and airborne) technologies and integrated pedo-geophysical inversion techniques (mechanistic data fusion) (ii) the relation between the geophysical parameters and the soil properties, (iii) the integration of the derived soil properties for mapping soil functions and soil threats, (iv) the evaluation, standardisation and sub-industrialization of the proposed methodologies, including technical and economical studies.ect to these issues, the preliminary tasks of the DIGISOIL project were to develop, test and validate the most relevant geophysical technologies for mapping soil properties. The different field tests, realized at this time, allow focusing on technological suitable solutions for each of identified methods: geoelectric, GPR, seismics, magnetic and hyperspectral. Data acquisition systems, sensor geometry, data processing are thus presented and discussed in the perspectives of producing information layers for Digital Soil Mapping.

Title: iSOIL -Integration of geophysical technologies in measuring platforms

Author(s): U. Werban[1]; A.K. Nuesch [1]; S. Kathage [2]; F.M. van Egmond [3]; T. Wunderlich [4]; S.A. al Hagrey [4] and P. Dietrich [1]

Institution(s):
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[2]Allied Associates Geophysical Ltd.
[3]The Soil Company
[4]Christian-Albrechts-University of Kiel

Abstract
High-resolution soil property maps are one major prerequisite for the specific protection of soil functions and restoration of degraded soils as well as sustainable land use, water and environmental management. The focus in further research is on improving fast and reliable mapping of soil properties, soil functions and soil degradation threats. The project iSOIL deals with these topics and is supported by the 7th Framework Programme of the European Commission. The project started on June 1, 2008 and the consortium consists of 19 partners from nine European countries, including 6 research organisations, 7 universities and 6 SME`s. By our presentation we will introduce the main topics of iSOIL and show the criteria, tools and means of acquisition taken into consideration within the iSOIL project.

iSOIL will develop, validate and evaluate concepts and strategies for an improved soil mapping. Therefore, three topics are of major methodological interest (1) Development of geophysical techniques, (2) Development of geophysical transfer functions and (3) Digital Soil Mapping. This requires the combination and integration of different measuring techniques, of pedometrical and pedophysical approaches, enhanced DSM techniques, as well as subsequent modelling approaches. In so doing, structures of landscapes and different types of land use must be taken into account using a hierarchical approach. The final aim of the project is to provide techniques and recommendations for high resolution, economically feasible, and target oriented soil mapping under conditions realistic for end-user.

Title: NMR Relaxation times and Pore size distribution: A comparison with morphological modelling

Author(s): U. Weller[1], S. Haber-Pohlmeier[2], A. Pohlmeier[3]

Institution(s):
[1] Deparment of Soil Physics, UFZ
[2] ITMC, RWTH Aachen
[3] ICG-4, Research Center Jülich

Abstract
The NMR relaxation signal in soil depends on the travel time of an excited water molecule to the pore wall. The probability of a molecule to relax (and emit a signal) is much higher if it reaches the solid phase, especially if it hits on iron oxides. At lower water contents the molecules have a much shorter travel time to the walls, and therefore the signal changes. We have measured the signal at different water contents and compared it with the morphological pore size distribution that was determined with Xray MicroCT. We were able to simulate the NMR signal form with a simple Wiener process on the pore space.

Session 9: Innovative Site Characterization *(May 14, 11:45- 13:05)*

Title: Application of the Membrane Interphase Probe (MIP): an evaluation

Author(s): I. Van Keer, J. Bronders, K. Touchant, D. Wilczek

Institution(s): Flemish Institute for Technological Research (VITO)

Abstract
In environmental soil studies the use of the membrane interphase probe (MIP) has been proved to be very useful. However, with respect to the interpretation of the data obtained some difficulties and misinterpretations occur. To evaluate the effect of different pollutants on the detector signals registered, to compare MIP-signals with measured concentration, and to indicate the advantages versus limitations of the MIP-system, measurements were carried out using the Membrane Interphase Probe (MIP™) from Geoprobe Systems®. Both laboratory tests and field measurements using different system configurations were carried out.

These configurations were: i) detectors stand alone using flame ionisation detector (FID), photo ionisation detector (PID) and dry electrolytic conductivity detector (DELCD) ; ii) the use of a 2 ml sample loop and iii) a purge and trap system. Lab tests were performed to observe the effect of different pollutants on the detector signals. The recorded signals were compared to analytical results. Subsequently, the configurations ii) en iii) were used in combination with a capillary column to carry out qualitative analyses. Finally, field measurements were carried out to evaluate 1) the classic MIP set-up and 2) the MIP-GC configuration.

The major results of the study indicate that:

- careful interpretation of the data, collected using the MIP, is necessary;
- understanding the MIP principles and the detection limitations is essential;
- to avoid misuse and wrong interpretations, detection limits related to the site specific pollutants have to be known to a certain extent;
- the absence of a significant MIP signal does not mean that concentrations above soil reference values are not possible.

Title: Real time characterization of spatial contaminant distribution using multiple technology approach

Author(s): A. Oppermann[1], Dr. J. Körner[1], S. Pitkin[2], M. Rossi[2]

Institution(s):
[1] geo-log GmbH, Braunschweig [speaker]
[2] Stone Enivronmental Inc. USA

Abstract
By several reasons for example a risk assessment using the contaminant flux approach but especially for the successful application of innovative in-situ remediation technologies a rapid and detailed spatial characterization of contaminant distribution and hydraulic site characterization becomes more and more essential. To gain the data which are required for a detailed conceptual site model different Direct-Push technologies for sampling and in-situ sensing are available.

The presentation will give a short summary about technologies which are applied by geo-log GmbH and it's partner Stone Environmental in Europe and how they are used in terms of highly effective, rapid site characterization.

The concentration of volatile organic compounds like CHC or BTX can be screened versus depth using the Membrane Interface Probe (MIP) technology. The MIP enables to get detailed vertical profiles of geology by measuring the soil conductivity and contaminant distribution. The system provides a sum signal of all contaminants which are present in the subsoil regardless whether they are free or residual product, sorbed to the soil matrix, dissolved into the groundwater or volatile in soil gas. By use of three detectors different kind of contaminants like BTX or CHC or even types of contaminants like chloroethenes and chloroethanes can be distinguished. The MIP technology is the first choice for screening and delineating core plumes or source areas.

MIP data should be supported by sampling and analyzing groundwater, soil and soil vapour from discrete intervals identified by the MIP. Therefore different Direct-Push methods are available which provides high quality samples without the need of a continuous borehole from surface.

The most advanced technology for sampling groundwater and for recording the hydraulic properties versus depth is the Waterloo Advanced Profiler System (WaterlooAPS). The WaterlooAPS is a direct push, continuous profiling, discrete interval sampling tool and integrated data collection platform. Its strength is in rapidly characterizing sources and plumes, particularly where dense non-aqueous phase liquid (DNAPL) contaminants are of concern. The WaterlooAPS is a proprietary modification of the innovative Waterloo Profiler originally designed at the Univ. Waterloo to obtain samples from overburden aquifer media with minimum hydraulic conductivities (K) of 10-4 cm/sec. Stone modified and upgraded it to collect samples in lower K settings; collect samples using a nitrogen gas-drive pump (WaterlooAPS-D) where the water table is below the suction limit; drive through resistant formations; resist sampler screen plugging; measure hydraulic head; measure a continuous Index of Hydraulic Conductivity (Ik) in real-time; and measure physiochemical properties such as pH, specific conductance (SC), dissolved oxygen (DO), and oxidation/reduction potential (ORP).

Integrated sensors provide hydrostratigraphic and physiochemical data displayed graphically in a data acquisition sastem as the WaterlooAPS tooling is advanced, allowing real-time identification of optimum sampling locations and to measure formation stabilization to ensure high sample quality.

To support data interpretation on-site labs outfitted with GC/MS and GC units and supporting materiel, provide 30 minute or less turnaround time using Solid Phase Micro Extraction (SPME). Uniquely used by Stone for over 10 years, SPME is now a standard ASTM analytical practice. MobiLab's analytical results are definitive, of equivalent quality to a "fixed-base" laboratory (not screening).

The real-time acquisition of data allows to plot contaminant profiles within hours and to distribute the results by email to all experts involved in site investigation for decision making. The investigation points can be placed highly efficient using 3-D visualization software eliminating lack of information in creating the spatial model of contaminant distribution.

Title: Site characterization with the video cone

Author(s): V. Hopman, J. Olie, N. Hartog, D. van Ree, S. Paul

Institution(s): Deltares

Abstract
In situ measurements generally are restricted to a small number of parameters performed at a restricted number of depths. Geotechnical based direct push tools hold the promise to increase the vertical spatial resolution and increase the number of parameters that can be detected quickly and at relative low cost. In the most favourable case, the measurement density is large enough to get a quasi-continuous quantity along a vertical line.

Optical sensing and detection methods have shown to be powerful tools in combination with push in equipment. Hardware and measurement principles (glass fibres, detectors, wavelength) have led to different tools like e.g. the Rapid Optical Screening Tool (ROST), the Hydrocarbon probe. In the visual wavelengths, video cones have also been build over time. Recently Deltares has redesigned its video cone and extended its capabilities. These include a reduction in diameter, use of a high-resolution digital camera, increasing the window size and incorporating an injection port for fluids.

Potential applications for the video cone are environmental studies as well as civil engineering uses. Thin layers become visible and the soil can be studied in-situ without the need to first bring the material to the surface. This is a considerable advantage, particularly when investigating contaminated soil. Other benefits of the video cone are layer recognition and the observability of (colored) contaminants.

A number of practical applications on geotechnical and environmental problems will be shown in which the video cone has been applied successfully to obtain information that could not have been acquired by other methods. In addition, the combination with other push in techniques will be elucidated.

To demonstrate the technologies benefit, field tests have been performed and a comparison was made to undisturbed samples obtained with the continuous Begemann soil sampling system and data from standard piezocone penetration tests. Thus, a measurement strategy can evolve to improve risk assessments and help design more efficient delivery of remedial agents to source zones.

Title: Joint analysis of the Super-Sauze (French Alps) mudslide by Nanoseismic Monitoring and UAV-based remote sensing

Author(s): M. Walter, U. Niethammer & M. Joswig

Institution(s): Institute for Geophysics, Universität Stuttgart

Abstract
We describe the joint analysis of the fast moving mudslide in Super-Sauze, southern French Alps, by Nanoseismic Monitoring and UAV-based (Unmanned Aerial Vehicle) remote sensing approaches. The joint observation of subsurface fracture processes during the movement of the slope and the mapping of mass dynamics at the surface allows a common interpretation of complex slope dynamics.
During a 10 days field campaign in July 2008, we were able to detect and locate different signals (type 'A' – 'C') caused by the movement of the mudslide by applying Nanoseismic Monitoring. While the events type 'A' are caused by rockfalls in the source area of the slope, we could identify different types of signals (type 'B' and 'C'), which have been obviously generated by material failure within the unstable part of the mudslide. The spatial distribution of the epicenters (type 'B'), respectively the estimated source area (type 'C'), correlates well with parts of the slope moving with higher velocities at the surface.
Beside the seismic observation, a series of UAV-borne photographs of the Super-Sauze mudslide has been acquired during the field campaign. The covered area was in the range of 850 m x 250 m. The acquired photographs have been combined to an ortho-mosaic. The achievable ground cell resolution was in the range between 3 cm to 8 cm. A comparison between the achieved ortho-mosaic and an airborne ortho-mosaic from May 2007 has been carried out. In this period displacements, varying between 2.7 m and 55.4 m have been detected and different structures, indicating variable deformation and sedimentation processes at the surface of the slope have been identified.
The comparison of the results achieved by the seismic monitoring of slope dynamics with observations based on UAV-based remote sensing approaches assists the estimation of source areas and possible source mechanisms and vice versa. The analysis and the data-fusion of the seismically detected signals and the observed dynamic processes by the UAV-based remote sensing methods lead us to the interpretation, that most of the dynamic processes take place close to the in-situ crests, mostly covered by the mudslide today.

Session 10: Sub-Surface Transport *(May 14, 11:45- 13:05)*

Title: Why do we still need tracer tests-an example by using Direct Push technology
Author(s): Dietze, M.[1]; Dietrich, P.[2]

Institution(s):
[1] TU Dresden, Institute for groundwater management, Dresden, Germany
[2] Helmholtz Centre for Environmental Research-UFZ, Monitoring- & Exploration Technologies, Leipzig, Germany

Abstract
Natural Attenuation (NA), enhanced Natural Attenuation (ENA) and monitored Natural Attenuation (MNA) represent a growing field of remediation methods to observe and enforce natural processes that have a declining effect in contaminant mass. For calculating NA degradation rates it is of great importance to determine the natural groundwater flow direction and flow velocity. Due to economic reasons, flow parameters are often determined by modelling or based on interpolated ground water contour maps. Hereby, the significance depends on the certain degree of investigation process.

In our study, we compared flow parameter results obtained by modelling using Modflow, ground water contour maps and natural ground water tracer tests based on different flow paths at the heavily BTEX-contaminated test site Zeitz, Germany. The location of the contaminant plume was investigated in detail in several sampling campaigns. The subsurface of the test site is separated by silt and clay layers into two aquifers, whereof the upper aquifer was examined. The upper aquifer consists of fluvioglacial gravel and sand deposits of tertiary to quarternary age with a thickness of 2 to 5 m in the examined area. The sampling net of the tracer tests consisted of ground water wells and Direct-Push (DP) wells equipped with mini pressure pumps in several depths of the aquifer. The DP-wells of the first survey line were installed perpendicular to the natural flow direction covering the total width of the contaminant plume with distances of 10 m. In the centre of the plume, these distances were decreased to 2 – 3 m. In a distance of 11 m down gradient of the first survey line in the centre of the contaminant plume, a second survey line consisting of DP wells and one ground water well was installed to maximize the tracer recovery. To colour the ground water, we used the fluorescence tracers Uranine, Sodium-Naphthionate and Sulforhodamine B. Sampling at the ground water wells were taken with a bailer system and at the DP wells with continuously operating mini pressure pumps. The samples were analysed on-site by using a fibre-optic fluorimeter (Hellma, Germany) after 43 µm-filtration.

On the test site, two short distance flow paths were identified with flow distances of 14.9 and 23.8 m (36.4 m for the second survey line) and two long distance flow paths of 106.4 and 134.8 m. Real effective flow velocities were determined to be 0.39 md-1 concerning the shortest flow path and 0.73 to 1.07 md-1 at different DP wells at survey line 1 and 2 concerning the second short distance test. Real effective flow velocities concerning the first long distance flow path covering 106.4 m ranged from 0.49 to 0.61 md-1 and concerning the second test covering 134.8 m from 0.4 to 0.64 md-1. Calculated longitudinal dispersivities regarding all flow paths ranged from 0.57 to 36.69 m.

Results of the model and ground water contour maps differed moderately compared to the real data concerning flow velocity and direction. In median of the four flow paths, the direction deviated about 20 to 30 degrees and the flow velocity was modelled to be up to three times faster than obtained by real data. Therefore, tracer tests should be performed leading to confident results and accurate parameters, e. g. to calculate contaminant degradation rates and to determine the exact geometrical extension of a contaminant plume, especially the centre and the fringes. By using automatically operating fluorimeters and/or ground water samplers, time and effort can be saved. Additionally, the application of DP-technology allows a faster progress in subsurface investigation and installation of e. g. multi-level sampling wells leading to increased safety of tracer recovery.

Title: Temperature as a Tracer

Author(s): J. Dornstädter

Institution(s): GTC Kappelmeyer GmbH

Abstract
Many phenomena in soil can be investigated by ground temperature measurements. In all cases the temperature is used as a tracer for flow. Ground temperature measurements below 1m depth are an excellent tool for the detection of leaks in dams and dikes and their foundation, for the investigation of pollutant plumes downstream of waste deposits and landfill sites with organic content and for the detection of leaks in cement-sealed deep building pits. Uprising zones of thermal or karstic water in sediment basins can be investigated as well as leaks in sewers, district heating and other buried pipeline systems.

In 1991 GTC Kappelmeyer GmbH developed a patented temperature sounding method - temperature measurement by direct push - for economic measuring the temperature depth profiles. A chain of conventional temperature sensors is inserted a hollow pipe with a small diameter. This hollow pipe has to be rammed into the ground by a vibrating hammer before. Depending on grain size distribution and compactation 40 to 45 meter depth have been reached in the past. These depths are only reachable because special metal pipes are used and due to the low mantle friction of the small diameter pipes. More than 50 000 temperature soundings have been realised in the last 18 years. The method will be explained and results from different applications will be presented.

Title: Field tracer tests for characterization of local subsurface flow regimes

Author(s): U. Mohrlok, E. Bethge

Institution(s): University Karlsruhe, Institute for Hydromechanics

Abstract
The characterization of subsurface flow regimes in the field is a still a challenge because there is no direct access to the flow paths. The most common investigation method is the conduction of tracer tests where the addition of any substance of significant concentration above the natural background. Recently, a large progress has been made by testing the applicability of different kinds of substances for different purposes.

At the test site of the Institute for Hydromechanics in Karlsruhe-Knielingen several tracer tests were conducted to investigate the influence of aquifer heterogeneity on the three-dimensional flow field of a groundwater circulation well. Dye and salt tracer were injected during different experiments into the inflow to the circulation well and to the circulation itself. Flow paths and travel times of the tracers determined at multilevel monitoring wells were influenced by the heterogeneity in the vicinity of the well.

One of these salt tracer experiments were additionally monitored by geoelectrical tomography in cooperation with the University of Tuebingen. The migration of the injected salt plume could be reconstructed continuously within the three-dimensional flow field.

In cooperation with the Queens University Belfast the applicability of the noble gas Kr as an inert groundwater tracer for natural groundwater flow was investigated. The injected tracer plume could be detected at its margins in a downstream cross-section by very low Kr concentration.

Furthermore, dye tracer tests were used to visualize the flow pathways due to surface infiltration through the unsaturated topsoil within a planned flood water retention area. Highly structured soils with preferential pathways could be distinguished from more homogeneous soil profiles.

The successful observation of tracer migration in groundwater and unsaturated soils could provide detailed information about the flow and transport conditions. Local structures of the subsurface have a significant effect on the tracer behaviour. The injection of tracer far above background concentration is essential in particular for detection of the plume margins. Salt tracers show usually density effects if they have to be applied in high concentrations to avoid disappearance due to dilution even at the plume margins.

Title: Fully Coupled Hydrogeophysical Inversion of Salt Tracer Experiments

Author(s): Davina Pollock[1] and Olaf A. Cirpka[2]

Institution(s):
[1] Eawag, Swiss Federal Institute of Aquatic Science and Technology, Switzerland; currently at Centre for Applied Geoscience, University of Tübingen
[2] Centre for Applied Geoscience, University of Tübingen

Abstract
Electrical resistivity tomography has been used in various studies to monitor salt tracer experiments. We have introduced a new approach to infer the hydraulic conductivity distribution directly from measurements of electrical potential differences during salt tracer tests. This method has the advantage of not having to divide the analysis into two steps (in which the electrical conductivity distribution is obtained first and the hydraulic quantities are subsequently estimated), which has been mostly done so far. The key point of our analysis lies in the use of temporal moments of electrical potential perturbations resulting from the tracer injection. The set of equations used to obtain the hydraulic conductivity distribution from hydraulic head and electrical potential measurements considers geoelectrics, groundwater flow and solute transport as a coupled system, in order to avoid obtaining results which are in contradiction with the underlying physical laws, e.g. mass conservation. We have now integrated the forward calculation into a fully coupled hydrogeophysical inversion approach, in which the target of the inversion is the hydraulic conductivity field. We applied the quasi-linear geostatistical inversion approach to this problem. We show some results obtained from the geostatistical inversion of synthetic data. Our data simulates hydraulic head and electrical potential measurements during tracer tests in a quasi two-dimensional sandbox; the analysis is therefore restricted to two spatial dimensions. Different electrode configurations are used in the simulations.

Session 11: Innovative Site Investigation *(May 14, 14:45- 15:45)*

Title: SonicSensing – a start

Author(s): P.J.L. Derikx, T.A.A.R. Schenkels, H. Eijkelkamp

Institution(s): SonicSampdrill, The Netherlands

Abstract
SonicSensing is the name of the ambition of SonicSampDrill to add on-line measurements to its powerful drilling technology. By the application of about 150 Hz vibrations towards the drill string a drilling speed of 2 m per 10 seconds in soft soils up to a depth of 50 m is achievable. With this, the drilling technique is highly suitable for most environmental drilling purposes.

Up till now the exact localisation of a pollution plume is a tedious job, which mostly needs a number of investigation cycles. Each cycle consists of planning, on site drilling and sampling, detailed analysis in the laboratory, and reporting. Due to the time consuming character and the related high costs of these cycles in the past many soil remediation plans are based on very limited field data. As a consequence the final results of the remediation do often not meet the set goals. With an accurate on-line measuring technique linked to a high speed drilling technique, the time and costs for field investigations can be reduced remarkably. More data, collected at the appropriate spots, can be gathered in less time. Needless to say it will decrease the risks of any remediation plan and therefore improve the results of the remediation. In addition to the application described above, SonicSensing can be used for geotechnical studies and mineral exploration for mining purposes as well.

As a start of this new development in the end of 2008 a consortium of 10 European partners has started a project with co funding of the European Committee. In the framework of this project, investigations are started focusing on the intensity of the vibrations down the hole. The first results will be presented at NovCare 2009.

Title: Use of a Heated Trunkline to Enhance Performance of the Membrane Interface Probe (MIP)

Author(s): T. Christy and D. Pipp

Institution(s): Geoprobe Systems

Abstract
The Membrane Interface Probe (MIP) is a direct push logging tool used measure the position and relative concentration of volatile organic contaminants (VOC's) in the subsurface. This tool has been in use for site characterization for over a decade. The most common configurations of the MIP system in use today utilize tubing of either Teflon or PEEK to transport VOC's from the heated membrane of the downhole probe to gas phase detectors at ground surface. These tubing sets, commonly referred to as "trunklines", are operated at ambient temperatures and are therefore subject to condensation and dispersion of membrane target compounds. In addition to creating non-ideal logging of MIP signal, ambient trunkline temperatures also limit the range of VOC's that can be investigated using MIP logging. Another significant limitation of ambient temperature MIP trunklines is the time required to clean them to baseline conditions when the tool is pushed through pure product in the subsurface; a not infrequent occurrence.

This presentation will detail the results of testing performed using a heated stainless steel trunkline to transport membrane separated compounds. For this testing a stainless steel tubing 1.6mm in diameter and 45m in length is used as the trunkline return line. This tubing is heated to approximately 100 deg. C during logging operations. This presentation will show comparisons of MIP response (bench) testing on both heated and unheated trunklines using compounds of increasing molecular weight. In addition, results will be shown from actual case studies of both fuel hydrocarbon and chlorinated VOC contaminated sites using this heated trunkline technology. Example data will also be presented comparing the rate of "clean-up" of both heated and unheated trunklines exposed to extremely high concentrations of VOC's encountered in pure product zones.

Title: New developments of Direct Push probes

Author(s): Traugott Scheytt[1], Martin Asbrand[2]

Institution(s):
[1] Institute of Applied Geosciences, Technische Universität Berlin, Germany
[2] Institute of Applied Geosciences, Technische Universität Berlin, Germany

Abstract
Direct Push technologies are applied in almost all cases of groundwater studies. However, in cases of contaminated groundwater Direct Push is heavily recommended as it offers a unique way to gather three-dimensional information of the aquifer and groundwater. These advantages of Direct Push technologies have been recognized widely, although only relatively few parameters can be determined until now. Additionally, application of Direct Push probes often requires heavy duty machinery and expensive equipment. In the future, cheaper and lighter Direct Push techniques will be required for a wider distribution of this technology.

At this time a new generation of Direct Push probes is developed with the aim of providing fast and relatively simple techniques to determine a wide range of different parameters while gathering these data in-situ, online and at depth specific intervals that are relevant for groundwater gradients. The research plan includes detailed studies starting at the workshop to assemble the probe itself followed by laboratory experiments and finally building a prototype to test it on site in the field. We will present the latest developments and - depending on the progress – even experiments with the prototype.

Session 12: Sub-Surface Transport *(May 14, 14:45- 15:45)*

Title: Geophysical methods to characterize a highly heterogeneous aquifer

Author(s): M. Dogan, D. W. Hyndman, and R. L. Van Dam

Institution(s): Michigan State University, Department of Geological Sciences

Abstract
Consumption, remediation, and protection of water are becoming increasingly important due to population growth, industrial development, and limited natural resources. Maintaining the quality of water resources in areas that have experienced contamination requires characterizing the physical properties of aquifers and monitoring transient behavior. This interdisciplinary research area improves knowledge of flow regimes in aquifers, which is necessary for efficient remediation of groundwater. While transport through homogeneous and mildly heterogeneous aquifers can be simulated using codes based on the classical advection-dispersion theory, existing transport theories have had difficulty simulating transport through highly heterogeneous aquifers, in part due to insufficient characterization data. This study investigates a new approach to measure the parameters of, and tracer transport in a highly heterogeneous aquifer, the Macro Dispersion Experiment (MADE) site at the Columbus Air Force Base (CAFB), Columbus, Mississippi.

Hydraulic parameters of the site have been characterized using tracer experiments, well-logging, as well as borehole and geophysical measurements. Improving the accuracy of tracer simulations at the site requires detailed characterization of the properties in three dimensions. Accurate measurements can be obtained vertically from cores and wells, and geophysical methods can image subsurface structures and provide insight into undisturbed physical parameters. For the first part of this project, 4 km of GPR data were collected in a grid of profiles and in high-resolution 3D data cubes. Vertical radar profiles, cross-borehole and common-mid point measurements were collected to estimate the velocities. These data were then processed to obtain detailed images of the sedimentary structures, including bounding surfaces and cross bedding. We will also integrate our GPR data with direct push electrical conductivity logs and grain size data from cores.

Title: Airborne and ground geophysical measurements to investigate mechanisms of salt dissolution and subsidence in abandoned mining areas

Author(s): Y. Krause, T. Kerner, B. Siemon, C. Grissemann, M. Furche, U. Noell

Institution(s): Federal Institute for Geosciences and Natural Resources, Hannover, Germany

Abstract
Within the framework of the project ”Dynamics of inundated or flooded salt mines and overburden layers” (BMBF 02C1476) funded by the German Federal Ministry of Education and Research, investigations aim at the identification and characterization of dissolution-subsidence mechanisms associated with abandoned salt mining. Study site is the old potash mining village of Stassfurt being affected by surface subsidence, waterlogging and sinkhole development.

Geophysical investigation comprised two steps. First, an extensive airborne geophysical survey covering an area of 470 km2 of the Stassfurt salt structure and adjacent areas was conducted. The helicopter-borne electromagnetic (HEM) data were converted into a spacious 3D conductivity distribution. Areas with distinct conductivity anomalies, interpreted as evidence of potential groundwater recharge (low conductivity) or salinization zones (high conductivity), were selected for more detailed studies by high-resolution ground geophysics in a second step. Ground geophysical surveys run preferentially alongside helicopter flight lines and use transient electromagnetic (TEM) and DC geoelectrical methods.

The results of airborne and ground geophysical measurements on coincident profiles are generally in accordance. Interpretation performance is improved as DC and TEM methods complement one another. The higher DC resolution adds to the larger TEM penetration depth. In an exemplary area of groundwater recharge, geophysical investigation revealed deep infiltration of fresh water to the triassic aquifer (see figure below). Significant conductivity structures were identified by all three geophysical methods. As fluid conductivity is a mineralization tracer and a key parameter for the interpretation of DC and EM measurements, groundwater observation wells and shafts were used for vertical profiling of fluid conductivities.

Title: Estimation of CO2 baseline emissions of coal fires and description of coal fire driven changes of physical properties based on geophysical observations

Author(s): U. Meyer[1], A. Lambrecht[1], S. Schlömer[1], V. Gundelach[1], D. Chen-Brauchler[1], J. Kus[1], C. Fischer[2], H. Rüter[3], K. Bing[4] and W. Jianjun [5]

Institution(s):
[1] Bundesanstalt für Geowissenschaften und Rohstoffe
[2] Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhofen
[3] HarbourDom, Köln
[4] Beijing Remote Sensing & Geo-Engineering Company, Beijing
[5] Beijing Normal University, Beijing

Abstract
Coal fires are a world wide problem. They change their environment dramatically. In order to estimate the amount of CO2 that is set free as exhaust gases by the fires, different approaches are set-up. The first one is the energy approach in which the surface temperature distribution is used to estimate the energy that is being set free by the coal fire. With knowledge about the calorific value of the coal and a simple burning formula, the amount of coal and related CO2 exhausts can be estimated. The second is the volume approach in which the geometry of the coal seam is given. Then the burning volume and the fire propagation velocity must be determined. The third on is the direct approach in which gas measurements are used to determine the CO2 fluxes. For field applications, this is the most problematic approach.

All approaches need geophysical data for input and make use changed physical properties in the vicinity of the coal fire (magnetic susceptibility, electrical conductivity, etc.) . Main questions in the given tasks are to determine the subsurface transport of the CO2 exhaust gas and the subsurface energy transport. These key questions are not yet fully solved and make more thorough scientific investigations necessary.

Needs and Opportunities for Research and Technology Transfer *(May 14, 17:00-17:40)*

Title: Opportunities and limitations of large-reserach infrastructures (MOSAIC, TERENO)

Author(s): P. Dietrich[1], S. Zacharias[1], U. Weiban[1], C. Leven[2], G. Teutsch[1]

Institution(s):
[1]Helmholtz-Centre for Environmental Research – UFZ
[2]University of Tübingen, Center for Applied Geoscience

Abstract
Please see description of MOSAIC and TERENO (page 44-45)

Title: How can be promoted the technology transfer: experiences of the TASK-project

Author(s): E. Martac

Institution(s): TASK – The Centre of Competence for Soil, Groundwater and Site Revitalisation, Helmholtz-Centre for Environmental Research - UFZ

Abstract
The last 10 to 15 years the Federal Ministry of Education and Research (BMBF) as well as the European Commission have been funding numerous practice-oriented projects in the field of soil & groundwater remediation, contaminated land management, and sustainable land revitalisation, with a total estimated volume of 100 million EURO. However, many technologies and concepts developed in these R&D projects have not been sufficiently implemented in practice and therefore cannot compete on the market. In order to foster the widespread use of emerging knowledge and new technologies in contaminated land management, the TASK initiative (Terra-, Aqua- & Site Remediation Competence Centre and Network) was funded in 2007 under the direction of the Helmholtz Centre for Environmental Research - UFZ and the German Ministry of Science and Education (BMBF). Based on an analysis of already funded research products (concepts and technologies) as well as the situation at the market, TASK identifies research products of high innovation potential. Such products are for example: methods and technologies, models, software tools, management strategies, guidelines and standards. Products are entered into the TASK Product Database (to date, approx. 200 identified products) and sorted according to their category and their stage of implementation. Supported by a network of experts, TASK will then conduct technology transfer measures for selected technology lines and concepts. These measures include exhibition of technologies at annual product fairs, organisation of workshops and expert panels, set-up of recommendations for policy makers, networking and teaching activities as well as product demonstrations at field sites.

Session 13: Watershed *(May 15, 9:15- 10:35)*

Title: SoilNet - A hybrid underground wireless sensor network for near real-time monitoring of hydrological processes

Author(s): H.R. Bogena, J.A. Huisman, U. Rosenbaum, A. Weuthen & H. Vereecken

Institution(s): Agrosphere Institute (ICG 4), Research Centre Juelich, Juelich, Germany

Abstract
Wireless sensor network technology allows near real-time monitoring of soil properties with a high spatial and temporal resolution for observing hydrological processes in small watersheds. The novel wireless sensor network SoilNet uses the low-cost ZigBee radio network for communication and a hybrid topology with a mixture of underground end devices each wired to several soil sensors and aboveground router devices. The SoilNet sensor network consists of soil water content, salinity and temperature sensors attached to end devices by cables, router devices and a coordinator device. The end devices are buried in the soil and linked wirelessly with nearby aboveground router devices. This ZigBee network design considers channel errors, delays, packet losses, and power and topology constraints. In order to conserve battery power, a reactive routing protocol is used that determines a new route only when it is required. The sensor network is also able to react to external influences, e.g. the occurrence of precipitation. The SoilNet communicator, routing and end devices have been developed by the Forschungszentrum Juelich and will be marketed through external companies. Simultaneously, we have also developed a data management and visualisation system. Recently, a small forest catchment Wüstebach (~27 ha) was instrumented with 50 end devices and more than 400 soil sensors in the frame of the TERENO-RUR hydrological observatory. We will present first results of this large sensor network both in terms of spatial-temporal variations in soil water content and the performance of the sensor network (e.g. network stability and power use).

Title: Spatial TDR a new approach for observing 4d- soil moisture dynamics at the plot and small field scale: Promise, Progress, Problems

Author(s): T. Graeff [2], E. Zehe[1], S. Schlaeger[3], M. Morgner[1], A. Bauer[2], R. Becker[4], A. Bronstert[2]

Institution(s):
[1] Institute for Water and Environment, Department of Hydrology and River Basin Management, Technische Universität München, Germany.
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[4] IMKO GmbH, Ettlingen, Germany.

Abstract

Time Domain Reflectometry (TDR) is frequently used to assess soil moisture data at the point scale. TDR and capacitance methods depend on probes to guide the signal into the soil of interest. Both methods usually have made use of parallel rods inserted into the soil from the surface to serve as transmission line. Most TDR instruments launch a fast rise voltage step along the transmission line in the soil. The TDR step pulse travels to the end of the probe reflects back to the instrument where it is detected. Pulse velocity is determined from the measured travel time for one round trip and converted to an average electrical permittivity /average water content along the transmission line.

Spatial TDR (STDR) is an advanced method, which allows the retrieval of the soil moisture profile by means of simulating the TDR signal using the Telegraph equation and optimising the capacitance profile along the transmission line. A STDR cluster consists of up to 40 sensors that are connected via a mutltiplexer to a single sampling TDR. It allows thus observation of the 4d soil moisture pattern at an extent of up to 1000 m2 and a temporal resolution of 10 min. Hence, in principle STDR technology allows in principle representative sampling of soil moisture data, which is crucial for understanding small scale soil moisture variability, or how initial soil moisture determines runoff response or for a reasonable ground truthing of remote sensing data.

However, the inversion of the TDR signal requires a relationship between the capacity and the electric conductivity along the transmission line that has to be calibrated for the soil of interest. Additional error sources in natural soils for reconstruction of soil moisture profiles are furthermore a) deviations from the ideal parallel geometry of the TDR rods, b) the presence of solids (stones, wood) close to the TDR rods and in c) higher clay fraction in the soil and (d) influence of temperature.

The objectives of this study are threefold. First, to present most recent laboratory and field experiments that shed light on how these error sources contaminate retrieval of soil moisture profiles in natural soils. Second, to present moisture data from two STDR clusters installed in a small headwater catchment in Germany to shed light on how much we may learn about 4d soil moisture patterns from this technology. And third, to compare soil moisture data derived with STDR with simulation results of a physically based model.

Title: Characterization and simulation of hydraulic conductivity fields using Copula based approaches

Author(s): A. Bardossy[1], S. Van der Zee[1] and L. Jing[2]

Institution(s):
[1] Uni-Stuttgart
[2] Wageningen University

Abstract
The flow and transport behavior in the subsurface is influenced by the heterogeneity of the sub-soils. To estimate the effective flow and transport parameters, flow and transport simulations with the spatial fields of hydraulic or chemical properties of the subsurface are necessary. Hence the characterization of the spatial variabilities of relevant soil properties and subsequent simulations of the spatial fields are required. However, in traditional geostatistics, the spatial variability is often described by a variogram, which describes the dependence in an averaged sense and encounters problems if the marginal distribution is highly skewed. Furthermore, these conventional statistics are only sufficient to characterize spatial fields with Guassian dependence. Non-Guassian spatial fields may exhibit spatial patterns which cannot be characterized by the conventional statistics. Moreover, in most cases, spatial simulations are carried out for log-conductivity values assuming a multivariate normal distribution. This assumption is in contradiction with some geological formations, e.g. channels or flow barriers, which are critical for flow and transport.

To conquer these problems, more and more researches have been carried out recently for modelling non-Gaussian dependence. The aims of this work are to apply the concept of copula to describe the spatial dependence of the hydraulic conductivity fields to reveal how the dependence strength varies across the whole distribution of the attribute values without the influence of the marginal distribution, and to develop different multivariate random functions and stochastic simulation procedures to generate random fields with non-Gaussian dependence.

The content of the presentation is organized as following: first, the methodology of using copulas to investigate spatial variabilities will be introduced; second, the procedures of both unconditional simulation and conditional simulation of hydraulic conductivity fields with non-Gaussian dependence will be discussed; third, the inference of a copula model from a dataset based on multi-point geostatistics and maximum likelihood method will be presented; finally, a summary and outlook of the work will be given.

Title: Precise Monitoring of Underground Water Level Variations (Geophysical Observatory of IDG RAS "Mikhnevo")

Author(s): Ella Gorbunova, N.V. Kabychenko, N.V. Kabychenko

Institution(s):
Institute of Geospheres Dynamics of Russian Academy of Science

Abstract
An extensive material has been accumulated for the previous tens of years on underground water precise monitoring in seismically active regions. At platforms such a monitoring was conducted only occasionally. But it is the aseismatic regions that are of special interest in studying the reaction of an aquifer to changes of strain conditions of a massif, because they are characterized by relatively stable conditions, and are almost free of the effects of oceanic tides.
One of the most promising sites for precise monitoring of underground water level variations is the Geophysical Observatory of IDG RAS "Mikhnevo" located in the central part of the Russian Plate (Moscow region). A complex for monitoring various geophysical parameters is set there, including seismic events, variations of the Earth's magnetic and electrical fields, and parameters of the ionosphere.
On February 6, 2008 one of the wells was equipped with a submersible sensor LMP308i (Germany). Since then continuous precise observations of water level in the well are being performed. At the same time the atmospheric pressure is being continuously measured at the wellhead site. The accuracy of water level measurements is about 0.5mm, atmospheric pressure – 0.1hPa, the sampling rate is 1s. In order to obtain representative time series the initial water level data is processed to remove the influence of atmospheric pressure. At the next stage different types of diurnal and semidiurnal tidal waves are detected.
After that phase shifts between tidal variations of water level in the well and corresponding volumetric deformations in tidal waves are estimated. Variations of water level are proportional to volumetric deformation. The slope of linear dependence characterizes the tidal response of water level and can be considered as the sensitivity of water level to the theoretical tidal volumetric deformation of the aquifer. Continuous expansion of the database of precise measurements can be used to detect statistically meaningful variations of underground water level, which correspond to changes of strain conditions of the rock massif under control.

Session 14: Innovative Site Characterization *(May 15, 9:15- 10:35)*

Title: Underground DC-geoelectrical and seismic surveys to investigate problem zones in salt rock formations

Author(s): Schütze C.[1], Just A.[1], Rücker C.[1], Zöllner H.[1], Matthes K.[1,2], Schicht T.[3]

Institution(s):
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[2] Helmholtz Centre for Environmental Research – UFZ Leipzig - Halle
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Abstract
Rock-salt formations have been selected as a suitable geological media for subsurface repositories of chemo-toxic waste, because of the barrier features due to its tightness (low porosity and hydraulic permeability). The safety of the waste disposal depends particularly on the presence and migration of brines. Therefore, processes like the influx of solutions, the leaching of contaminants from waste and the subsequent reactive transport in the aqueous phase have to be taken into account in a long-term safety analysis. The results of a research project (supported by the German Federal Ministry of Education and Research BMBF) concerning the safety assessment of underground waste disposal sites using non-destructive subsurface geophysical surveys within salt rock are presented here. Several geophysical techniques (GPR, geosonar, DC-geoelectrics, seismics) were methodically adapted to detect possible problem areas, like fault zones, disturbed rock zones and fractures with brines. The recent results concern DC-geoelectrical and seismic investigations within disused potash mines in Central Germany where brine reservoirs were supposed to exist in the fractured anhydrite layers. The geoelectrical investigations served to determine areas with higher water content, the seismic surveys were useful to image layer boundaries of the geological units. Additional laboratory investigations on rock salt samples were helpful in order to provide quantitative parameters determined under defined conditions. The combined interpretation of the methods leads to more reliable information on the occurrence of potential weakness areas within the salt rock. In relation to the required penetration depth and resolution for the disposal site safety observation the presented method combination offers the chance to detect anomalies within the geological layering and brine occurrence.

Title: Combination of different seismic methods and geotechnical soundings for a rapid characterization of the near-surface ground

Author(s): Steffen Popp, Falko Kretschmer, Thomas Vienken, Peter Dietrich

Institution(s): Helmholtz Centre for Environmental Research – UFZ, Department Monitoring and Exploration Technologies, Leipzig, Germany

Abstract

For economical and feasible seismic exploration of the near-surface ground, an approach has been developed for the joint application of reflection and refraction seismics as well as multi-channel analysis of surface waves (MASW). The measuring concept was tested within the research project COMEXTECH, dealing with the exploration of construction ground. Besides the overall characterization of the subsurface by refraction and reflection seismics, the MASW can be used for the derivation of relevant soil parameters such as soil stiffness. The centre of the measuring concept represents a land streamer, pulled by a vehicle equipped with the seismic source. The 24-channel land streamer may be tipped with different geophones, according to the focus of investigation.

We used three fully equipped land streamers with 72 channels at all at the test site Nauen close to Berlin, Germany. The first 24 positions of the land streamer nearby the seismic source were filled with 4.5 Hz geophones. The next two land streamers were tipped with 14 Hz geophones, respectively. The idea behind this arrangement is that the positions close to the shot point, which are not utilisable for reflection seismics, can be used for the interpretation of surface waves. The signal was given with an accelerated weight drop mounted on a cross-country vehicle. Shots were arranged every meter, and four shots per shot point were executed for an increased signal/noise ratio. Three registration units (GeodeTM by Geometrics) were connected in series for signal recording.

At the site, a profile of 164 m length was investigated in bidirectional manner in combination with geotechnical exploration technique. The purpose of bidirectional recording is to check the reliability and sensitivity of the seismic array and to increase the resolution of the image of the subsurface. By using the same shot points forth and back, a multiple overlap rate for certain common depth points (CDP) can be achieved, which is thought to result in an increased data quality. Geotechnical investigations comprise the use of Cone Penetrating Tests (CPT) for characterization of properties of the subsurface. Thereby the lithology may be derived by means of the friction ratio, which represents the ratio of the in-situ determined parameters of sleeve friction and cone resistance during CPT soundings.

First results of data processing are available for the interpolated shear wave velocities (Vs) of the analysis of the Rayleigh-type surface waves on a multichannel record (MASW) by using the program SURFSEIS. The velocities are more or less laterally layered with zones of lower velocities (<180 m/s) in the upper subsurface and in about 5 m depth at the southern part of the profile. The strong increase of shear-wave velocities in 10 m depth and below (>250 m/s) is supposed to correspondent to a glacial moraine underlying the sandy sediments. The characterization of the near-surface ground by MASW corresponds well with the results of the nearby CPT soundings. By comparing the MASW results of the forward and backward recording of the profile, however, it turns out that the methodical approach of bidirectional seismic measurements still needs some tests. The produced 2-D Vs profiles show some marginal differences in the Vs-distribution in detail. Processing of seismic refraction and reflection data are in progress yet.

In summery, the land streamer has the real advantage of fast data recording with a variable geophone array for different applications. The slight loss in quality of seismic data does not limit the use of the land streamer even on arable land. If carefully performed, geophones fitted on the land streamer still record data in an adequate quality for a feasible characterization of the subsurface, as shown in our study. Especially along long profiles the employment of a land streamer outplays stuck geophones by the fast progress in data recording due to the pulled array of geophones in a fixed geometry.

Title: Using heat as a tracer in a porous aquifer: Estimation of effective flow and transport parameters

Author(s): T. Li[1], C. Leven[1], P. Dietrich[2], P. Grathwohl[1], P. Blum[1]

Institution(s):
[1] University of Tübingen, Center for Applied Geoscience (ZAG), Tübingen, Germany
[2] Helmholtz – Centre for Environmental Research (UFZ), Leipzig, Germany

Abstract
In the early 1960s, attention was called to the potential for using heat as a tracer. Until now, this method has been developed and being applied confidently in some studies, such as delineating the groundwater regimes of basins and streambed-aquifer systems. In the current study, the feasibility of using temperature data to derive effective transport parameters of an aquifer such as hydraulic and thermal parameters is evaluated using a small-scale (~ 10 m) thermal tracer test. The field experiments were carried in a ground-water protection area at the well-equipped “Lauswiesen” test site, which is located close to the city of Tübingen, South Germany. During the test 16 m3 of warm water (22°C) was injected constantly into the unconfined aquifer, where the average groundwater temperature is 11°C. Multilevel thermal breakthrough curves with various temporal resolutions were measured for the resulting temperature changes at different depths within different observation wells using submerged thermometers (PT100 chains). The observed temperature data is interpreted and applied to calibrate an analytical and a numerical model. The analytical model enabled the determination of average values for hydraulic parameters such as porosity, hydraulic conductivity and longitudinal dispersivity as well as for thermal parameters such as the thermal conductivity. The finite-element model FEFLOW is used to determine their spatial variations. The results of the sensitivity analysis with the analytical model demonstrate that the heat transport processes in the aquifer are highly dependent on the aforementioned hydraulic parameters; whereas thermal conductivity in this circumstance might have minor influence, due to the fluid-solid matrix tends to provide a homogenous media for heat transfer. Furthermore, the derived parameters such as hydraulic conductivity and longitudinal dispersivity were compared with previous site-specific and non site-specific studies. Within the above described framework, the derived average hydraulic conductivity is 0.003 m/s, while the longitudinal dispersivity has an average value of 0.6 m. These results are comparable with results from other previous studies using pumping, flowmeter and dyed-tracer tests. Therefore, we conclude that thermal tracer tests can be used as a field characterization method in hydrogeological studies. However, the determined effective parameters are spatially variable suggesting that a complex numerical flow and transport modeling is also needed to adequately describe the thermal transport behaviors observed in the field experiment.

Title: 3-D georadar and its potential in site characterization: from structural images towards petrophysical parameters

Author(s): J. Tronicke, C. Schmelzbach, U. Böniger

Institution(s):
Universität Potsdam, Institut für Geowissenschaften

Abstract
Within the past decades, georadar reflection surveying has been established as one of the key geophysical techniques for exploring the shallow subsurface. In typical environmental, engineering, and geological applications, the popularity of this technique is based on its ability to resolve subsurface features in the decimeter range while concurrently providing investigation depths in the order of several meters to tens of meters. Although the advantages of high-resolution 3-D surveying approaches have been recognized, they are seldom found in practice, mainly because efficient surveying solutions using off-the-shelf instruments are not available. In addition, the analysis of the resulting reflection images is usually limited to a pure structural interpretation, e.g., outlining geological boundaries or man made anomalies such as buried utilities. The development of practical approaches for a more quantitative interpretation, e.g., providing estimates on material properties, is largely untapped.

Here, we present some of the most recent developments in 3-D georadar reflection surveying. First, we present an accurate, flexible, and efficient 3-D surveying strategy which is based on combining a standard georadar instrument and the latest generation of a commercially available self-tracking total station (TTS). In contrast to GPS solutions, which may not provide the required cm-range accuracy (e.g., in urban areas), a TTS system provides stable and high-precision positioning data with limited sensitivity to environmental variables. Furthermore, we illustrate the potential of advanced data interpretation approaches based on the analysis of selected data attributes. For example, the calculation of a polarization attribute allows for identifying material properties, e.g., to detect and distinguish metallic and non-metallic buried utilities. Integrating georadar data with complementary information (such as direct-push logs), provides new possibilities towards a more quantitative interpretation, e.g., to generate depth-calibrated 3-D models of hydraulic relevant parameters. Using data sets from a recently established test site, we demonstrate the potential of these developments to provide detailed structural and parameter-related 3-D models of the shallow subsurface.

Session 15: Stream-Aquifer Interaction /Watershed *(May 15, 11:00- 12:00)*

Title: Short- and Long-term Processes regarding Surface-Subsurface Water Interaction and Gypsum Karst Evolution

Author(s): J. Epting[1], P. Huggenberger[1], D. Romanov[2], G. Kaufmann[2]

Institution(s):
[1] Department of Environmental Sciences, Applied and Environmental Geology, University of Basel
[2] Institute of Geological Science, FU Berlin, Berlin, Germany

Abstract
Integrated and adaptive surface- and subsurface water monitoring and management in urban areas require innovative process-oriented approaches. To accomplish this, it is necessary to develop and combine interdisciplinary instruments that facilitate the adequate quantification of cumulative effects on water resources.

While the characterization and modeling of flow in heterogeneous and fractured media has been investigated intensively, there are no well-developed long-term hydrogeological research sites for gypsum karst. Subsidence of a river dam and an adjacent highway, both constructed on gypsum-containing rock, Southeast of Basel, Switzerland, required remedial construction measures. To safeguard surface and subsurface water during the construction measures, an extensive monitoring network was set up.

Integrated process-oriented investigation methods are presented, comprising the combination of multiple data sources (incl. hydrogeophysics) with high-resolution numerical groundwater modeling and model simulations of karstification. The various investigative methods for karst aquifer characterization complement each other and allow the interpretation of short-term impacts and long-term development on system-dynamics. Temperature data analysis of river water and riverine groundwater led to transient riverbed conductance values that could be incorporated into the groundwater model. This approach facilitated an accurate description of the transient character of flow regimes (surface-subsurface water interaction, conduit flow) during and after episodic flood events. Simulations of karstification facilitated the evaluation of long-term processes like local breakthrough events within the gypsum rock and time scales for karstevolution.

Results allow the optimization of investigative methods for similar subsidence problems and within karst areas in general, leading from universal measurements and monitoring technologies to tools with predictive character.

Title: Quantifying water and contaminant fluxes at the stream groundwater interface

Author(s): Christian Schmidt[1], Edda Kalbus[2],Martí Bayer-Raich[3], Frido Reinstorf[4] ,Mario Schirmer[5]

Institution(s):
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[2]acatech - GERMAN ACADEMY OF SCIENCE AND ENGINEERING, Germany
[4]University of Applied Sciences Magdeburg-Stendal, Dept. of Water and Recycling Management, Germany
[5]EAWAG, the Swiss Federal Institute of Aquatic Science and Technology, Dept. of Water Resources and Drinking Water, Switzerland

Abstract
The quantification of water fluxes through the streambed with fine spatial resolution can be crucial for understanding near stream flow pattern. Particularly, in temperate climates groundwater is typically discharging into streams. At contaminated sites, dissolved contaminants will migrate into the stream associated with groundwater discharge.
In a case-study the water fluxes to a small man-made stream were quantified using mapped streambed temperatures. The method takes advantage of the naturally occurring temperature gradient between the groundwater and the stream water. Since temperatures can be easily and inexpensively measured at hundreds of locations along a stream reach, the spatial pattern of groundwater discharge can be resolved with fine spatial resolution.
The potential mass fluxes towards the stream were estimated by combining the streambed temperature measurements with an integral pumping test (IPT). With the IPT the average mass flow rates of monochlorobenzene and the isomers of dichlorobenzene in the aquifer across a control plane adjacent to the stream were estimated. The potential contaminant mass fluxes from the aquifer to the stream were estimated from the average concentrations in the groundwater and the groundwater fluxes that effectively discharge into the stream.
Measurements of aqueous concentrations in the streambed revealed higher concentrations than those observed in the groundwater. Thus, the streambed sediments may act as secondary contaminant source for the stream water.

Title: Watershed Characterization for a Water Resources Decision Support System in Honduras

Author(s): P. Akomiah, D. Boateng, A. frimpong

Institution(s):
Watershed characterization studies in southeastern Honduras are being conducted by the Centre for Water Research at the University of Texas at San Antonio, the National Autonomous University of Honduras and several non-governmental entities.

Abstract:
The major emphasis is the application of a Decision Support System for Village Water Resources (DSSVWR) developed as a research project at UTSA to determine sustainable water supplies in remote areas of Honduras. In order to quantify water resources available on a seasonal basis, drainage basins were delineated and characterized by precipitation, runoff characteristics, soil type, land use and geology. Drainage basins were studied for potential for groundwater yield from extensive Miocene ignimbrite sequences and alluvial deposits in numerous structural and erosional valleys. Two types of regional aquifers were identified; ignimbrite sequences with low potential yields and excellent alluvial aquifers in valleys. Ground-water investigations included geophysical resisitivity surveys. Because of the heterogeneous nature of both the ignimbrite sequences and the alluvial deposits, results from apparent resistivities from dipole-dipole arrays could be readily plotted on transverse cross sections indicating depth to water table. Input from these hydrologic studies will be used in the DSS to estimate yields on a seasonal basis from various sources for individual watersheds in rural Honduras.

Session 16:Soils *(May 15, 11:00- 12:00)*

Title: Stokes'-Flow Approach to Infiltration

Author(s): Peter Germann

Institution(s): University of Ben (Switzerland)

Abstract

Water flow in the vadose zone of unconsolidated sediments or fissured rocks is conceptualized as exclusively gravity-driven and viscosity-controlled laminar flow. On one side, the concept explains coherently various observations like constant velocity of wetting fronts in homogeneous media, formation of fingers at interfaces from finer to coarser grained media, and the relationships between mobile water content, wetting front velocity and volume flux density. On the other side, it allows for the quantification of flow and transport that is based on *in-situ* measurements with ground penetrating radar, TDR-equipment, electrical resistivity, and the rise of water levels due to infiltration. The presentation will briefly introduce the basics and recommend measurement procedures.

Title: Full-waveform forward and inverse modeling of electromagnetic induction data for improved soil electrical conductivity estimation

Author(s): F. André[1], D. Moghadas[1], H. Vereecken[1], S. Lambot[1,2]

Institution(s):
[1]Agrosphere (ICG-4), Forschungszentrum Jülich, Germany
[2]Department of Environmental Sciences and Land Use Planning, Université Catholique de Louvain, Belgium

Abstract
Electromagnetic induction (EMI) has been intensively used since the 70's to retrieve soil physico-chemical properties through the measurement of the soil electrical conductivity. Non-invasiveness and fast data acquisition make EMI a relevant technique for characterizing large areas with fine spatial and/or temporal resolutions. However, existing EMI sensors present limitations, related more specifically to their empirical calibration procedure and the strong simplifying assumptions usually considered in modeling the EMI-subsurface system.

We present a new full-waveform EMI model developed for zero-offset, off-ground loop antennas. The model includes antenna propagation phenomena through a linear system of transfer functions. The air-subsurface is represented by a 3-D multilayered medium, for which Maxwell's equations are exactly solved. Signal inversion is performed iteratively combining global and local optimization algorithms. The transmitter and receiver is set up using a vector network analyzer (VNA), for which the calibration is physically well-defined as an international standard, thereby ensuring robust and accurate measurements.

The approach was successfully validated in laboratory conditions for measurements performed at different heights above a perfect electrical conductor. Despite the high dynamic range of VNA, regular loop antenna efficiency is not sufficient to ensure enough sensitivity to the soil electrical conductivity in zero-offset, off-ground mode. For higher efficiency, we designed a specific transmitting antenna consisting in two concentric coplanar coils generating two magnetic fields with opposite polarity to produce a magnetic cavity, where a regular receiving coil is placed. This set up allows to eliminate direct coupling between the transmitting and receiving antennas, thereby increasing the dynamic range of the system. The results obtained with this new method show great promise for accurate and robust soil characterization with EMI.

Title: Full-Waveform Hydrogeophysical Inversion of Time-Lapse GPR Data to Infer the Unsaturated Soil Hydraulic Properties in a Digital Soil Mapping Context

Author(s): K. Z. Jadoon[1], S. Lambot[1,2], E. C. Slob[3] and H. Vereecken[1]

Institution(s):
[1] Forschungszentrum Juelich GmbH, Germany
[2] Université catholique de Louvain, Belgium
[3] Delft University of Technology, Netherlands

Abstract
Sustainable and optimal management of soil and water resources requires mathematical models that predict subsurface flow and transport processes. A major shortcoming in the application of these models is the lack of knowledge regarding the spatial and temporal distributions of the model parameters at scales that are pertinent to the management scales. In that respect, non invasive geophysical methods show great promise for field scale digital soil mapping. Nevertheless, these tools still suffer from the underconstrained nature of the data sets, which leads to uncertain estimates.

We explore an alternative method by using integrated hydrogeophysical inversion of time-lapse, proximal ground penetrating radar (GPR) data to remotely estimate the unsaturated soil hydraulic properties. The radar system is based on international standard vector network analyzer technology and a full-waveform model is used to describe wave propagation in the antenna-air-soil system, including antenna-soil interactions. A hydrodynamic model is used to constrain the inverse electromagnetic problem in reconstructing vertical water content profiles. In that case the estimated parameters reduce to the soil hydraulic properties, thereby strongly reducing the dimensionality of the inverse problem. The uniqueness of the inverse solution is analyzed using numerical experiments for different textured soils and infiltration events. The stability of the inverse solution with respect to errors in fixed key hydraulic and petrophysical parameters is quantified. Finally, the approach is tested in controlled laboratory conditions for a variable infiltration event in a homogeneous sandy soil. In total, 16 GPR observations were made with uneven time steps, to catch most of the observed water dynamics. Results were compared with TDR and ground truth measurements. The results suggest that the proposed method is promising for characterizing the shallow subsurface hydraulic properties at the field scale.

Abstracts - Poster Presentation

Nr:	Title	Author(s)	Institution(s)
1	**Puls-Neutron-Neutron Tool for the Investigation of Highly Contaminated Areas**	Philipp Buckup [1] , Peter Dietrich [1] , Klaus Buckup [2]	[1] Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research ; [2] Der Bohrlochmesser – DBM
2	**Volatilization Potential of Benzene and MTBE in horizontal-flow constructed wetlands**	Nils Reiche [1,] Helko Borsdorf [1]	[1] Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research
3	**Use of commercially available 13C methods to demonstrate enhanced in- situ biodegradation of plume hydrocarbons following oxygen injection**	Mike Spence [1]; Gerard Spinnler, Cristin Bruce [2], Anton Reed [3], Dieter Stupp [4]	[1]Shell Global Solutions (UK); [2] Shell Global Solutions (US); [3] Shell Deutschland Oil GmbH; [4] Stupp Consulting GmbH
4	**Development of a "direct push" TDR/TDT-probe**	A. Mester and N. Klitzsch	Institute for Applied Geophysics and Geothermal Energy; E.ON Energy Research Centre (E.ON ERC)
5	**On-Site Analysis by Mobile X-ray Fluorescence - A Comparison of Two Different Instruments With Regard to Precision, Accuracy and Detection Limits**	A.Rämmler	Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research
6	**Study of agricultural off-road traffic impact using mobile geophysical techniques**	H. Petersen[1,] W. Rabbel[1], R. Horn[2], L. Volk[3], T. Wunderlich[1]	[1] Institute of Geosciences, Kiel University (Germany); [2] Institute of Plant Nutrition and Soil Science, Kiel University (Germany); [3] University of Applied Sciences South-Westphalia Soest (Germany)
7	**Comparison of Different Pumping Techniques for Depth-Discrete Groundwater Sampling**	U. Schneidewind [1] , L. Macis, M. Margagliotti, H. Paschke[1], C. Leven [2]	[1] Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany; [2] University of Tuebingen
8	**Modelling of nitrogen transport in the unsaturated zone and groundwater recharge calculation using an alternative method due to insufficient land-use data**	J. C. Draxler[1] and Gernot Klammler[2]	[1]Joanneum Research, Institute of Water Resources Management, Graz, Austria; [2] University of Graz, Austria. Institute of Geography and Regional Science

Nr:	Title	Author(s)	Institution(s)
9	**DC-Geoelectrical Surveys for Landfill Leachate Plume Detection**	Markus Hirsch[1], Augusto C. Pires[2], Holger Weiss[1]	[1] Helmholtz Centre for Environmental Research, UFZ,Department Groundwater Remediation, [2] University of Brasília, Institute of Geosciences
10	**Geological characterisation and mapping of preferential flow paths at a clayey till site in Denmark**	T.C. Kessler[1, 2,*], I. Damgaard[1], K.E.S. Klint[2], M.M. Broholm[1], C.M. Christiansen[1], P.L. Bjerg[1], B. Nilsson[2]	[1] Technical University of Denmark, Department of Environmental Engineering [2] Geological Survey of Denmark and Greenland
11	**Interpolation of Steady-State Concentration Data by Inverse Modeling**	R. L. Schwede and O. A. Cirpka	University of Tübingen, Centre for Applied Geoscience
12	**Development of Mathematical Models for the Characterization of the MIP-System**	J.Bumberger[1] T. Goblirsch[1], C. Leven[2], H. Borsdorf[1], P. Dietrich[1]	[1]Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research [2] University of Tübingen
13	**Influence of drainage state on direct-push hydraulic conductivity profiling using the CPT "on-the-fly" method**	M. Fitzgerald[1], M. Randolph[2] and D. Elsworth[3]	[1] Penn State University, Goettingen University; [2] University of Western Australia; [3] Penn State University
14	**Long-term monitoring of PAH leaching from soils using laboratory scale lysimeters**	O. Krüger, G. Christoph, H. Walzel, W. Berger	BAM
15	**The dynamics of Cu Contents in System Water-bottom Sediments- Fish in River Debed Waters (Armenia)**	Mher Mikayelyan	Center for Ecological-Noosphere Studies of NAS RA
16	**Seismic monitoring of slope dynamics caused by a slow-moving landslide in the Vorarlberg Alps, Austria**	M. Walter & M. Joswig	Institute for Geophysics, Universität Stuttgart
17	**Seismic monitoring of slope dynamics caused by the mudslide at Super-Sauze in the southern French Alps**	M. Walter & M. Joswig	Institute for Geophysics, Universität Stuttgart
18	**Rapid onsite determination of Volatile Organic Compounds (VOCs) in water samples using Ion Mobility Spectrometry (IMS)**	H.Borsdorf	Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research
19	**Comparision of non- and minimum invasive geophysical dike evaluation- techniques- a case study**	Thomas Vienken [1], Ulrike Werban [1], Carsten Leven [2], Martin Wahle [1], Anne-Kristin Push [3]	[1]Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research; [2]University of Tuebingen; [3]University of Leipzig

Title: Puls-Neutron-Neutron Tool for the Investigation of Highly Contaminated Areas

Author(s): Philipp Buckup [1] , Peter Dietrich [1] , Klaus Buckup [2]

Institution(s):
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[2] Der Bohrlochmesser – DBM

Abstract
The PNN technology utilizes a controllable physical source of fast neutrons and records curves of the distribution of thermal neutrons/neutron life time, bearing the information on the investigated medium (geological matrix, type of fluid, porosity and others).

PNN was used many years for the search of oil resources. New PNN application areas lie in ecological/environmental research, for the allocation and mapping of zones with organic and heavy metal pollution. The PNN application is not only used in classical vertical geometry, but also as a method for long time monitoring in one or several points of polluted zones. In the presentation two samples of PNN application on industrially polluted objects in Zeitz are discussed.

Examine an application from a curve of recession of thermal neutrons influence, their further classification and concentration of polluting substances is considered. Possibility of long time monitoring open new prospects to control of dynamics of a fluid and polluting substances in the geological environment. Possibilities of PNN application usibility with Direct-Push technologies.

Puls-Neutron-Neutron Tool for the Investigation of Highly Contaminated Areas

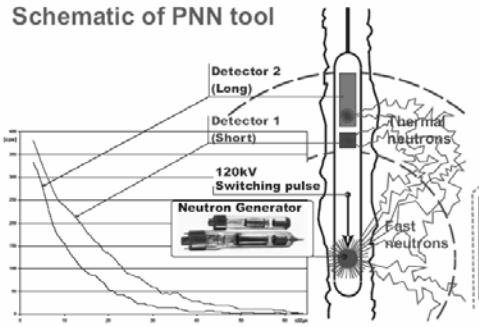
The Pulse-Neutron-Neutron (PNN) system is built around a neutron generator, a physical source of fast neutrons, and allows a strict thermal neutron recording of the whole induced decay curve. The decay curve is divided by hardware into 64 recording windows.

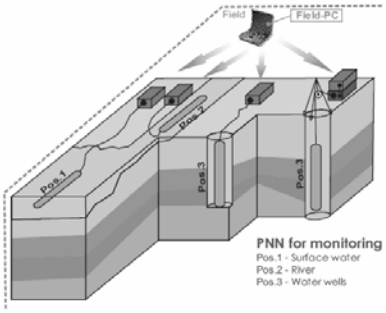
The 3 types of neutron reactions with materials find their response in different parts of the decay curve: pair creation, slowing-down and capturing. The majority of chemical elements is creating an effect in the middle part of the recorded decay between 400 and 1200 µs and basic reaction depends on slowing-down of the fast neutrons be the medium. The amplitude will be mainly influenced by the dominating components like hydrogenium and metals, for slowing down, and chlorine for capturing.

The PNN technique is unique and offers the possibility to investigate pollution in any medium water or soil. A large range of metallic pollutants and organics may be indicated and after sufficient calibration quantitatively recorded. The information is carried by the so called "decay"-curves, which reflect the content of the dominating component by their shape. Irregularities in the curve indicate the presence of further components. So far all present pollutants may deliver a share to the decay curve and consequently indicated.

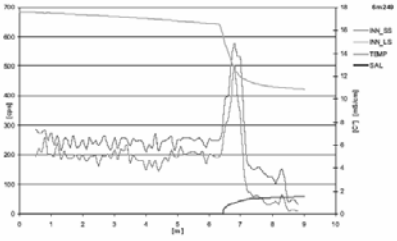
The PNN reacts differently to polluting components like are:
- Organic and inorganic pollutants
- Pollutants in water can be recognized on ppm-level.
- PNN may be performed in metallic pipes (direct-push or well technologies)
- PNN measurement technology could be use also for an in-situ monitoring.

Schematic of PNN tool

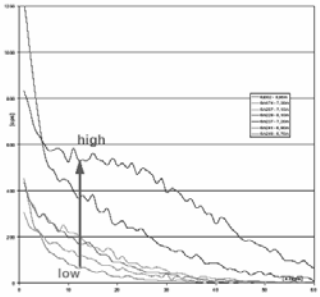




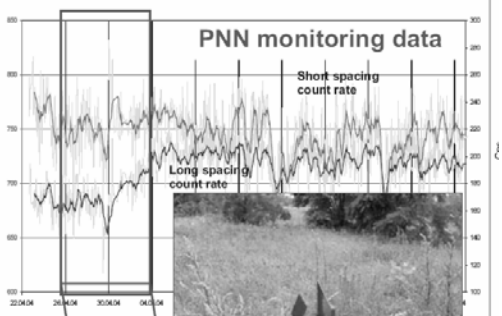
PNN Profile in DP well 6m249

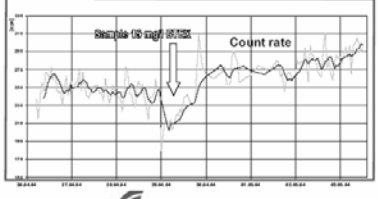


Decay curve effected by pollutant

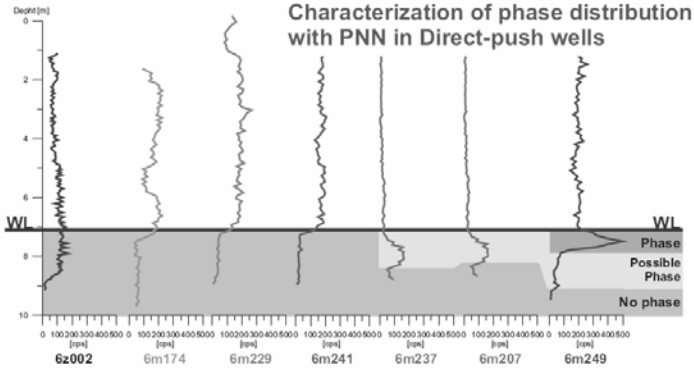


PNN monitoring data





Characterization of phase distribution with PNN in Direct-push wells



HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

NovCare 2009, 13-16 May 2009, Leipzig, Buckup Philipp, philipp.buckup@ufz.de

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

Title: Volatilization Potential of Benzene and MTBE in horizontal-flow constructed wetlands

Author(s): Nils Reiche, Helko Borsdorf

Institution(s): Helmholtz Centre for Environmental Research – UFZ

Abstract
Beside treatment of domestic wastewater, constructed wetland techniques are matters of concern for groundwater remediation at large scale brownfields since a few years, especially for contaminants, recalcitrant at usually anaerobic aquifers. Oxygen release to the rhizosphere by plants (i.e. phragmites or juncus species) enhances aerobic microbial degradation of pollutants. On the other hand roots loosen soil structure and enhance soil gas diffusion processes. Therefore, in case of VOC remediation, volatilization has to be taken into account, due to the usually small vadose zone of constructed wetlands. Distinguish parts degraded and volatilised is important for technology evaluation and of increasing relevance for emission control of remediation technologies, governed by environmental requirements.

Field investigations at the Leuna (Saxony-Anhalt) location using a meso-scale wetland planted with phragmites australis and a similar non planted system site showed enhanced decrease water polluting by priority pollutants within the flowpath (benzene and methyl tertiary butyl ether, MTBE) at the planted system. At both remediation approaches volatilization rates were analysed with methods based on dynamic air chambers.

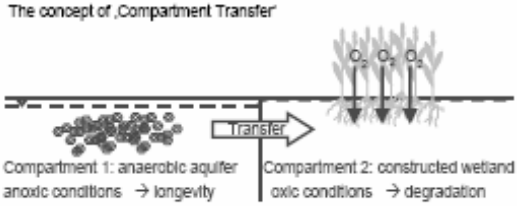
In general minor to none volatilization rates were found at the surface of the unplanted reference system. Significant higher volatilization was found on the planted wetland, where the extent of MTBE volatilization was greater than for benzene. Seasonal variations were observed for the volatilization rates with lower ones in the winter and spring campaigns and higher values were obtained in the summer campaigns. After balancing the volatilization with the overall contaminant mass loss in the system, we could show that the volatilization is a minor process in this certain phytoremediation technique. The volatilization part on the contaminant mass loss stays below 10 % for both routing substances. Also we were able to identify the air and soil temperatures inside the chambers and the evapotranspiration as the decisive parameters for contaminant volatilization.

Volatilization Potential of Benzene and MTBE in horizontal-flow constructed wetlands

N. Reiche, H. Borsdorf
Department Monitoring and Exploration Technologies
Helmholtz Centre for Environmental Research – UFZ, D-04318 Leipzig

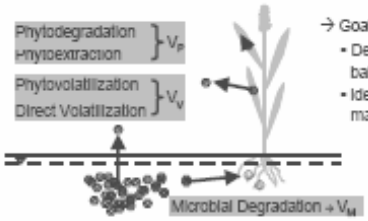
Introduction

Groundwater remediation using constructed wetlands (Phytoremediation)
The concept of ‚Compartment Transfer'



→ Clean and cost-effective technology, particularly at groundwater to surface water interface

Volatilization as part of relevant processes for contaminant distribution between compartments in Phytoremediation



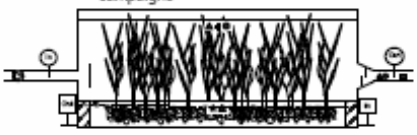
→ Goals:
- Determination of mass balance: $\Delta m = V_V + V_P + V_M$
- Identify volatilization part of mass balance

Experimental Setup

Constructed wetlands (pilot plant Leuna):
- Dimension 5*1.1*0.5 m
- Groundwater load 6 L h^{-1}
- Planted with common reed (*Phragmites*)
- Inflow concentration Benzene ~20000 µg L^{-1}
  MTBE ~4000 µg L^{-1}

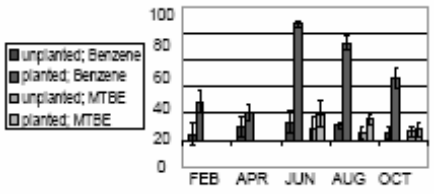
Dynamic Air Chambers (DAC)
- Stainless steel frame; ETFE-cover (200 µm)
- Adjustable blower (air exchange ~50 h^{-1})
- Quantification and totalization of air throughput

→ Five 2-week sampling campaigns every 6-8 weeks in 2008
- ○ Active air sampling with external pumps on sorbent cartridges: 24 h samples
- □ Water sampling: daily during sampling campaigns

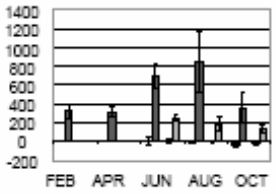


Embedded Sensors:
▲Temperature ● Relative humidity ◆Global radiation
★ Soil moisture ■Quantification and totalization device

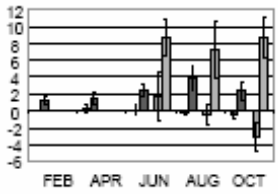
Results



1. Mass loss [%]: Percentage rest concentration: Δ (inflow-outflow) inflow^{-1}: Δ m



2. Volatilization rate [µg m^{-2} h^{-1}]:
Contaminant air concentration relating to 1 m^2 surface area and 1 h



3. Volatilization part of mass loss [%]:
Percentage part of volatilization on overall contaminant mass loss:
$\Delta m = V_V + V_P + V_M$

Conclusions

- Significant higher volatilization on planted wetland compared to unplanted reference
- Seasonal variations were observed for the volatilization rates; lower in winter/ spring campaigns, higher in summer campaigns
- Volatilization is a minor process (≤ 10 %) in Phytoremediation
- Maximum Volatilization in summer: Benzene ~700 µg h^{-1} m^{-2}
  MTBE ~250 µg h^{-1} m^{-2}
- Air and soil temperatures and evapotranspiration have greatest impact on VOC volatilization
  (result of statistical testing, not presented here)

Acknowledgement

This work was supported by the Helmholtz Centre for Environmental Research – UFZ in the scope of the SAFIRA II Research Programme (Revitalization of Contaminated Land and Groundwater at Megasites, subproject "Compartment Transfer - CoTra").

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Contact: nils.reiche@ufz.de

Title: Use of commercially available 13C methods to demonstrate enhanced in- situ biodegradation of plume hydrocarbons following oxygen injection

Author(s): M. Spence[1], G. Spinnler[2], Cristin Bruce[2], Anton Reed[3], Dieter Stupp[4]

Institution(s):
[1] Shell Global Solutions (UK)
[2] Shell Global Solutions (US)
[3] Shell Deutschland Oil GmbH
[4] Stupp Consulting GmbH

Abstract
The effect of pulsed oxygen injection remediation (OPIS) on in-situ biodegradation rates in groundwater was evaluated using two commercially available in-situ microcosm technologies: Biotraps (Microbial Insights, US) and Bactraps (Isodetect, Germany). The traps, supplied pre-loaded with ^{13}C-hydrocarbon substrates, were incubated for a period of 2 months in boreholes located in anaerobic groundwater, and aerobic groundwater oxygenated to >30 mg/L O_2. The traps were later removed and analysed to determine the ^{13}C-content of dissolved inorganic carbon (DIC) and phospholipid fatty acid (PLFA) in the microbial biomass. Biodegradation was quantified through the ^{13}C-enrichment of PLFA in the biomass.

PLFA recovered from Bactraps incubated in aerobic groundwater shows clear ^{13}C-enrichment ($\delta^{13}C$= +11,491‰), but there is no significant ^{13}C-enrichment in PLFA from traps incubated in anaerobic groundwater ($\delta^{13}C$= -24 to -31‰). This is consistent with enhanced biodegradation only at elevated oxygen concentrations.

Data from the Biotraps shows ^{13}C- enrichment of PLFA in both aerobic ($\delta^{13}C$= +17,703‰) and anaerobic groundwater ($\delta^{13}C$= +2249‰), although the degree of enrichment is greater where O_2 is present. This is consistent with biodegradation under both aerobic and anaerobic conditions, but with higher rates at elevated oxygen concentrations.

The reason for increased incorporation of ^{13}C into PLFA recovered from the anaerobic Biotraps is not yet clear. Possible reasons include differences in the ^{13}C-substrates used (Bactraps were loaded with 100% ^{13}C-labelled substrates, Biotraps with 10% ^{13}C-labelled substrates), or differences in the sorbent materials used in the construction of the devices. Subtle variations in the chemistry of the anaerobic groundwater could also have contributed to the difference, since the Bactraps and Biotraps were incubated in different boreholes.

The ^{13}C content of DIC was quantified differently by the two laboratories, with Isodetect analyzing a groundwater sample recovered from the borehole after the incubation period and Microbial Insights isolating CO_2 recovered from the Biotrap. Isotopic analysis of DIC was found to be a less sensitive indicator of biodegradation activity, with only one of the substrates tested yielding significant ^{13}C enrichment of associated DIC under aerobic conditions. Exchange of DIC between the devices and the groundwater prevented the ^{13}C-DIC data being used to calculate the % of ^{13}C-substrate degraded.

In summary, results from both the Bactrap and Biotrap investigations clearly show that pulsed oxygen injection increased in-situ biodegradation rates for all the compounds tested relative to untreated groundwater. This finding is in agreement with the results of aerobic microcosm studies, carried out using samples of aquifer sediment and groundwater from the same site.

Shell Global Solutions

Use of ^{13}C methods to demonstrate enhanced in- situ biodegradation of hydrocarbons in groundwater following oxygen injection

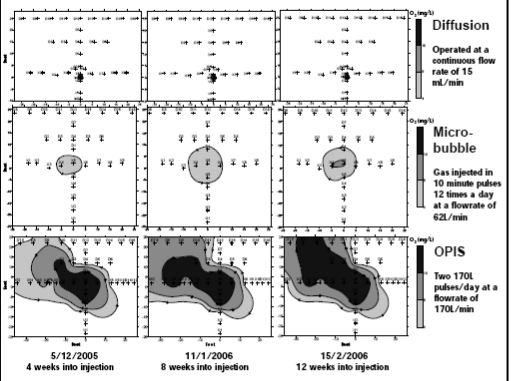
Mike Spence*, Gerard Spinnler**, Cristin Bruce**, Anton Reed†, Dieter Stupp‡

* Shell Global Solutions (UK). email: Mike.Spence@shell.com (corresponding author)
** Shell Global Solutions (US) Inc.
† Shell Deutschland Oil GmbH.
‡ Dr Stupp Consulting GmbH.

Background

- Oxygen Pulsed Injection Systems (OPIS) have been developed by Shell as a sustainable, cost effective, alternative to plume control by pump and treat.
- Advantages of OPIS:
  - ✓ Reduced energy consumption
  - ✓ No need to remove water from the aquifer so no loss of water resource
  - ✓ Low surface profile- no need for extensive above ground treatment plant; no operator exposure
  - ✓ Easy to maintain and operate, requires minimal power and oxygen supply
  - ✓ Pulsed mode of injection maximises oxygen distribution in aquifer
  - ✓ Frequency of oxygen injection can be varied to meet groundwater oxygen demand without compromising distribution efficiency

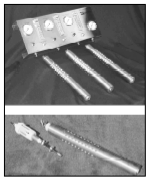
Case Study 1: Evaluation of oxygen distribution technologies under standard conditions



Points of interest for OPIS system:
- Useful zone of influence established within 1 month
- Oxygenated zone remains stable over evaluation period

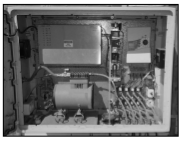
Oxygen Distribution Technologies:

Diffusion- based system



Using oxygen and hydrophobic hollow fibers which infuse high levels of oxygen into groundwater, this technology creates a superoxygenated environment within the well

Microbubble- based system



Gas micro-bubbles are injected directly into the groundwater and are randomly dispersed through the water and the saturated soil formation

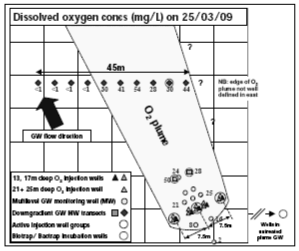
Pulsed injection system (OPIS)

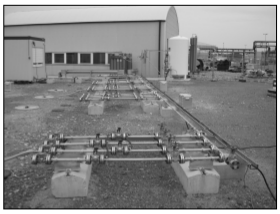
Discrete volumes of oxygen delivered once or twice a day using pressure tanks and solenoid valves

Case study 2: Use of Biotraps and Bactraps to show that OPIS increases in-situ biodegradation potential

- OPIS has recently been evaluated at a manufacturing site as a potential alternative to long- term pump and treat.
- A pilot system was installed after gene probe and laboratory microcosm studies indicated that bacteria present in aquifer sediments could rapidly biodegrade benzene and MTBE in the presence of oxygen
- In order to prove that bacteria in the aquifer were responding to the added oxygen and utilising it for breakdown of benzene and MTBE, an in-situ assay of biodegradation activity was required.
- Commercially available Bactraps and Biotraps, loaded with ^{13}C-labelled benzene and MTBE, were deployed in untreated groundwater and in the oxygen plume downgradient of the OPIS system.
- In-situ bacteria biodegrading the ^{13}C-labelled substrates incorporate some of the ^{13}C atoms into phospho-lipid fatty acids (PLFA) in their cell membranes, or oxidise them to release $^{13}CO_2$. This $^{13}CO_2$ can then dissolve to increase the dissolved inorganic carbon (DIC) concentration in surrounding groundwater
- After 2 months the Biotraps & Bactraps were returned to the suppliers for extraction of biomass and isotopic analysis of biomass PLFA and DIC

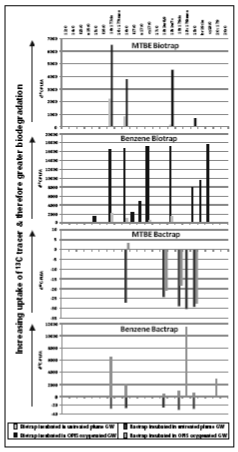
OPIS pilot trial at a manufacturing site





Central line of oxygen injection wells, with oxygen ballast tank and compressed oxygen supply cylinders in background

Results of Bactrap/ Biotrap investigations



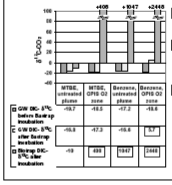
Biotraps PLFA analysis

- ➢ Significantly greater ^{13}C enrichment of PLFA in Biotraps incubated in OPIS oxygenated groundwater. E.g.
  - MTBE: 687 to 6491 ‰ vs 20 to 22494‰ in untreated plume groundwater
  - Benzene: 1367 to 17703 ‰ vs 4 to 2214 ‰ in untreated plume groundwater
- ✓ OPIS has significantly increased in-situ biodegradation rates for both benzene and MTBE relative to the untreated plume.

Bactraps PLFA analysis

- ➢ Significant ^{13}C enrichment of PLFA recovered from ^{13}C-MTBE or ^{13}C-benzene Bactraps incubated in OPIS oxygenated groundwater. E.g.
  - MTBE: -3.2 to -27.6 ‰ vs -23.9 to -28.6 ‰ in std MTBE Bactraps
  - Benzene: 425 to 11491 ‰ vs -27.04 to -31.09 ‰ in std benzene Bactraps
- ➢ No significant ^{13}C enrichment of PLFA recovered from ^{13}C-MTBE or ^{13}C-benzene Bactraps incubated in untreated plume groundwater. E.g.
  - MTBE: -24.4 to -30.4 ‰ (vs -27.97 to -29.59 ‰ in std MTBE Bactraps)
  - Benzene: -25.7 to -30.7 ‰ (vs -27.04 to -31.09 ‰ in std benzene Bactraps)
- ✓ OPIS has greatly increased in-situ biodegradation rates for benzene, and also (to a lesser extent) MTBE relative to the untreated plume.

Dissolved inorganic carbon (DIC)



Benzene

- ^{13}C- enriched DIC detected after incubation of both ^{13}C- benzene Bactraps and Biotraps in OPIS oxygenated groundwater.
- ^{13}C- enriched DIC detected after incubation of the ^{13}C- benzene Biotrap in the untreated groundwater, but not the ^{13}C- benzene Bactrap

MTBE

- ^{13}C- enriched DIC detected after incubation of the ^{13}C- MTBE Biotrap in the OPIS oxygenated groundwater, but not the ^{13}C- MTBE Bactrap
- ✓ Bactraps and Biotraps indicate increased benzene mineralisation rates in response to oxygen injection by OPIS.
- ✓ Biotraps indicate increased MTBE mineralisation rates in response to oxygen injection by OPIS

Conclusions

- In comparative trials carried out under comparable conditions, OPIS appeared to outperform diffusion and microbubble- based oxygen distribution technologies
- Pilot testing has shown that OPIS can maintain high dissolved oxygen concentrations (>30 mg/L) for long periods of time, even at high groundwater flow rates of 3m/day
- Bactrap and Biotrap data show that benzene and MTBE biodegradation rates were significantly increased in the oxygen- enriched (by OPIS) groundwater relative to the untreated plume
- Pilot test data indicate oxygen pulsed injection systems may be a sustainable alternative to pump and treat at this site

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

Title: Development of a “direct push” TDR/TDT-probe

Author(s): A. Mester and N. Klitzsch

Institution(s):
Institute for Applied Geophysics and Geothermal Energy
E.ON Energy Research Centre (E.ON ERC)

Abstract
For some problems the vertical resolution of geophysical surface methods is insufficient (e.g. for lithostratigraphic studies). Drilling holes to analyse the drill cores or to acquire geophysical logging data can overcome the resolution problem. Unfortunately, these methods are often too expensive for near surface applications. The ``direct push'' method is a time- and cost-effective alternative for unconsolidated sediments. Here, probes measure while pushed into the ground. Today, the number of available geophysical probes is limited.

We develop a “direct push'' time domain reflectometry/transmissiometry (TDR/TDT) probe. Such probes measure the traveltime of electromagnetic (EM) pulses/waves propagating along wave guides in soils to deduce the electric permittivity and thus the water content (of the soils). Two different probe concepts are assessed and optimised by modelling the EM waves propagating along the probes (wave guides).

1. The first concept uses the steel rod itself as wave guide (probe). The EM wave guided by a cylindrical steel probe has an axialsymmetric field and therefore ideal penetration depth. The main difficulty within this approach is the coupling of the electromagnetic pulse from the coaxial cable into the steel rod. The field modes must be transformed and this leads to losses. A conducting cone, which guides the shielding of the coaxial cable away from the probe, reduces this effect.

2. The second probe concept uses a nonconducting cylinder with the wave guide wrapped around. The wave guide consists of two parallel metallic wires connected to the core and the shield of the supplying coaxial cable. This provides a higher vertical resolution and a better coupling. It also leads to a smaller region of influence. Besides, the probe is more damageable than the first probe. Both probe concepts were tested with a 200 ps rise-time step pulse (peak voltage 0.25 V). We present the results of these experiments and our numerical simulations.

Development of a "Direct Push" TDR/TDT-Probe

RWTH AACHEN UNIVERSITY

Achim Mester and Norbert Klitzsch

Applied Geophysics and Geothermal Energy, E.ON Energy Research Center, RWTH Aachen University, Aachen, Germany

E.ON Energy Research Center

Introduction

We are developing a TDR/TDT probe for direct push measurements in order to increase the vertical resolution of near surface geophysical methods. We aim at a radial sensitivity that reaches beyond the compaction zone of the direct push probe. We study two probe geometries and two measurement concepts by numerical modelling and test measurements. The studied probe geometries are:

single rod probe (SRP) helical shaft mounted probe (HSMP)

TDR/TDT

The studied measurement concepts are time domain reflectometry and transmissiometry (TDR/TDT). Both techniques use a step-pulse with extremely short rise-times of some picoseconds. With TDR and TDT the reflected and the transmitted signal is measured, respectively (figure 1). Applying TDR/TDT for soil probing, the electromagnetic signal propagates along and not inside the conductor. Hence, the soil properties strongly influence the signal properties (velocity v, attenuation ϵ'').

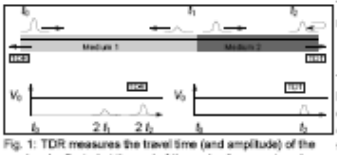


Fig. 1: TDR measures the travel time (and amplitude) of the signal reflected at the end of the probe (two-way travel time), whereas TDT measures the one way travel time at the end of the probe. The diagrams show examples for TDR/TDT signals.

The velocity of an electromagnetic wave is

$$v = \frac{1}{\sqrt{\epsilon\mu}} \qquad (1)$$

The magnetic susceptibility μ has no considerable influence on the signal for the used frequencies and the analysed material (soil). The electric permittivity ϵ is the product of the electric constant ϵ_0 and a relative el. permittivity ϵ_r, which represents a correction for specific materials (i.e. $\epsilon_{r,water} \approx 80$, $\epsilon_{r,soil,wet} \approx 30$, $\epsilon_{r,a} \approx 1$, ...). Those material properties also have complex parts, which descibe the attenuation of a signal:

$$\epsilon = \epsilon' + i\epsilon'' = \epsilon' + i\frac{\sigma}{\omega} \qquad (2)$$

ϵ' and ϵ'' are real and imaginary part of the el. permittivity. Both are generally depending on the frequency ω. The imaginary part provides information about the ground conductivity σ.

Single Rod Probe (SRP)

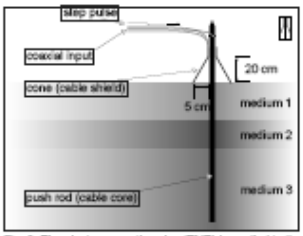


Fig. 2: The electromagnetic pulse (EMP) is applied to the push rod and a mode converter (cone) at the earth surface. The rod is pushed through the cone into the ground.[1]

The SRP geometry was studied in a version, where the probe is the push rod itself (figure 2). The mode converter (which converts the transversal electromagnetic (TEM) mode from the coaxial line to the transversal magnetic (TM) mode that is able to propagate along a single conductor rod) is a conducting cone at the earth surface. The rod is pushed through the cone.

Helical Shaft Mounted Probe (HSMP)

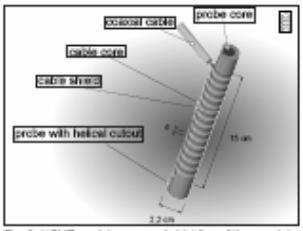


Fig. 3: HSMP model - core and shielding of the coaxial cable run around a cylindrical (isolating) body. The shown model was constructed using SolidWorks and is used for simulations.

Our second geometry consists of a cylindrical core with a helical mounted conductor pair, which acts as waveguide (figure 3). For this design a high vertical resolution is achived. The probe length is fixed and therefore the pulse travel time is influenced by the soil permittivity only. Keeping the shield beside the core of the coaxial line, the loss at the transmission point to the probe is noticeably smaller than with the SRP geometry. [2]

References

[1] G. Goubau, Single-conductor surface-wave transmission lines, Proceedings of the IRE 39 (6) (1951) 619–624.

[2] G. Topp, D. Lapen, G. Young, M. Edwards, Evaluation of shaft-mounted tdt readings in disturbed and undisturbed media, TDR 2001 - 2. International Symposium and Workshop on TDR for Innovative Geotechnical Applications.

Simulations

The decision for one probe type, which we are going to build, will be based on our simulations. We simulate the electromagnetic wave propagation for both probes using the FEM program Comsol Multiphysics. The electromagnetic field is basically derived from the telegraph equation

$$\Delta\vec{E} = \mu\sigma\frac{\partial\vec{E}}{\partial t} + \mu\epsilon\frac{\partial^2\vec{E}}{\partial t^2}, \qquad (3)$$

containing the electric field $\vec{E}$ and the electromagnetic material properties (el. permittivity ϵ, mag. susceptibility μ). With the simulations we can analyse the reflected (TDR) and the transmitted (TDT) signal. We want to assess the probe types by studying the influence of soil permittivity ϵ_r and soil conductivity σ on the signal as well as the signals region of influence (ROI).

Results

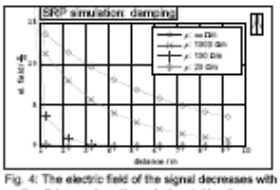
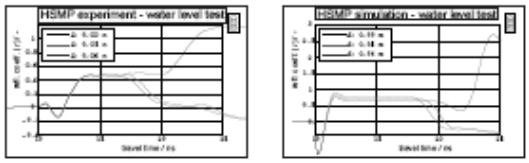


Fig. 4: The electric field of the signal decreases with the distance along the rod when taking the conductivity of the soil into account.

Our simulations show a ROI of about 10 cm for the SRP design. The damping of the signal depends on the conductivity of the surrounding material. Our simulations lead to the conclusion, that the signal is lost after 4 meters in a medium with a specific el. resistance of $\rho = 100$ Ωm (figure 4). This would limit possible applications.

Because of the relative large ROI we consider a second design, where the probe is included into the push rod (figure 6) and therefore has a constant length. First simulations show significant losses when coupling the signal into the probe. A cone as illustrated in fig. 2 can not be used. Some considerations are given below in the outlook section.

The simulation of the HSMP design confirms the expected resolution advantage of the helical conductor shape in horizontal layers. For comparison a handmade HSMP model was build and tested in TDR mode. The results are shown in figure 5.



(a) experiment (b) simulation

Fig. 5: A HSMP model was tested with a Campbell Scientific TDR 100. The probe was placed in a bucket and the water level raised from 0 to 8 cm in steps of one centimeter. Fig. 5(a) shows the reflection coefficient for three water levels. The signal increases when the pulse enters the probe and decreases when reaching the water level (the blue line was measured without water around the probe). Fig 5(b) is the solution from our simulations for no water and for water levels of 5 and 6 centimeters.

Conclusion and Outlook

The SRP, as illustrated in figure 2, can not be used for larger distances since the signal gets lost in conductive soils. An integration of the SRP into the push rod means losses of about 90 % when coupling the pulse into the probe. We are trying to optimize the transmission. Figure 6 shows a model of a modifed SRP. It may be used in TDT mode, where only the amplitude and the travel time is analysed. First simulations are shown in figure 7.

The HSMP design is much more complex since there are no symmetries to simplify the simulation. First results could be confirmed by test measurements (figure 5). The region of influence has to be studied for different cable spacings d (figure 3).

During our study we found some pros and cons for the SRP and the HSMP concept. A summary is given in tab. 1.

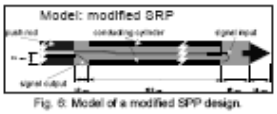


Fig. 6: Model of a modified SRP design.

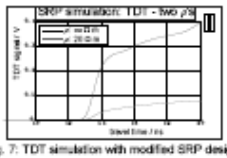


Fig. 7: TDT simulation with modified SRP design.

	SRP	HSMP
losses	–	+
attenuation	–	+
region of influence	+	–

Tab. 1: Overview of SRP and HSMP concepts.

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Title: On-Site Analysis by Mobile X-ray Fluorescence - A Comparison of Two Different Instruments With Regard to Precision, Accuracy and Detection Limits

Author(s): A. Rämmler

Institution(s): Helmholtzzentrum für Umweltforschung UFZ

Abstract
Ease of use and adaptability have made energy dispersive X-ray fluorescence (EDXRF) one of the most widely applied instrumental methods for elemental analysis. EDXRF can simultaneously determine concentrations of 20 or more elements in the range from sodium through uranium within only a few minutes. Sample preparation is not required or can be done with minimal efforts. Performance of modern portable instruments is comparable to laboratory techniques. For this reasons EDXRF became the ideal analytical technique for on-site elemental analysis in soils or waste material.
Spectrace QuanX is a transportable bench top spectrometer. The spectrometer is a single module, including auto sampler. An adjustable output x-ray tube source (max. 50kV, 1 mA) and the use of 8 primary filters provide selective excitation for elements of interest. The spectrometer is equipped with a thermoelectrically cooled Si(Li) detector that makes possible a resolution of 165 eV (at 5.9 keV). The device is handled by an external PC and needs external AC for operation.

The Thermo Scientific Niton XL3t handheld x-ray fluorescence (XRF) analyzer has the size and shape of a cordless screwdriver and is powered by a battery pack. It is equipped with a miniaturized x-ray tube (max. 50kV, 40 µA), 3 primary filters and a thermoelectrically cooled semiconductor detector. For operation and calculation of the analysis results it contains a pocket-pc processor and a touch screen.
To compare both instruments with regard to precision, accuracy and detection limits different geological standard reference materials (SRM) were placed into sample cups and then measured with both instruments. Three sets of excitation conditions were used to analyse the elements in the sample. The realtime for an analysis is about 10 - 15 minutes (QuanX) resp. about 2 minutes (XL3t).

The present poster article reports the conditions of use, advantages and disadvantages, and analytical results reached by application of the introduced instruments. Furthermore the influence of suitable standard reference materials on the analytical result will be shown.

ON-SITE ANALYSIS BY MOBILE X-RAY FLUORESCENCE – A COMPARISON OF TWO DIFFERENT INSTRUMENTS WITH REGARD TO PRECISION, ACCURACY AND DETECTION LIMITS

Introduction – Why mobile X-ray fluorescence?

- pollutants are mostly distributed very inhomogeneous in the area of waste deposits and contaminated land
- during an investigation project this fact may cause sampling errors of some hundreds percent and lead to a disproportion to the efforts and costs of the following analytical procedures
- this disproportion could be avoided by the use of field screening techniques
- application of on-site techniques does not only save time and costs required for the analysis of the samples because results are available immediately and the location of the next sampling point can be choosen accordingly
- for this reason the use of on-site techniques leads also to improved effectiveness and a reduction of the total project time
- ease of use and adaptability have made energy dispersive x-ray fluorescence (EDXRF) one of the most widely applied instrumental methods for elemental analysis
- EDXRF can simultaneously determine concentrations of 20 or more elements in the range between sodium and uranium within only a few minutes
- sample preparation is not required or can be done with minimal efforts
- performance of modern portable instruments is comparable to laboratory techniques
- for this reasons EDXRF became the ideal analytical technique for on-site elemental analysis in soils or waste material

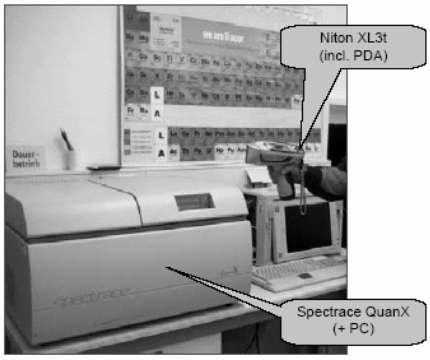
Instrumentation – Comparison of both instruments

Spectrace QuanX

- transportable bench top spectrometer
- single spectrometer module including auto sampler; different sample trays allow the measurement of single samples up to chamber size, 20-position samples up to 32mm diameter or 10-position-spinning samples up to 47mm diameter
- x-ray tube (50kV, 1 mA maximum power) and the use of 8 primary filters and a thermoelectrically cooled Si(Li) detector that makes possible a resolution of 165 eV (at 5.9 keV)
- device is handled by an external PC and needs external AC for operation

Niton XL3t

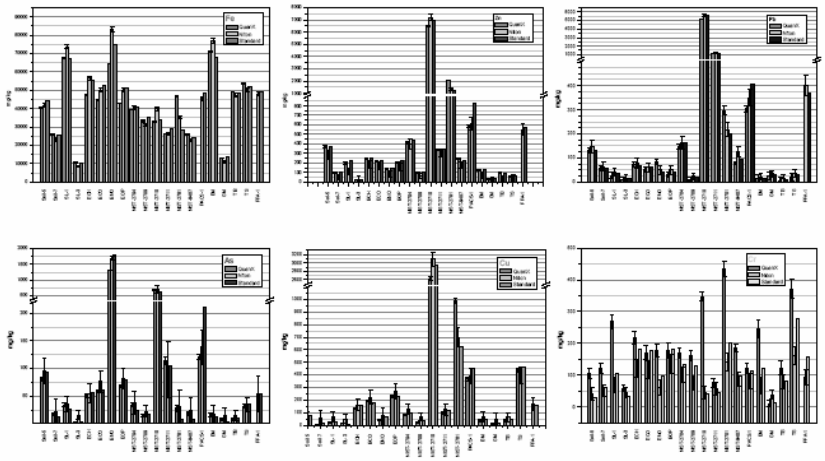
- handheld analyzer
- size and shape of a cordless screwdriver
- powered by a battery pack
- equipped with a miniaturized x-ray tube (50kV, 40 µA maximum power), 3 primary filters and a thermoelectrically cooled semiconductor detector
- for operation and calculation of the analysis results it contains a pocket-pc processor and a touch screen



Experimental

- different geological standard reference materials (SRM) were measured with both instruments
- three sets of excitation conditions were used to analyse the elements in the sample
- realtime for an analysis is about 10 – 15 minutes (QuanX) resp. about 2 minutes (XL3t)
- spectral intensities were corrected and quantified by both instruments using Fundamental Parameter programs

Results for some selected elements



SRM	Origin
SOIL-5	soil [1]
SOIL-7	soil Austria [1]
SL-1	lake sediment [1]
SL-3	lake sediment [1]
ECH	fly ash [2]
ECO	fly ash [2]
ENO	fly ash [2]
EOP	fly ash [2]
NIST-2704	Buffalo River sediment [3]
NIST-2709	San Joaquin soil [3]
NIST-2710	Montana soil [3]
NIST 2711	Montana soil [3]
NIST-2781	sludge [3]
NIST-8407	flooding soil [3]
PACS-1	sludge [4]
BM	granite [5]
GM	granite [5]
TB	argillite [5]
TS	slate [5]
CTA-FFA-1	fly ash [6]

[1] International Atomic Energy Agency (IAEA), Vienna
[2] Institute of Radioecology and Applied Nuclear Sciences, Kosice
[3] National Institute of Standards and Technology (NIST)
[4] National Research Council of Canada (NRCC), Ottawa
[5] Zentrales Geologisches Institut (ZGI), Berlin
[6] Institute of Nuclear Chemistry and Technology (INCT), Warsaw

- results are showing in most cases reasonable concordance between certified SRM values and measured values of both instruments
- QuanX provides lower detection limits then XL3t; in case of low concentrations near the detection limit the use of QuanX gives an advantage in spite of limited mobility
- because of its low weight, cordless power, short measurement time and mobility XL3t is the favoured device for the exploration of heavy contaminated land

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FH-DGG

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Title: Study of agricultural off-road traffic impact using mobile geophysical techniques

Author(s): H. Petersen[1], W. Rabbel[1], R. Horn[2], L. Volk[3], T. Wunderlich[1]

Institution(s):
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[2] Institute of Plant Nutrition and Soil Science, Kiel University (Germany)
[3] University of Applied Sciences South-Westphalia Soest (Germany)

Abstract
During 2005-2008 a research project was conducted at the University of Kiel (Germany) and the University of Applied Sciences Soest (Germany) (1) to investigate the impacts of agricultural off-road traffic on soil compaction at different loads, tire inflation pressures and tillage systems and (2) to assess, if geophysical mapping methods are suitable for extensive detection of soil compaction.

The Geophysical Department of Kiel University performed mobile time-lapse field measurements with electro-magnetic induction technique (EMI) in frequency mode, ground penetrating radar (GPR) and gamma spectrometer to map the variability of soils on all experimental locations and to investigate sensitivity of different geophysical mapping methods to compaction processes.

EM38 data showed a clear trend of an increasing apparent electric conductivity ECa on heavily trafficked areas. In first order the magnitude of that effect was dependent on soil status (porous-compact) before trafficking, but also on soil type and time gap between trafficking and measurements. Soil physical properties like pore size distribution and soil functions like saturated hydraulic conductivity were negatively influenced and therefore mainly responsible for the increasing electrical conductivity (fewer air filled pores, higher connectivity, more corn contacts). The same parameters caused attenuation in GPR signal and thus an increase in depth penetration on heavily compacted areas. Results of our field experiments will give advice in future execution and interpretation of geophysical mapping of arable land.

Title: Comparison of Different Pumping Techniques for Depth-Discrete Groundwater Sampling

Author(s): U. Schneidewind[1], L. Macis, M. Margagliotti, H. Paschke[1], C. Leven-Pfister[2]

Institution(s):
[1]Helmoltz - Centre for Environmental Research (UFZ), Leipzig, Germany
[2]University of Tübingen, Center for Applied Geoscience

Abstract
Groundwater sampling for subsequent chemical analysis is done everyday all over the world and lots of research has been carried out regarding all aspects of sampling in conventional wells. A common rule is to purge about 3-5 times the volume of the sampled well in order to receive a representative sample. For small diameter wells (around one inch) installed with Direct-Push technology in-depth investigations demonstrating the influence of different pumps, well as well as tubing material and the purged volume on the measured concentration, are still sparse.
In this context, the influence of different pumps commonly used in small-diameter well sampling was investigated at the SAFIRA research site in Bitterfeld near Leipzig. The tested unconfined Quaternary aquifer is highly heterogeneous and consists mainly of medium to coarse sand with occasionally high accumulations of finer material. Its average hydraulic conductivity is around
10^{-4} m/s and the aquifer is highly contaminated with aromatic and aliphatic chlorinated hydrocarbons from mining and chemical industry. After compiling an initial continuous contamination profile over the whole aquifer by using monochlorobenzene (MCB) as an indicator for the vertical contaminant distribution, five horizons were investigated in detail. Those horizons were sampled by applying a peristaltic pump, a mechanical bladder pump and a simple inertial pump operated by a hand lever. Following the guidelines of low flow purging and sampling (LFPS), the pump rates were held constant at around 0.25 L/min and during pumping various water quality parameters (pH, electric conductivity, O_2-concentration, temperature, Eh potential) were monitored. As a result, it was found that in small diameter wells the volume purged before receiving a qualitative sample was always between 10-15 L independent of the well volume. Samples taken with the bladder pump show least variations in concentration, whereas the simple inertial pump shows highest variations in concentrations. Samples from the peristaltic pump show lowest overall concentrations but in a separate test it was observed that with the peristaltic pump operated at different pumping rates (0.25, 0.5 and 1 L/min) samples do not vary much in concentration and quality.

Comparison of Different Methods and Techniques for Depth-Discrete Groundwater Sampling

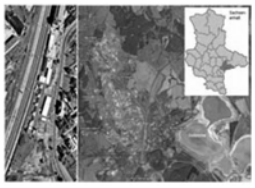
Uwe Schneidewind[1], Loredana Macis, Matteo Margagliotti, Heidrun Paschke[2], Carsten Leven[3]

Project Objectives

- Description of influence and impact of different direct-push based sampling methods and equipment on the concentration of volatile organic compounds in groundwater samples.
- Overall Aim: Minimization of purging and sampling volume under the premise of obtaining representative results.
- Phase One: Use of Low Flow Purging and Sampling (LFPS) with different pumps.

Description of Test-Site

- UFZ-SAFIRA Site in Bitterfeld near Leipzig, Germany.
- Quaternary aquifer (ca. 3-23 m below surface) in the test-region is highly heterogeneous, unconfined and consists of mainly medium to coarse sand and gravel with locally high accumulation of fine material. It is underlain by a lignite layer. Groundwater flow direction is mainly NW-SE. Average $K = 10^{-4}$ m/s.
- Aquifer is highly contaminated with chlorinated hydrocarbons (both aromatic and aliphatic) from mining and chemical industry in the 20th century.



Map of test site

Methods

1. Compilation of a continuous contamination profile for the aquifer focussing on Monochlorobezene as an indicator.
2. Sampling in five horizons of varying depth by installing SP16 screens (Geoprobe) by means of Direct-Push technology.

3.1 In each SP16 screen, water samples were taken by using a peristaltic pump from Eijkelkamp, an inertial pump (GW4220) and a Mechanical Bladder Pump (MB470) both from Geoprobe. Pumping rates were around 0.25 L/min.

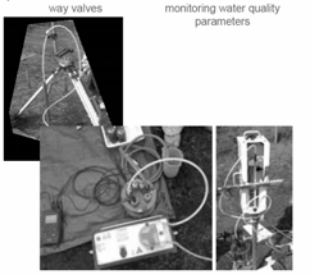
- During sampling, water was flushed through a flow cell, and pH, O_2-concentration, redox-potential, temperature and electric conductivity were monitored.
- Samples were taken after different purging volumes by connecting 100 mL vials to the systems by applying two three-way valves.

3.2 In three horizons the peristaltic pump was used with different pumping rates (0.25, 0.5 and 1 L/min) to check for differences in concentrations.

4. Samples were analyzed in the on-site lab immediately after sampling to avoid gassing out of dissolved chlorinated hydrocarbons.

Special vial connected to three-way valves

Flow cell with sensors monitoring water quality parameters



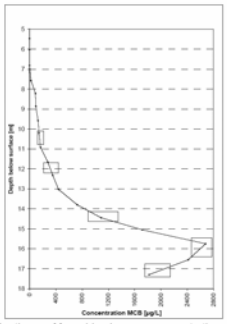
Inertial pump (IN), peristaltic pump (PP) and bladder pump (BL)

	Type	Model	Tubing	
			Model	Material
Pumps	Peristaltic (PP)	Eijkelkamp (mod. 12Vdc Art.Nr.12.26)	Geoprobe® (mod. TB25L)	Polyethylene, 6,3 mm (¼") ID
	Inertial (IN)	Geoprobe® (mod GW4220)	Geoprobe® (mod. TB25L)	Polyethylene, 6,3 mm (¼") ID
	Bladder (BL)	Geoprobe® (mod MB470)	Geoprobe® (mod. GV1432)	Outer: HDPE, 10mm ID Inner: FEP, 4mm ID

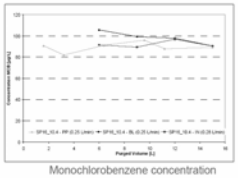
Vials in the gas-chromatograph

Results

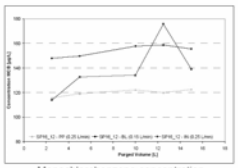
- Samples taken with all three pumps show relatively similar concentrations.
- After a purging volume of around 10 L, concentrations as well as water quality parameters are almost constant. It is thus advisable to take samples after 10-15 L have been purged.
- Samples taken with the peristaltic pump show lowest overall concentrations. However, the peristaltic pump can be operated with higher pumping rates without large differences in concentrations, which makes it most economical (Figure 7).
- Concentrations of samples from bladder pump show least variations. It is thus most feasible for taking undisturbed samples. However, the maximum achievable pumping rate is 0.25 L/min or less, even in zones with higher conductivity.
- Samples taken with inertial pump show highest variability and pumping rates are hard to keep constant. Furthermore, two people are needed to take samples as one always has to operate the pump.



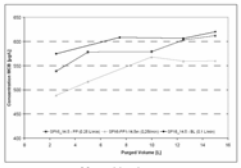
Continuous Monochlorobenzene concentration profile. Areas with rectangles symbolize horizons that have been investigated further.



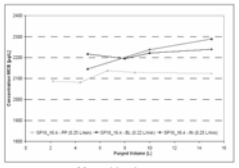
Monochlorobenzene concentration at 10.4 m below surface



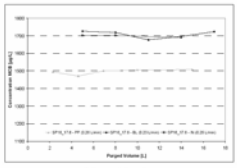
Monochlorobenzene concentration at 12 m below surface



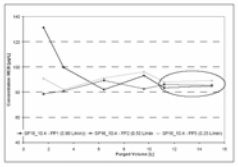
Monochlorobenzene concentration at 14.5 m below surface



Monochlorobenzene concentration at 16.4 m below surface



Monochlorobenzene concentration at 17.6 m below surface



Monochlorobenzene concentration at 14.5 m below surface

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Title: Modelling of nitrogen transport in the unsaturated zone and groundwater recharge calculation using an alternative method due to insufficient land-use data

Author(s): J. C. Draxler[1] and Gernot Klammler[2]

Institution(s): [1]Joanneum Research, Institute of Water Resources Management, Graz, Austria.
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Abstract
To assess the risk of diffuse impact in the Dravsko Polje on shallow groundwater there has been investigated the impact on the Nitrate load of seepage water by generating virtual types of farming under the climatic conditions of this region and simulating long term seepage water amount (1958 – 2007) and Nitrate load comparing a typical crop rotation with organic farming and extensification.

To reach this goal several simulations using STOTRASIM were done by analysing seven different crop rotations and fertilisation strategies leading to varieties in groundwater recharge and nitrogen leaching.
Organic Farming reduces the nitrogen concentration in seepage water in comparison to typical farming to a very low level and grassland lowering the nitrogen concentration again.

So to resolve the Nitrate problem, a change of agricultural management with other fertilisation or crop rotation is necessary.

In a preceding project groundwater recharge of Dravsko Polje was determined using the climatic water balance in combination with a soil water balance model. Input data of cultivated plants were not available as it was for the recent simulations with STOTRASIM. As an alternative solution JOANNEUM RESEARCH Graz developed an averaging procedure which handles mixed crop rotations for which only the successive order of cultivated crops is known, but neither the exact location nor the periods of cultivation are available. This so-called *crop-mixer* allows determining groundewater recharge using mean values representing the influence of cultivation. In a first step four representative crop rotations were assumed, all possible orders of one crop rotation are generated and groundwater recharge is calculated as the average of all these possible orders. Afterwards, these crop rotations are averaged again, thus resulting in statistically averaged values which can be assumed as best possible estimation of groundwater recharge using insufficient information concerning cultivation.

Modelling of nitrogen transport in the unsaturated zone and groundwater recharge calculation using an alternative method due to insufficient data

Johannes C. DRAXLER[1], Johann FANK[1], Gernot KLAMMLER[2]

[1]JOANNEUM RESEARCH, Institute of Water Resources Management
[2]University of Graz, Institute of Geography and Regional Science

Introduction

A model can assist to discover gaps of knowledge of subsurface transport and can help authorities, environmental advisers and finally farmers to determine soil or crop management strategies and effective fertilisation amounts. In other words: models are used as decision support systems. A model can be simple, flexible and cost-saving, but good results are depending on high quality of input data. Two studies show model applications including possible workarounds due to insufficient input data.

NITROGEN TRANSPORT

What was the question of the study?

To assess the risk of diffuse impact in the Dravsko Polje (Slovenia) on shallow groundwater there has been investigated the impact of different farming systems on the nitrate load of seepage water. How have to be changed agriculture to ensure a lower pressure on groundwater quality?
To reach this goal several simulations using STOTRASIM [FEICHTINGER, 1998] were done by analysing different crop rotations and fertilisation strategies under climatic conditions (1953-2007) of this region leading to varieties in groundwater recharge and nitrogen leaching.

What was our strategy?

Soil hydrological models try to describe hydrological processes in the unsaturated zone for a certain period of time including soil and plant processes considering different weather situations.
STOTRASIM (solute transport model based on SIMWASER for soil hydrology) calculates the nitrogen dynamic of agricultural used soils on daily base. The model describes the vertical one-dimensional nitrogen and partly the carbon dynamics of agricultural soils.

What were the data basics?

→daily meteorological parameters
→soil information is generated of a soil profile location from KLAMMLER [2008] in a very typical soil area with Dystric Cambisol and results of different soil analysis are implemented.
→crop and soil management (e.g. tillage, fertilisation, dates of planting and harvesting): Seven different virtual types of crop rotations are realised:

1. Cattle Farming
2. Cattle Organic Farming
3. Pig Farming
4. Pig Organic Farming
5. Mixture Farming
6. Mixture Organic Farming
7. Grassland Farming

→generating virtual types of crop rotation and fertilisation management

Table 1: Soil texture and soil parameters used in STOTRASIM

Table 2: Pig Farming – crop rotation information

What did we actually simulate?

→balance time: 1958-2007 (per-run period of 5 years)
→13 different scenarios comparing typical crop rotations with organic farming and extensification (change in 1984)
→evaluation of groundwater recharge and nitrogen leaching

What did we actually find?

Organic Farming reduces the nitrogen concentration in seepage water in comparison to typical farming to a very low level (Figure 1) and grassland lowering the nitrogen concentration again.

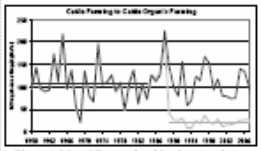

Figure 1: Mean Nitrogen leaching in groundwater

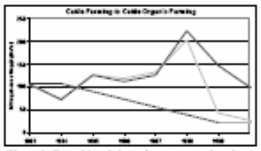

Figure 2: Transitional time after crop rotation change

In Figure 2 the transitional period of Cattle Farming to Cattle Organic Farming is illustrated. Due to the residence time of seepage water in the unsaturated zone there is a time delay of about 5 years.

What did we think it all means?

Organic Farming reduces the nitrogen concentration in seepage water in comparison to typical farming to a very low level and grassland lowering the nitrogen concentration again. So to resolve the nitrate problem, a change of agricultural management with other fertilisation or crop rotation is necessary. The question is: What is the favoured level of nitrate concentration or more important nitrogen leaching in the groundwater? Guidelines about how to change agriculture are necessary to ensure a lower pressure on groundwater quality!

Where do we go from here?

The visualised results are only examples for a typical soil with typical crop rotation!
→How much nitrogen leaching can we expect under an other soil type?
→What are the differences when we use real farming information: harvest dates, fertilisation analysis,...?

GROUNDWATER RECHARGE

Background

The FAO-Penman-Monteith method [ALLEN et al., 1998] to determine ET_c for solving the climatic water balance CWB is a cost and time effective methodology and achieves most suitable results of calculated ET_c compared to ET_c measured by a grass-reference lysimeter [FANK, 2008]. Thus, CWB provides a good method to give an overview of groundwater recharge GWRC which is an important aspect regarding subsurface transport. Insufficient input data have to be compensated applying appropriate workarounds. However, these modifications have to be considered in the interpretation of the results.

Methodology and input data treatment

1 Soil

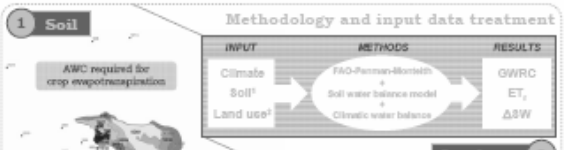

Figure 3: Areas of different values of AWC (different soil types) and location of the soil profiles used; from MKGP (2003)

Land use 2

Land use data:
- No detailed information according cultivated crops available

Workaround:
- Four representative crop rotations assumed (ZADRAVEC, 2008)
- It's not known, which crop rotation is used on which field and when the crop rotation started
- EVAPOTRANS (FANK et al., 2008) runs several calculations for the same crop rotation where stages of the rotations are changed and average amounts of GWRC can be determined

Homosim soil map:
- *Soil Mapping Units* → soil polygons
- *Soil Systematic Units* → soil types
- Polygons composed of up to three soil types
- Not every *Soil Mapping Unit* has a representative soil profile
- No links between soil-type-layer and soil-profile-layer

Workaround:
→Assigning soil profiles to soil polygons with same soil type manually

Table 3: Effect on GWRC by using crop rotations which start at different stages from FANK et al. (2008)

Results

Annual averages from 2003-2007*:
P = 913 mm
ET_c = 604 mm
GWRC = 305 mm

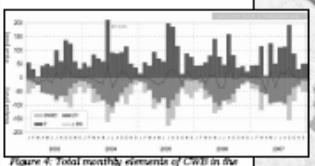

Figure 4: Total monthly elements of CWB in the investigation area from 2003 to 2007 in mm from KLAMMLER (2008)

Table 4: Annual average climatic water balance in the investigation area for the period 2003 - 2007 in mm from KLAMMLER (2008)

[mm]	P	ET$_c$	ΔSW	Q
2003	711.8	306.2	15.0	-1.8
2004	995.3	629.7	350.1	15.5
2005	1,093.8	615.5	200.0	112.2
2006	852.1	616.5	219.2	4.8
2007	909.8	622.1	213.5	4.8
Annual average	912.8	658.6	205.5	6.2

*) CWB is not balanced because of considering surface water bodies for ET_c-calculation but not for GWRC-calculation

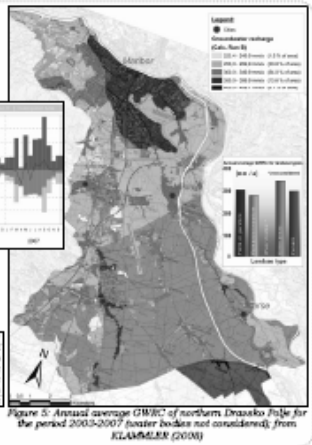

Figure 5: Annual average GWRC of northern Dravsko Polje for the period 2003-2007 (water bodies not considered); from KLAMMLER (2008)

Conclusion

Although precise weighing lysimeters are best tools to measure water flow and solute transport from the unsaturated zone down to the groundwater system it is impossible to investigate different crop rotations on diverse soil types experimentally. Mainly the results of lysimeter and field measurements are used to calibrate and validate numerical models. So a lot of high quality basic data are necessary for good model results.

Acknowledgement

The study was funded by the Health Care Institute Maribor, Environmental Protection Institute.

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Acknowledgement

I would like to thank the Institute for Ecological Engineering (IEI) in Maribor and JOANNEUM RESEARCH Graz for funding this work and SYNERGIS Wien for providing GIS-software.

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

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HIGRADE

Title: DC-Geoelectrical Surveys for Landfill Leachate Plume Detection

Author(s): Markus Hirsch[1], Augusto C. Pires[2], Holger Weiss[1]

Institution(s):
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[2] University of Brasília, Institute of Geosciences

Abstract
During December 2008 and March 2009 several DC-geoelectrical surveys were conducted in the vicinity of an urban landfill in the Federal District of Brasília, Brasil (Fig. 1). Previous geophysical investigations and groundwater quality monitoring unveiled possible contamination of percolating rainwater and groundwater by the landfill. The landfill was used for the deposition of domestic and industrial waste without any separation for about 50 years. No basement or surface liner was installed at this landfill.

To investigate soil and groundwater contamination in detail and to delineate the development and direction of leachate plume(s) several geoelectrical measurements were conducted on roads and paths adjoining the landfill.
Highly mineralised leachate and impacted groundwater have a significant effect on the electrical resistivity distribution in sections contaminated with these waters. Due to higher ionic strength electrical resistivities are lower than in not impacted portions of the aquifer.

To gain information about the pristine electrical resistivity values, geoelectrical measurements were conducted in the National Park northeast of the landfill within the same geological setting (Fig. 2). Previous investigation suspected the existence of a leachate plume originating from the landfill towards a natural drainage in the National Park.
Our investigation revealed strong electrical resistivity contrast between measurements in areas affected and unaffected by contamination. Electrical resistivities up to 10.000 Ωm were measured in uncontaminated areas while resistivities in the contaminant plume dropped as low as 10 Ωm (Fig. 3).
With this strong effect on electrical properties of the subsurface the contaminant plume could be efficiently delineated and localised.

A comprehensive investigation campaign at the landfill is planned for Summer 2009. By the help of Direct-Push investigation, groundwater and soil sampling the geophysical investigation will be verified. The resulting knowledge will be the base for decision-making about concepts for remediation and/or containment of contaminated soil and groundwater.

Fig. 1: Location of landfill, National Park and geoelectrical survey profiles

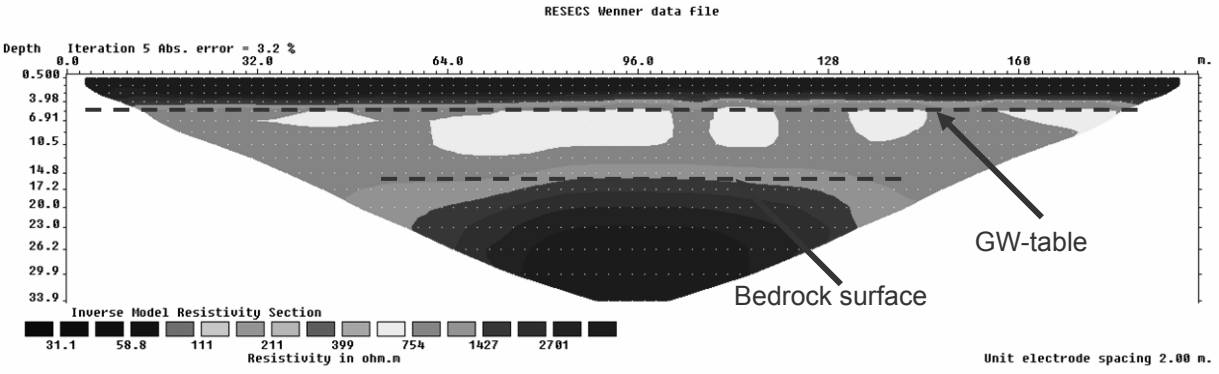

Fig. 2: Electrical resistivity distribution in National Park (unaffected by contamination)

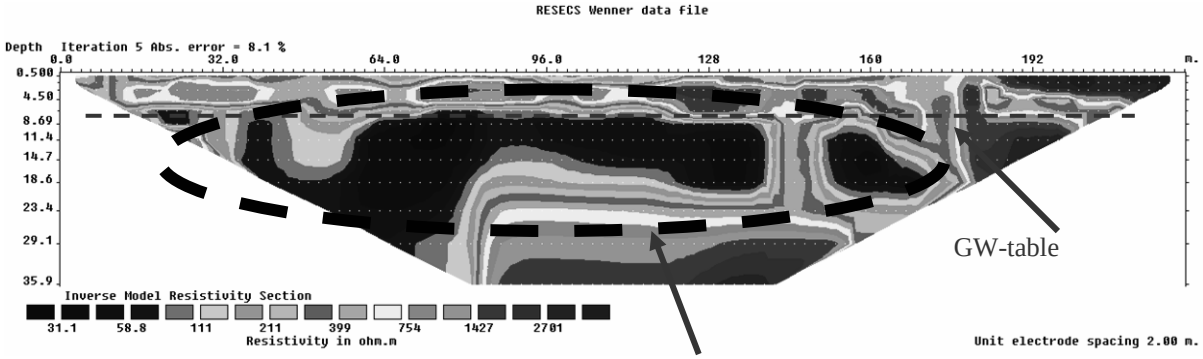

Fig. 3: Strong electrical resistivity contrast between sections affected (blue) and unaffected by contamination

DC-Geoelectrical Surveys for Landfill Leachate Plume Detection

M. Hirsch[1], A.C. Pires[2], H. Weiss[1]

[1]Helmholtz-Centre for Environmental Research – UFZ, [2]University of Brasília

INTRODUCTION

During December 2008 and March 2009 several DC-geoelectrical surveys were conducted in the vicinity of an urban landfill (~1 x 2 km) in the Federal District of Brasília, Brazil (Fig. 1 & 2). Previous geophysical investigations and groundwater quality monitoring unveiled possible contamination of percolating rainwater and groundwater by the landfill. The landfill was used for the deposition of mixed domestic and industrial waste for about 50 years. No basement/surface liner or a drainage system was installed during construction of this landfill. A precipitation of 1500 mm/a leads to a contamination of seepage water in the landfill body and a further spreading in the groundwater.

Fig. 1: Field site for geophysical surveys


Fig. 2: City of Brasília, Brazil

GEOELECTRICAL INVESTIGATION

The geoelectrical investigation method applied during this study is based on the injection of an electrical DC-current into the subsurface by a set of electrodes (A/B) (Fig. 3). A second set of electrodes is used for measurements of electrical potentials (M/N) (Fig. 3). By the ratio of injected current and measured potentials electrical resistivities/ conductivities can be calculated.
For this survey the multi-channel resistivity meter RESECS®, installed in a van (Fig. 4) was used in combination with a layout of 112 electrodes. With an electrode spacing of 2 meters profiles of 222 meter length could be measured in around 2 hours (Fig. 5).

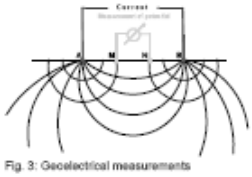

Fig. 3: Geoelectrical measurements


Fig. 4: Field equipment during survey


Fig. 5: Electrode layout (222 meters)

Highly mineralised leachate and impacted groundwater have a significant effect on the electrical resistivity distribution in sections contaminated with these waters. Due to higher ionic strength electrical resistivities are lower than in non impacted portions of the aquifer.
To gain information about electrical resistivity background values, geoelectrical measurements were conducted in the National Park northeast of the landfill within the same geological setting (Fig. 6). A natural drainage towards the National Park was suspected to act as the main catchment area for the leachate plume.

RESULTS

The investigation revealed strong electrical resistivity contrasts between measurements in areas affected and unaffected by contamination. Electrical resistivities up to 10.000 Ωm were measured in uncontaminated areas while resistivities in the contaminant plume dropped as low as 10 Ωm (Fig. 7).
With this strong effect on electrical properties of the subsurface the contaminant plume could be efficiently delineated and localised.

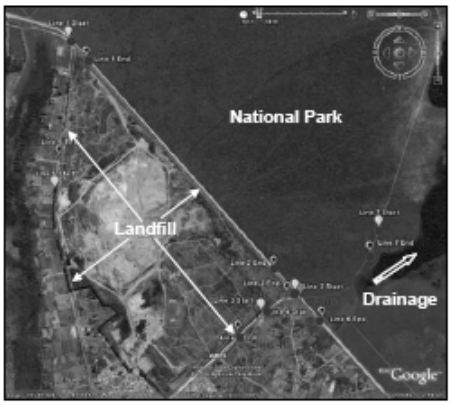

Fig. 6: Satellite image of landfill with survey lines (red)

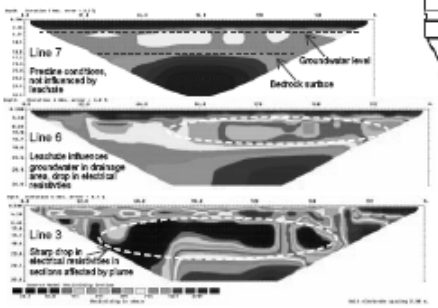

Fig. 7: DC-geoelectrical resistivity measurements

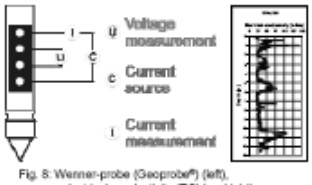

Fig. 8: Wenner-probe (Geoprobe®) (left), electrical conductivity (EC)-log (right)


Fig. 9: Geoprobe® Direct-Push unit during EC-logging

A comprehensive investigation campaign at the landfill is planned for Summer 2009. Using Direct-Push techniques, groundwater and soil sampling, the results of the geophysical investigations are to be verified. A major part in this campaign will be the correlation of electrical conductivity logs (EC-logs) (Fig. 8 & 9) with the results of geoelectrical surface measurements. The resulting knowledge will support the decision-making for remediation measures and/or the containment of contaminated soil and groundwater.

CONCLUSIONS

- Geoelectrical resistivity measurements allow a distinction between groundwater sections affected by landfill leachate and pristine areas, additionally the degree of leachate impact can be estimated
- The low electrical resistivities of the local soil and groundwater provide an excellent contrast to the high conductive leachate
- A verification of geoelectrical surface measurements by electrical conductivity logs and groundwater sampling will provide a reliable base for the development of remediation strategies

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HIGRADE

Title: Geological characterisation and mapping of preferential flow paths at a clayey till site in Denmark

Author(s): T.C. Kessler[1, 2,*], I. Damgaard[1], K.E.S. Klint[2], M.M. Broholm[1], C.M. Christiansen[1], P.L. Bjerg[1], B. Nilsson[2]

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Abstract
Remediation of contaminated sites is often limited by precise characterisation of site geology determining flow paths and storages of the contaminant. In Denmark many sites are described as low-permeability, heterogeneous clayey till interspersed with fractures and sand-lenses at various scales. The challenge in remediation by mass removal technologies is to bring a remedial agent, the contaminant, and for microbial degradation the bacteria in contact. Remediation of the matrix is diffusion limited, as contaminants have to diffuse to high permeable features, where reactions can occur. It is generally believed that the bacteria are related to large, hydraulically active fractures or sand lenses. Two methods have been investigated in order to compare performance of injection methods: (1) A direct push technique with tracer injection in different depths (2) Hydraulic fracturing at various depths combined with tracer injection. The results can in addition be used for deducing solute transport in natural macropores (incl. fractures) and transport in undisturbed clayey tills, which is the primary aim of this poster. The tracer distribution was quantified by fluorescent dye tracer on photographs of both, vertical and horizontal faces. The preliminary results from excavations at the most shallow hydraulic fracture revealed a fracture extent of up to six meters from the injection point. Tracer distribution exceeds the fracture dimensions and is furthermore transported perpendicular to the artificial fracture via macropores and channels. Geological characteristics such as fracture spacing and local heterogeneities controlling advective transport and diffusion were recorded to produce a detailed picture of the small-scale geology. This information was used to develop a 3D geological model of the site including preferential flow paths. The poster introduces methods to document and to quantify tracer distribution, but also puts emphasis on the precise geological characterisation of sites that is essential for transport modelling and remedial actions.

Title: Interpolation of Steady-State Concentration Data by Inverse Modeling

Author(s): R. L. Schwede and O. A. Cirpka

Institution(s): University of Tübingen, Centre for Applied Geoscience

Abstract
In subsurface hydrology the estimation of total mass fluxes through a cross-sectional area and its uncertainty is an essential quantity, because it is needed to quantify the effect of natural attenuation or active remediation techniques. The available concentration measurements are typically point-like measurements and they are sparsely distributed within the domain of interest. The estimation of mass fluxes based on the small number of available measurements makes interpolation techniques necessary. Standard interpolation techniques are not suitable because the measurements are sparse, and the unconditional probability density function (pdf) of concentration is strongly non-Gaussian.

A geostatistical method for the interpolation of steady-state concentration measurements by inverse modeling will be presented. In the first step, the use of steady-state concentration measurements in geostatistical inversion will be introduced. With this method we are able to calculate hydraulic conductivity fields which are conditioned on steady-state concentration measurements. In the second step, the interpolation method of steady-state concentrations is presented, which uses the inverse modeling appoach.

The presented method is tested to computer generated hydraulic conductivity fields in 2-dimensional and 3-dimensional space. These fields are used as "true" reference field.

Interpolation of Steady-State Concentration Data by Inverse Modeling

Center for Applied Geoscience (ZAG)
Hydrogeology

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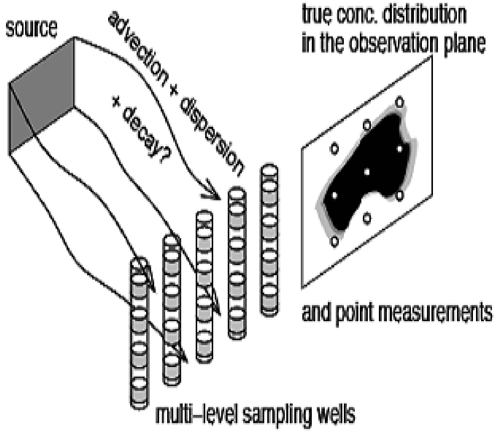
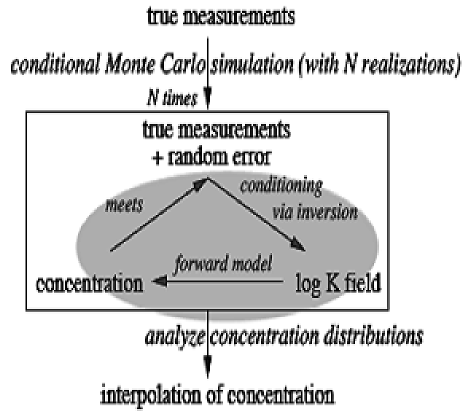


Problem Statement

- Sparse spatial distribution of concentration measurements
- Continuous concentration distribution by interpolation
- Classical interpolation methods like kriging require gaussianity, which is not valid for steady-state concentration measurements
- Interpolation estimate and its uncertainty are needed

Approach

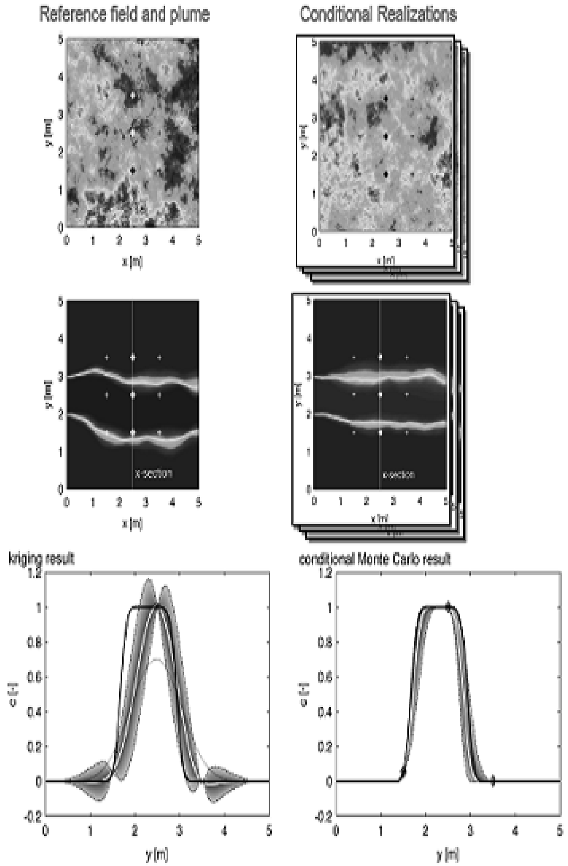


Conclusions

- Kriging-like interpolation gives physically impossible results (e.g. probability of negative concentrations)
- Interpolation by inverse modeling approach gives reliable results of interpolation and uncertainty
- Full conditional *pdf* of concentration obtained
- Physical bounds are automatically met
- Computationally demanding, but easy to parallelize
- Interpolation results are essential e.g. for the estimation of mass fluxes and their uncertainty

Inverse Method

- Quasi-linear geostatistical approach (*Kitanidis, 1995*)
- Method of smallest possible modifications
- Artificial increase of sampling volume to obtain larger sensitivities



- *Schwede R. L., and O. A. Cirpka (2009)*, Use of steady-state concentration measurements in geostatistical inversion, *Advances Water Resour.*, 32(4), 607–619, doi:10.1016/j.advwatres.2009.01.010
- *Schwede R. L., and O. A. Cirpka (2009)*, Interpolation of steady-state concentration data by inverse modeling, *Ground Water*, (submitted)

Title: Development of Mathematical Models for the Characterization of the MIP-System

Author(s): J.Bumberger[1], T. Goblirsch[1], C. Leven[2], H. Borsdord[1], P. Dietrich[1]

Institution(s): [1]Helmholtz Center for Environmental Research
[2]University of Tübingen

Abstract
The work presented is motivated by the incomprehension of processes and functionality from the Membrane Interface Probe system (MIP). Methods of network-analysis and finite-elements (FEM) are used to determinate the differential equations of the three parts of the MIP-system:

1) nitrogen-circuit
2) membrane
3) soil layers

Destination of the work is the development of a model for the identification of relevant processes and the parameter extraction for the characterization of the system.

Development of Mathematical Models for the Characterization of the MIP-System

J. Bumberger[1], T.Goblirsch[1], C.Leven[2], H. Borsdorf[1], P. Dietrich[1]

Background

- The Membrane Interface Probe (MIP) is a fast and efficient in-situ-system to explore organic pollutions in the subsurface (Figure 1)
- Better comprehension of measurement results and development of optimization strategies needs better understanding of relevant physical and chemical processes with the MIP in the subsurface

Approach

- To achieve a better system comprehension a model system is to be developed (Figure 2)
- The coupled differential equation system will be implemented in are numerical model under consideration of subcomponents
- Determination of the constants with experiments in the laboratory and at reference Sites

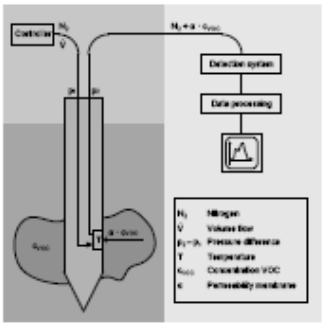


Figure1: Schematic diagram of the MIP-System

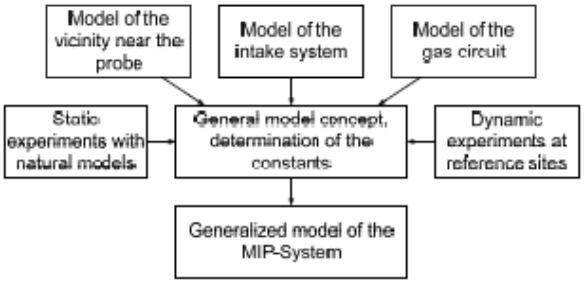


Figure 2: Geneal model concept (red boxes = currently in progress)

Example for investigation of in-situ processes

Deficits:

- Understanding of temperature effects (T-spreading, chemical reactions induced by high T, Volatilization)
- Advectiv transport of organic pollutions
- Limiteted processes, Time responses

Preliminary Results:

- More information could be available, if in decisive depth the signal is recorded over time (Figure 4)
- Temperature can cause chemical transformations
- Specific temperatur and trunkline conditions are needed for a reliable interpretation

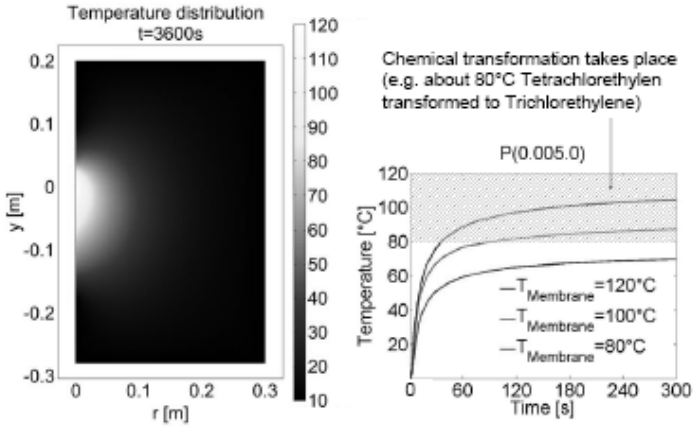


Figure 3: Analysis of the transient heating transfer with conduction in a soil with 80% sediment and 20% water - Temperature distribution arround the membrane located at P(0,0) and a parametric temperature plot at the point P(0.005,0)

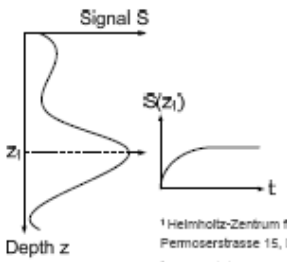


Figure 4: MIP vertical profil and at z_1 the signal is recorded over time $S(z_1)$

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Title: Influence of drainage state on direct-push hydraulic conductivity profiling using the CPT "on-the-fly" method

Author(s): M. Fitzgerald[1], M. Randolph[2] and D. Elsworth[3]

Institution(s):
Penn State University, Goettingen University[1]
University of Western Australia[2]
Penn State University[3]

Abstract
Direct-push methods, like the Cone Penetration Test (CPT), are well suited to characterize shallow unconsolidated soils including the recovery of hydraulic conductivity profiles. This work summarizes the results of an analysis to examine the influence of drainage state on peak magnitudes of CPT-metrics; and then to examine the ability to obtain hydraulic conductivity magnitudes during steady-rate advance of CPT using the “On-the-Fly” (OTF) method. Experimental data were obtained using a mini-CPT to measure CPT-metrics of end-bearing (qt) and pore pressure (u2) at the shoulder location, and for the first time sleeve friction (fs) on the following shaft. Experiments were conducted using the University of Western Australia’s 1.83m beam centrifuge at 100g on a normally-consolidated homogeneous sample of 75% kaolin mixed, by weight, with 25% fine sand and fully saturated. The soundings were conducted at selected constant penetration rates to evaluate peak magnitudes of CPT-metric data during the full transition of drainage state from near-fully drained through fully undrained. CPT-metric data plotted versus dimensionless penetration rates show that impeded drainage reduces peak soil strengths. Mechanical models are developed to calculate magnitudes of qt and fs as drainage state changes based on normalized u2 pore pressure data. Revised relations between CPT-metrics and dimensionless hydraulic conductivity (KD) magnitudes, following the OTF framework, provide verified relationships capable of returning magnitudes of hydraulic conductivity as Bq*Qt = 2.25/(1+KD)^5 as also for couplings between KD-Bq-Fr and KD-Qt-Fr. These observations provide additional evidence and correlations in support of the direct recovery of depth-continuous hydraulic conductivity magnitudes from steady profiling by CPT.

Title: Long-term monitoring of PAH leaching from soils using laboratory scale lysimeters

Author(s): O. Krüger, G. Christoph, H. Walzel, W. Berger

Institution(s): BAM

Abstract
Polycyclic Aromatic Hydrocarbons (PAHs) became a matter of increasing concern through the last decades due to their persistence and their carcinogenic and mutagenic properties. Therefore, monitoring of PAHs in the environment is of extreme importance. The fate of these contaminants in soils depends on the leaching rate and microbiological processes in the soil. To study the long term leaching behaviour of PAHs in soil, two laboratory scale lysimeters were assembled, filled with PAH-contaminated soil and irrigated periodically with the average seepage rate. The lysimeters were leached since two and a half and three years, respectively, with sampling every fortnight. The PAHs were measured via HPLC. Furthermore, accompanying parameters such as pH value, conductivity, DOC and turbidity were determined. The results for the eluates show a low level steady trend after a fast initial decrease of PAHs. Different trends were observed for some PAHs, presumably in relation to the number of fused aromatic rings. A previous lysimeter experiment was used upon completion to determine a PAH mass balance. The sum of the remaining PAHs of the leached soil and released PAHs in the leachates was found to be significantly lower than the initial PAH content of the soil. The results indicate a rapid leaching of PAHs from the tested soil as well as a significant microbiological degradation. The monitored PAH concentrations in relation to the liquid to solid ratio will be presented on the poster.

Long-term monitoring of PAH leaching from soils using laboratory scale lysimeters

O. Krüger, G. Christoph, H.-P. Walzel, W. Berger
BAM Bundesanstalt für Materialforschung und -prüfung, Berlin, Germany

Introduction

Polycyclic Aromatic Hydrocarbons (PAHs) are considered as priority pollutants due to their adverse effects including acute toxic, carcinogenic and mutagenic properties. Therefore, monitoring of PAHs in the environment is of extreme importance. The majority of PAH contamination is of anthropogenic origin, e.g. connected with gas production, petroleum refining and wood preservation facilities. 16 PAHs have been categorized by the US Environmental Protection Agency as the most considerable pollutants of this class (EPA-PAHs) and are thus tested and monitored primarily. To study the long term leaching behaviour of PAHs in soil, two laboratory scale lysimeters were assembled, filled with PAH-contaminated soil and irrigated periodically with the average seepage rate. The lysimeters have been leached since two and a half and three years, respectively, with sampling every fortnight. PAH concentrations were determined via HPLC and the respective mean values of both lysimeters were plotted versus time and liquid to solid ratio (figures 1-5). The accompanying parameters (pH value, conductivity, turbidity, DOC) are given in figure 6.

Table 1
Experimental conditions

Internal diameter of lysimeters	0.3 m
Filling level	0.25 m
Sample mass	approx. 30 kg
Irrigation	0.3 l per week
Test duration	166 weeks
Analysis	PAH concentration, pH, turbidity, conductivity, DOC

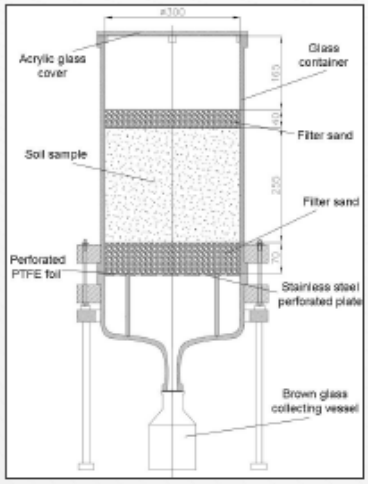

Figure 1
Experimental setup

Results and discussion

The results indicate a low level steady trend after a fast initial decay of PAH within a few weeks. For some PAHs, different trends were observed. For example, phenanthrene shows a fast decay followed by a steady trend with minor fluctuations according to the results of total PAH. Fluoranthene shows similar results, although with little more fluctuations. In the case of pyrene, a significantly slower decrease is observed together with considerable fluctuations. This different behaviour is presumably related to the number of fused aromatic rings in the respective PAHs since their size and configuration affects the water solubility as well as the microbiological degradation rate.

The results for the accompanying parameters indicate initial decays followed by steady values for turbidity, conductivity and DOC. pH values remained stable throughout the experiments with minor variations around pH eight. The data are quite consistent with the results for PAH leaching. However, turbidity, conductivity and especially DOC decreased significantly slower than expected considering the fast initial decay of PAH.

A previous lysimeter experiment was used to determine a PAH mass balance. The sum of remaining PAH in soil and released PAHs in the leachates was found to be significantly lower than the initial PAH content of the soil. The results indicate a rapid leaching of PAHs from the tested soil as well as a significant microbiological degradation.

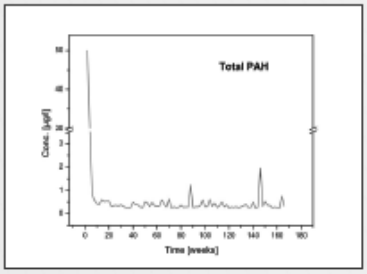

Figure 2
Total PAH

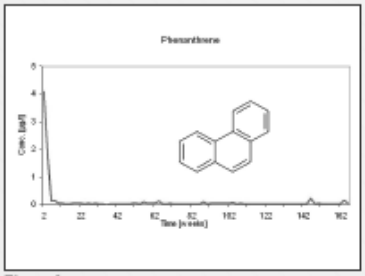

Figure 3
Phenanthrene

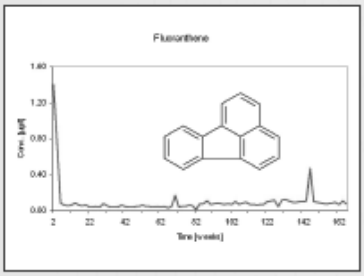

Figure 4
Fluoranthene

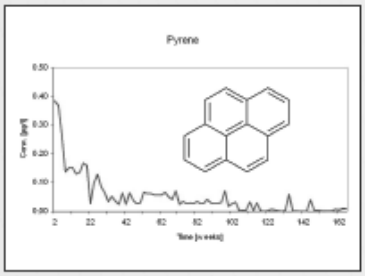

Figure 5
Pyrene

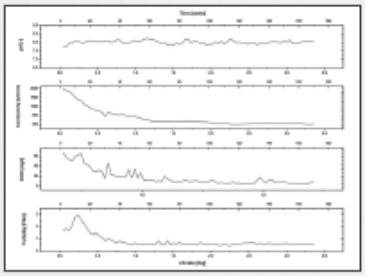

Figure 6
Accompanying parameters

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

Title: The dynamics of Cu Contents in System Water-bottom Sediments- Fish in River Debed Waters (Armenia)

Author(s): Mher Mikayelyan

Institution (s): Center for Ecological-Noosphere Studies of NAS RA

NovCare 2009 Conference in Leipzig, Germany

THE DYNAMICS OF Cu CONTENTS IN SYSTEM WATER-BOTTOM SEDIMENTS-FISH IN RIVER DEBED WATERS (ARMENIA)

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A MAP OF THE SOUTH CAUCASUS

INTRODUCTION

The research goal was studying Cu concentrations in system water-bottom sediments-fish in the waters of the most high-water river in Northern Armenia - River Debed which belongs to River Kura basin.

The research was performed in the frame of a USAID project "Water quality monitoring of the shared water resources of the South Caucasus and assessing the impact of pollution on biodiversity" (2007-2008).

RIVER DEBED

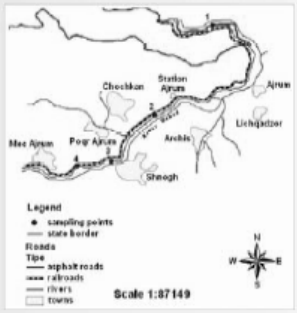
METHODS

The studied objects of this research were river water, bottom sediment and fish. All the samples were collected following a prepared plan from total 4 samlpling points on River Debed on a monthly basis between June 2007 and February 2008. The research covered both field and lab studies which were performed based on the developed SOPs according to ISO standards [1, 2].

After river water had been sampled at a depth 15-20 cm by polyethylene containers, in situ measurements were done for pH, conductivity, turbidity, dissolved oxygen, temperature and salinity on a Horiba U-10 portable multi-analyzer (Japan). Then the samples were filtered, preserved by nitric acid and transported to the CENS Central Analytical Laboratory to be analyzed for Cu through the atomic-absorption method on AAnalyst 800 (Perkin Elmer, USA).

During the entire studied period the selected river section was strongly impacted by the operating Alaverdi mining plants.

A SCHEMATIC MAP OF SAMPLING POINTS



HORIBA U-10

PE Aanalist -800

RESULTS

All the obtained data were collated with the background concentrations and maximum acceptable concentrations (MAC) of the studied element [3]. As a background, data on Shirakamut hydrostation were used. (see www.kura-araks-natosfp.org)

The results of lab analyses indicated that for the entire studied period Cu concentration in the river water varied from 2,44 to 42,85 mkg/L showing thus a 1.3-14.2 excess vs. the background being however lower than MAC (1000mkg/L).

High concentrations of Cu in August and September 2007 resulted from the low water season. Relatively low concentration of Cu in January 2008 was explained by low industrial activities. The research indicated that in fish muscles Cu concentrations were low vs. MAC (10mg/kg), approaching to MAC in fish liver [4].

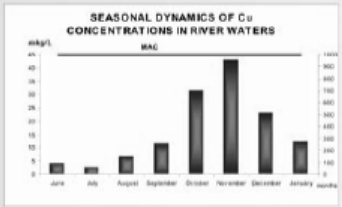
For the entire studied period, Cu concentrations in bottom sediments, too, remained high (1,1 times) vs. MAC [5].

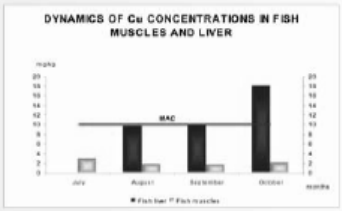
Thus, the research outcomes allowed indicating that for the studied period Cu concentrations in River Debed waters were rather low vs. MAC accumulating however in bottom sediments and fish and particularly in fish liver.

The studied specimens of Khramulya (*Varicorhinus*)

Parameters measured In Situ

Months	pH	Conductivity (mS/cm)	Turbidity (NTU)	DO (mg/L)	T (°C)	Salinity (%)
June	7,25	0,226	161	9,08	16,6	0,00
July	7,72	0,333	103	8,81	23,2	0,01
August	7,74	0,384	72	8,42	25,9	0,01
September	7,51	0,431	74	8,75	21,7	0,01
October	8,11	0,335	68	9,27	14,7	0,01
November	7,88	0,314	73	9,54	8,6	0,01
December	7,11	0,339	87	9,92	7,8	0,01
January	7,31	0,325	35	10,21	6,5	0,01





CONCLUSIONS

1. Cu contents in River Debed were high vs. the background showing however in-MAC variations.
2. Cu in the studied fish muscles was low vs. MAC, accumulating however in liver and showing excess vs. MAC.
3. The bottom sediment sample, too, was polluted with Cu which was excessive vs. MAC.

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

FH-DGG

HIGRADE

Title: Seismic monitoring of slope dynamics caused by a slow-moving landslide in the Vorarlberg Alps, Austria

Author(s): M. Walter & M. Joswig

Institution(s): Institute for Geophysics, Universität Stuttgart

Abstract
Our work within the research unit 'Coupling of flow and deformation processes for modeling the movement of natural slopes' is mainly focused on the monitoring of seismic signals caused by the movement of the Heumoes slope in the Vorarlberg Alps, Austria. The slope is set up by loamy scree and glacial till, mostly clayey material with embedded hardrock components of varying size, and moves with several cm per year at the surface (Lindenmaier et al. 2005, Hydrological Processes). During several field campaigns within the last three years we were able to detect and locate single fracture processes during the movement of the Heumoes slope by applying seismic mini-array techniques.
Dozens of fractures with magnitudes varying between $-0.7 \leq M_L \leq -2.4$ have been detected and located. The spatial distribution of the epicentres correlates with slope areas of higher movement rates.The epicenters are mainly clustered in the western part of the slope, while no events have been located in the eastern part. By contrast to the slope material of the eastern part of the slope, the water saturation of the slope material of the western part varies with the season. We therefore preliminary assume, that the recorded fractures have been generated in dependence of the water saturation of the unstable sediments. This assumption has been confirmed by in-situ field experiments within dried sediments in Israel, which will be presented.
The temporal occurrence of the detected fractures, up to 26 hours after intense rain events, seems to approve the assumption of a rainfall-triggered movement of the slope caused by fast subsurface water dynamics.
The statistical significance of the spatiotemporal occurrence of the fractures has been investigated within a one month lasting field campaign in August 2008, where five mini-arrays have been installed to monitor the dynamics of the whole slope. The first findings of these investigations will be presented.

Seismic Monitoring of Slope Dynamics caused by the Mudslide at Super-Sauze in the southern French Alps

Marco Walter & Manfred Joswig

DFG-Research Unit 581 "Coupling of Flow and Deformation Processes for Modeling the Movement of Natural Slopes"

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Introduction

The mudslide at Super-Sauze is situated in the Barcelonnette Basin in the southern French Alps, about 100 km north of Nice (Figure 1). The mudslide started to form in the 1960's, today it reaches a length of 850 m between 2105 m and 1740 m in elevation. The unstable slope with an estimated volume of 750000 m³ mainly consists of jurassic, black marls and shows an immense dynamic behaviour with velocities of more than 3 cm/day.

Within the research unit „Coupling of Flow and Deformation Processes for Modeling the Movement of Natural Slopes", the aim of our work is the observation of slope dynamics by applying the method Nanoseismic Monitoring to the mudslide in Super-Sauze.

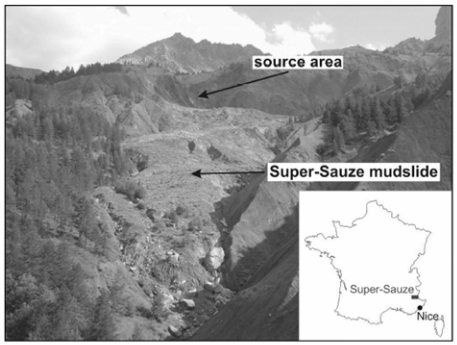


Figure 1: *Location of Super-Sauze and upward view of the mudslide and its source area in 2006.*

Data acquisition / signal classification

Seismic data was acquired during a 10-day campaign (14th – 24th of July 2008) by deploying four tripartite seismic mini arrays (Seismic Navigating System - SNS) on the Super-Sauze mudslide (Figure 4). During the field campaign we were able to detect and locate different types of events caused by material failure within the source area and the mudslide itself (Figure 1). The types differ in duration, amplitude, frequency content and consequently in sonogram patterns. These characteristics as well as the analysis of further site-effects, like amplitude decrease, absorption and attenuation effects, allowed us to distinguish the events. Generally, we identified 3 types of events (type 'A' – 'C') on the basis of the mentioned attributes (Table 1).

Table 1: *Classification criteria of recorded event types at the mudslide in Super-Sauze.*

	Typ 'A'	Typ 'B'	Typ 'C'
signal duration	sec.-min.	2-5 sec.	2-20 sec.
frequency content	10-130 Hz	10-80 Hz	5-150 Hz
stations	2-4 SNS	1-3 SNS	1 SNS
amplitude [nm/s]	80-1500	40-200	100-7500

Seismic characterization of slope dynamics

During the field campaign, we recorded hundreds of signals with durations between a few seconds (single event) and up to 20 minutes (multiple events) caused by rockfalls. The signals show a high-frequented 'noise band' up to ~130 Hz, comparable to signals caused by avalanches, with broadband spikes caused by falling blocks (Figure 2). The source area of the events of type 'A' is estimated to be at the upper most part of the slope, where rockfalls with components of varying size occur frequently.

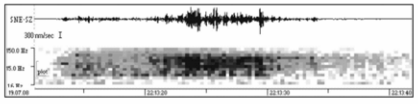
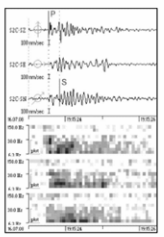


Figure 2: *Typical waveform and sonogram pattern of one event of type 'A', recorded with the closest 1c station in ~50 m distance.*

During the field campaign we could record, identify and locate 34 events of type 'B', which show clear P- and S-wave onsets, allowing their localization (Figure 3). The magnitudes of these type 'B' events vary between $-3.2 \leq M_L \leq -1.3$. The located fractures are mainly clustered in the mid part of the mudslide (Figure 4), correlating with the part of the slope showing the highest velocities at the surface. The three events located in the south, outside of the slope catchments, are probably generated by material failure in the hard rock mass in the source area of the mudslide. Remarkable is, that a cluster of these type 'B' events is located directly at the boundary between the mudslide material and one of the emerging in-situ crests in the mid part of the slope (Figure 4). A comparison between the event epicenters and an airborne picture taken in 1956 before the mudslide occurred, shows that most of the events are mainly located close to in-situ crests, hidden by the mudslide material today.

The temporal occurrence of the type 'B' events, their magnitudes and the rain intensity during the field campaign is displayed in Figure 5. It seems that the mudslide moves more or less continuously, indicated by the distributed temporal occurrence of the signals all over the measurement period. Note, that a cluster of events with the highest magnitudes occurred just a few hours after the rain event on 21st of July 2008.



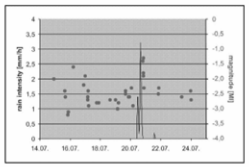


Figure 4: *Rain intensity (blue) and temporal occurrence of the type 'B' events with their magnitudes M_L (green) during the field campaign 14th -24th of July 2008.*

Figure 3: *Typical waveforms and sonogram patterns of an event of type 'B', M_L = -2.2 in ~120 m distance, recorded with a 3c-station, and the determined phase onsets (red).*

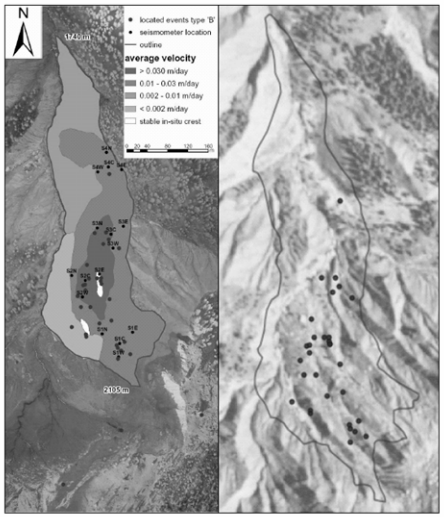


Figure 5: *Location of the installed seismometer stations (black dots), epicenters of the located events of type 'B' (red dots) and average movement velocity of the mudslide (1997-2007) mapped on a LiDAR scan from 2007 (left) and mapped on an airborne picture from 1956 (right).*

Beside the events of type 'A' and type 'B', we recorded 44 events of type 'C', which were only recorded at one single SNS. Due to the heterogeneity of the slope material, we observed enormous attenuation effects wihtin one single SNS; the amplitude decreases about ~30 times at the same time (Figure 7). Similar to the events of type ‚A', no wave phases could be identified. Therefore we only could estimate the source area, in the vicinity of the closest station with the highest recorded magnitudes. Like the type 'B' event locations, most of the type 'C' events occurred in the mid part of the slope (Figure 6). The source area of 64 % of these events is estimated to be close to the station S2E, at the boundary of the slope material and one of the emerging in-situ crests as well.

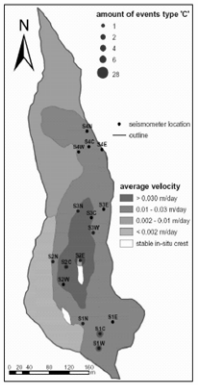


Figure 6: *Amount of the events of type 'C' generated close to them (red) and average movement velocity of the mudslide (1997-2007).*

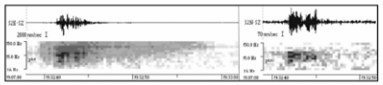


Figure 7: *Typical waveforms and sonogram patterns of one event of type 'C', recorded with a 1c-station close to the source location (left) and with a 1c-station in a distance of ~25m (right).*

Interpretation

Our actual hypothesis is that the events type 'B' are generated by impulsive fractures within the sliding material while the events of type 'C' are induced by "scratching" and "grinding" of the moving material against the, mostly covered, in-situ crests. A joint analysis of the seismic monitoring and observed structures by UAV-based remote sensing (Niethammer et al. 2009) indicates, that most of the dynamics on the mudslide in Super-Sauze take place close to these in-situ crests in general.

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Title: Seismic monitoring of slope dynamics caused by the mudslide at Super-Sauze in the southern French Alps

Author(s): M. Walter & M. Joswig

Institution(s): Institute for Geophysics, Universität Stuttgart

Abstract
In this study, we describe the application of 'Nanoseismic Monitoring' (Joswig 2008, First Break) to the fast moving mudslide at Super-Sauze in the southern French Alps. The unstable slope with an estimated volume of 750000 m3 mainly consists of jurassic, black marls and shows an immense dynamic behaviour with velocities of more than 3 cm/day (Amitrano et al. 2007, Bulletin de la Société Géologique de France).

During a 10 days field campaign in July 2008, we were able to detect and locate different signals (type 'A' – 'C') caused by the movement of the mudslide. While the events type 'A' are caused by rockfalls in the source area of the slope, we could identify different types of signals (type 'B' and 'C'), which have been obviously generated by material failure within the unstable part of the mudslide. The spatial distribution of the epicenters (type 'B'), respectively the estimated source area (type 'C'), correlates well with parts of the slope moving with higher velocities at the surface.

The comparison of the results achieved by the seismic monitoring of slope dynamics with observations based on UAV-based remote sensing approaches (Niethammer & Joswig 2009, EGU), assists with the estimation of source areas and possible source mechanisms. Most of these signals have been generated close to the "in-situ crests" (Amitrano et al. 2007, Bulletin de la Société Géologique de France), which are mostly covered by the mudslide material today. Our preliminary assumption is that the events of type 'B' are generated by impulsive fractures within the sliding material, while the events of type 'C' are caused by activities at the boundary between the sliding material and the bedrock. We hypothesize that these type 'C' events are induced by "scratching" and "grinding" of the moving material against these in-situ crests.

Seismic Monitoring of Slope Dynamics caused by a slow-moving Landslide in the Vorarlberg Alps, Austria

Marco Walter & Manfred Joswig

DFG-Research Unit 581 "Coupling of Flow and Deformation Processes for Modeling the Movement of Natural Slopes"

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Introduction

Within the research unit „Coupling of Flow and Deformation Processes for Modeling the Movement of Natural Slopes", our institute is dealing with the seismic monitoring of weak fracture processes during the movement of the unstable Heumoes slope.
The slope is situated ~25 km south of Bregenz in the Vorarlberg Alps, Austria (Figure 1). The sliding part of the slope which shows movement velocities up to several cm per year, mainly consists of loamy scree and cretaceous marls.

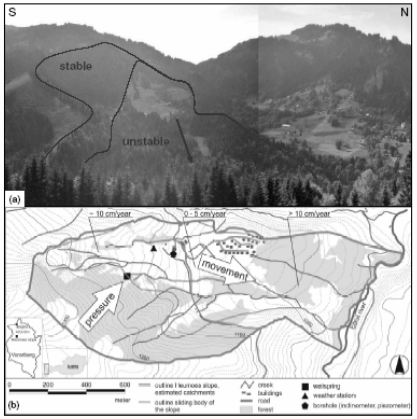


Figure 1: (a) view at the Heumoes slope
(b) estimated extension and general settings of the Heumoes slope (modified after Lindenmaier et al., 2008)

Possible source mechanisms

In-situ field experiments have been carried out in order to determine possible source mechanisms for the observed fracture processes. Therefor, we dig a cavity with a thin covering layer, above, we installed a rising load and a 3c-station next to. The aim of these experiments was to record possible signals before the covering layer collapsed. The in-situ experiments have been carried out within the water saturated material at the Heumoes slope as well as within dried sediments in Israel (Figure 5).
Within the material of the Heumoes slope, no signals could be identified, while we observed several events obviously caused by stress relief before the covering layer collapsed (Figure 5).
We therefor preliminary assume, that the fracture processes at the Heumoes slope are generated in dependence of the water saturation of the slope material.

Seismic Monitoring of Slope Dynamics

Applying the method *Nanoseismic Monitoring* (Joswig, 2008), we could observe during several field campaigns between 2005-2008 fracture processes caused by the movement of the slope. We installed between 2-5 mini-arrays on the slope on different locations and under varying climate conditions in order to determine possible influences to the slope stability and their seasonal variations.
44 fracture processes with magnitudes between $-2{,}2 < M_L < -0{,}7$ have been localized (Figure 2 and 3). The signals show clear phase-onsets, but the coda is dominated by surface waves. The sonogram-signature is quite similar to those of local earthquakes: high frequented P-phase, low frequented S-phase. The events have been localized with a layer (thickness 15 m; v_P = 500 m/s; v_P/v_S = 1,9) above halfspace (v_P = 2,2 km/s; v_P/v_S = 1,73) underground model.

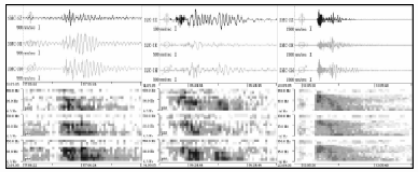
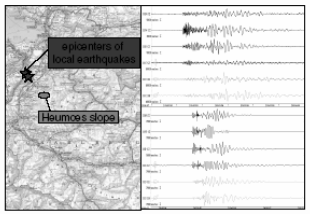


Figure 2: typical waveforms and sonograms of 3 events registered with a 3c-station:
fracture process of M_L -2,0 in ~160 m distance (left)
fracture process of M_L -1,4 in ~350 m distance (mid)
local earthquake of M_L 1,3 in ~10 km distance (right)

The spatial distribution of the localized events correlates with parts of the slope showing higher movement rates at the surface (Figure 4). The temporal occurrence of the fractures, up to 26 h after strong rain events, documents rainfall-triggered dynamics of the slope instability.



Beside rainfall, we could observe, during the field-campaign in June 2007, that small local earthquakes obviously affect the slope stability as well. Between 5 and 50 minutes after two local earthquakes we could observe five fracture processes on the Heumoes slope, in a time period, where the influence of rainfall can be eliminated.

Figure 3: epicentermap of the observed local earthquakes (M_L 2,0 and M_L 1,9) in June 2007 (left); Seismograms of one local earthquake, M_L 2,0 (right, top) and of a fracture process observed one hour later (right, below), both recorded with one mini-array.

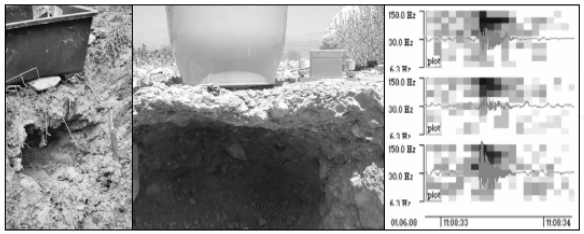


Figure 5: General set-up of the in-situ field-experiments at the Heumoes slope (left), in dried sediments in Israel (mid) and Seismograms and Sonograms of signals during the experiments in Israel, recorded with a 3c-station (right).

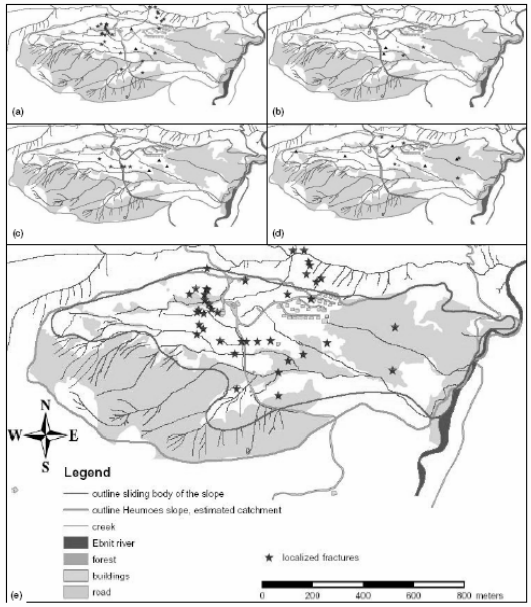


Figure 4: Epicentermap of the localized fracture processes on the Heumoes slope during the field-campaigns: September 2005 (a), Juni 2006 (b), Juli 2007 (c) and August-September 2008 (d) as well as a common illustration (e).

Acknowledgment

This work is funded by the Deutsche Forschungsgesellschaft (DFG).

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Weblinks

Nanoseismic Monitoring: http//:www.nanoseismic.net
Research unit 'Natural Slopes': http//: www.grosshang.de

Title: Rapid onsite determination of Volatile Organic Compounds (VOCs) in water samples using Ion Mobility Spectrometry (IMS)

Author(s): H. Borsdorf

Institution(s): Centre for Environmental Research Leipzig-Halle

Abstract
Ion mobility spectrometry (IMS) permits the fast detection of organic compounds by fieldable and hand-held devices. IMS is suitable as a field monitoring method due to the devices´ technical parameters (power supply, size, weight), the measuring conditions in which they operate (ambient pressure, air as drift gas), and their fast, accurate measuring performance (high sensitivity, recording of ion mobility spectra).

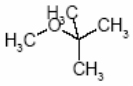
IMS works by measuring the drift velocities attained by ionized gaseous sample molecules in a weak electric field of a drift tube at atmospheric pressure. Therefore, determining ion mobilities initially requires the formation of ions from neutral sample molecules. Subsequently, the ions formed are separated within the drift tube and the drift velocities are determined.

Methyl tert-butyl ether (MTBE) is a commonly used fuel oxygenate. The widespread use of this compound has resulted in groundwater resources at numerous industrial sites becoming contaminated. As the treatment of groundwater calls for fast screening procedures to monitor remediation processes and assess the spatial distribution of contamination, an analytical procedure based on ion mobility spectrometry was developed for the rapid on-site analysis of MTBE in water samples.

MTBE is extracted from water using a membrane extraction unit and the sample gas stream is transferred in the IMS device without chromatographic separation. The influence of the sample matrix and accompanying substances on the ion mobility spectra of MTBE was studied. The results of ion mobility measurements were compared with those obtained by GC-MS.

The system developed permits the detection of MTBE concentrations >100 µg/L. No significant influence by inorganic compounds or the humic substances on the peak intensity of MTBE was established in ion mobility spectra. A low influence of BTEX (benzene, toluene, ethylbenzene and xylene) concentrations on the signal intensity of MTBE was established in range of concentration up to 700µg/L BTEX.

Rapid on-site determination of Volatile Organic Compounds (VOCs) in water samples using Ion Mobility Spectrometry (IMS)



- **the toxicity of MTBE is not clearly understood**
- **low odor and taste thresholds (20µg/L)**
- **high solubility in water (approximately 50g/L)**
- **low sorption of MTBE in soils**

Field monitoring methods

high sample throughput	fast availability of analytical results without transportation of samples
suitability of data analysis using statistical methods due to the large data sets	minimization of costs
minimization of possible errors owing to transportation and storage of samples	rapid decisions using the available analytical data
fast assessment of possible risk assessment	fast decisions on possible procedures in occupational health and safty
specific selection of samples for analysis in laboratories	

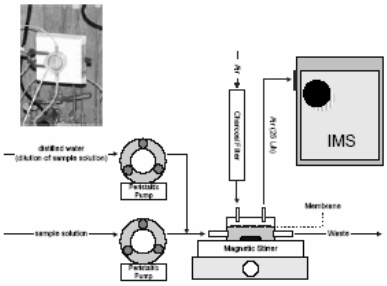
Why Ion Mobility Spectrometry in Field Screening?

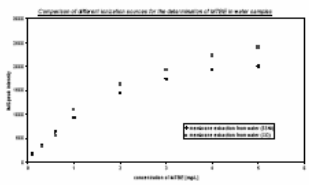
Technical parameters of devices:
power requirements, size, weight, measuring conditions
⇒ field-deployable devices

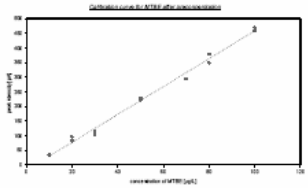
Information content of measurements:
additional information due to the detection of single response (decrease of reactant ions for ^{63}Ni- and Corona discharge ionization) and simultaneous acquisition of ion mobility spectra
⇒ complementary information about the substances investigated

Low detection limits for a broad range of substances:
detection limits in low ppm or ppb range (µg or ng /L (g)) for detectable compounds
⇒ current critical values can be detected

Experimental set-up



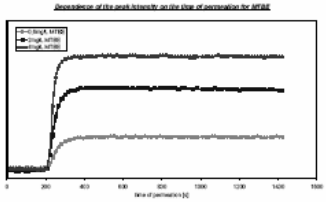




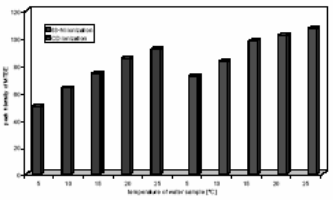
A detection limit of 100 µg/L was established for the on-line procedure. Using the inlet membrane as an enriching zone, concentrations between 10 µg/L and 100 µg/L can be determined. For these measurements, the gas flow through the extraction unit is interrupted.

Results

Establishment of equilibrium



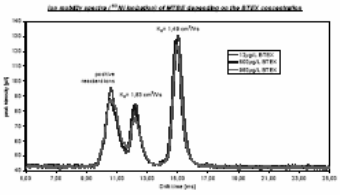
Influence of temperature

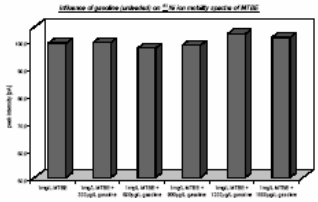


Correction factors of 1.7 (5° C), 1.35 (10° C), 1.15 (15° C) and 0.92 (25° C)

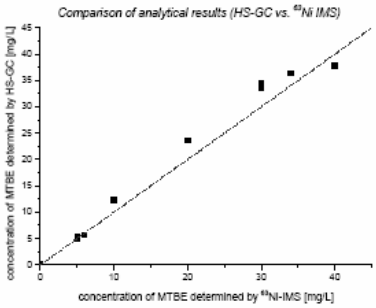
Investigation of matrix effects

- salinity: NaCl, $FeCl_2$, Na_2S
- humic acids
- organic contaminants (BTEX compounds) and unleaded gasoline as possible accompanying substances
- tert-butyl alcohol as a possible degradation product





Comparison of analytical results (HS-GC vs. ^{63}Ni IMS)



- sensitive detection of MTBE at concentrations >10µg/L
- method developed does not require any sample preparation
- the analytical results are available within 5min
- neither inorganic compounds, humic substances nor gasoline were found to significantly affect the peak intensity of the MTBE
- this technique makes analysis cheaper

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HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ

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HIGRADE

Title: Comparison of non- and minimum invasive geophysical dike evaluation techniques – a case study

Author(s): T. Vienken[1], U. Werban[1], C. Leven[2], M. Wahle[1], A. K. Pusch[1]

Institution(s):
[1] Helmholtz Centre for Environmental Research – UFZ; Department Monitoring and Exploration Technologies
[2] University of Tübingen
[3] University of Leipzig

An increase of severe flooding comparable to the flooding at the river Oder in 1997 and the flooding at the river Mulde in 2002 may be one of the results of the changing climate. Protection by dikes will gain in importance considering the increasing conversion of former fluviatile retention areas and a constant rise in vulnerability of the anthroposphere. Monitoring and maintenance of dikes, especially an adapted investigation of the structural integrity of dikes before, while and after flooding will be a key element.

Therefore, non- and minimum invasive geophysical dike evaluation techniques were tested and compared at a dike at Bennewitz about 25 km west of Leipzig. Due to the relocation of the dike, the existing dike was abandoned and its deconstruction planned. Field work concentrated on geophysical measurements using DC-Geoelectrics, OhmMapper, Ground Penetrating Radar (GPR) and Seismics. Measurements were supplemented by Direct Push vertical profiling and -soil sampling. During the deconstruction, the dike body could be inspected and the structure was mapped. The attained resolution was compared to the time- and personal effort required for each technique.

Results show that the highly heterogeneous structure of the dike was captured by all geophysical techniques, whereas the Direct Push electrical conductivity profiling and -soil sampling offered high resolution vertical profiles of the dike that were biased by the heterogeneity. The GPR measurements could offer highly detailed results that reflected foreign matter, layering and small scale structures.

Comparison of non- and minimum invasive geophysical dike evaluation techniques – a case study

Thomas Vienken, Ulrike Werban, Carsten Leven, Martin Wahle, Anne-Kristin Pusch

BACKGROUND

An increase of severe flooding comparable to the flooding at the river Oder in 1997 and the flooding at the river Mulde in 2002 may be one of the results of the predicted climate change. Protection by dikes will gain in importance considering the increasing conversion of former fluviatile retention areas and a constant rise in vulnerability of the anthroposphere. Monitoring and maintenance of dikes, especially an adapted investigation of the structural integrity of dikes before, while and after flooding will be a key element.

Therefore non- and minimum invasive geophysical dike evaluation techniques were tested and compared at a dike at Bennewitz about 25 km west of Leipzig. Due to the relocation of the dike, the existing dike was abandoned and its deconstruction planned. During the deconstruction, the dike body could be inspected and the structure was mapped.

Investigated dike before relocation and deconstruction. View towards southeast.

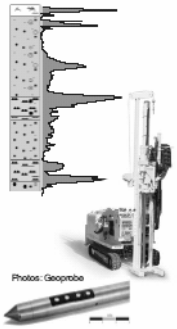
Regional view. The dike is located at the east of Bennewitz and to the southwest of Wurzen.

CONSIDERED METHODS AND RESULTS

DC-Geoelectrics:

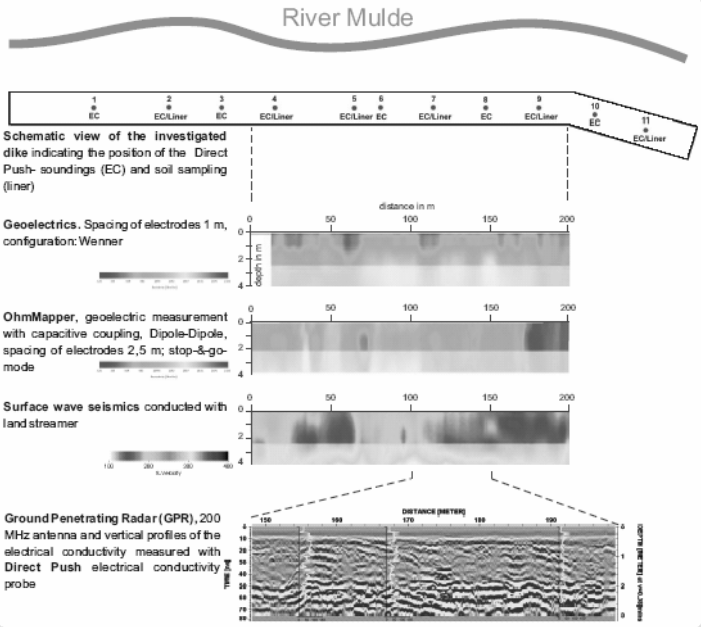
Basic principle of the DC-Geoelectrics, AB current electrodes, MN voltage electrodes (Lange & Jacobs from Knödel et al. 2005)

Direct Push (DP)-Technology:



Photos: Geoprobe

DP-rig and probe to measure vertical profiles of the electrical conductivity (EC). Correlation of the measured EC and lithology



Schematic view of the investigated dike indicating the position of the Direct Push- soundings (EC) and soil sampling (liner)

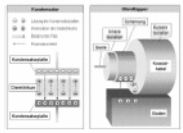
Geoelectrics. Spacing of electrodes 1 m, configuration: Wenner

OhmMapper, geoelectric measurement with capacitive coupling, Dipole-Dipole, spacing of electrodes 2,5 m; stop-&-go-mode

Surface wave seismics conducted with land streamer

Ground Penetrating Radar (GPR), 200 MHz antenna and vertical profiles of the electrical conductivity measured with **Direct Push** electrical conductivity probe

DC-Geoelectrics:



Capacitive coupling of the OhmMapper, 4 dipole cables are used as electrodes (see Gebbers & Lück 2007)

Exposed dike structure:

Excavation (top) and removal of top soil (bottom) reveal the heterogenous structure of the dike including clay, sand, gravel and debris

SUMMARY

The highly heterogeneous structure of the dike was captured by all geophysical techniques, whereas the Direct Push electrical conductivity probing and soil sampling offered high resolution vertical profiles of the dike that were biased by the heterogeneity. Only the GPR measurements could offer highly detailed results that reflected foreign matter, the dike base, layering and small scale structures. The following table compares the resolution of each of the applied techniques in this case study with the required time- and personal effort.

Technique	Resolution	Time-, personal effort
DC-Geoelectrics	large scale	+
OhmMapper	large scale	o (stop und go)
GPR	large, small scale dike base, layering, foreign matter	o
Surface wave seismics	large scale	++
DP EC	high resolution vertical profiles	o per profiling ++ dike
DP soil sampling using liners	quantify small scale structures	o per profiling ++ dike

++= very high; + high; o = medium; - small; -- very small

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HIGRADE

Title: Thermal signatures in river sediments: Application to the Lahn basin

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Abstract
The hyporheic zone is a region beneath and lateral to a river bed, where there is mixing of shallow groundwater and surface water. We present a modeling study on hyporheic exchange at a natural river. River flow rates and temperature time series at several depths up to 1.5 meters in the river sediments were recorded at two transects upstream and downstream of a riffle. Vertical water fluxes in the river sediments were determined over a summer/winter period by simulating advective-conductive heat transport in saturated porous media. Hyporheic exchange decreases significantly at river flow peaks and when a pool at an adjacent water treatment plant was filled.