International Conference NovCare 2013

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

Date: May 13-16, 2013
Place: UFZ- Helmholtz Centre for Environmental Research, Leipzig, Germany

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

The **3rd NovCare** Conference in 2013 will showcase newly developed and refined methods, novel applications of existing methods, and new concepts for subsurface characterization and monitoring. This conference will provide a rare opportunity for researchers and practitioners to exchange ideas about the field challenges of subsurface characterization and monitoring.

Organizing Committee:

- Peter Dietrich (UFZ-Helmholtz Centre for Environmental Research)
- Thomas Vienken (UFZ-Helmholtz Centre for Environmental Research)
- Carsten Leven-Pfister (University of Tübingen)
- Olaf Cirpka (University of Tübingen)
- James J. Butler, Jr. (Kansas Geological Survey, University of Kansas)
- Geoffrey Bohling (Kansas Geological Survey, University of Kansas)
- David Hyndman (Michigan State University)
- Remke van Dam (Michigan State University)

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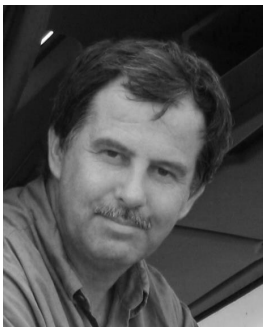
Welcome and Greetings



Peter Dietrich

Professor for Environmental and Engineering Geophysics at the Eberhard-Karls-University of Tübingen and Head of the UFZ-Department Monitoring and Exploration Technologies

Thomas Vienken

Head Working Group Direct Push and hydrogeological measurement methods at UFZ-Department Monitoring and Exploration Technologies

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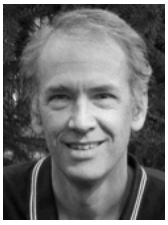
It is a great honour for us to welcome you in Leipzig to the 3rd NovCare International Conference 2013. We are pleased to organize this event, which provides a rare opportunity and an outstanding platform for researchers and practitioners from all over the world to exchange their ideas and experiences on dealing with challenges of subsurface characterization and monitoring using a variety of methods. We wish all participants of NovCare 2013 stimulating conference days in Leipzig, interesting discussions, and new inspirations.



James J. Butler, Jr.

Senior Scientist and Section Chief, Geohydrology Section, Kansas Geological Survey, The University of Kansas

David W. Hyndman

Professor and Chair Michigan State University, Dept. of Geological Sciences

Carsten Leven-Pfister

University of Tübingen | Center for Applied Geoscience, Hydrogeology

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The organizing committee would like to welcome you to Leipzig and the NovCare 2013 Conference. This conference series, which began here in Leipzig in 2009 and then moved to Cape Cod in the United States in 2011, has proven to be an excellent forum for exchanging ideas and experiences regarding the challenges of subsurface characterization and monitoring. NovCare 2013 will build on the successes of the previous conferences and provide attendees an opportunity to learn about novel approaches including a glimpse of topics still in development. We encourage you to use the discussion time and social activities to interact with your fellow attendees and our exhibitors to get the most out of the experience.

Once again, welcome to Leipzig and NovCare 2013!

Agenda

May 13, 2013

10:00-16:00	***Direct push field workshop (registration required)*** Station 1: DP Injection Logger Station 2: DP Slug test Station 3: CPT combined with water content profiler Station 4: MIP coupled with GC
18:00-20:00	***Ice breaker*** *(Moritzbastei, Universitätsstraße 9, Leipzig)*

May 14, 2013

9:30- 9:50	***Welcome address*** *(Vienken, T.)*
	Teutsch, G. and Dietrich, P. (UFZ-Helmholtz Centre for Environmental Research)
	Butler, J. (Kansas Geological Survey)
9:50-10:30 ***Keynote***	**K1)** Geotechnical characterization using direct push technology – some new trends *(Lunne, T.; Santos, R.)*
10:30-10:50	*Coffee break*
10:50-12:50	***Session 1: Direct push site characterization*** *(Vienken, T.)*
10:50-11:10	**1.1)** CPT-based direct sensing as high quality tool for reliable high resolution site characterization – experiences throughout Europe (*Martac, E.; Oppermann, A.)*
11:10-11:30	**1.2)** Multi-scale aquifer characterization and groundwater flow model parameterization using direct push technologies *(Rogiers, B.; Vienken, T.; Batelaan, O.; Gedeon, M.; Mallants, D.; Huysmans, M.; Dassargues, A.)*
11:30-11:50	**1.3)** Case studies using the combined MIP-HPT tool *(Christy, T.M.; McCall, W.; Pipp, D.; Terkelsen, M.; Christensen, A.; Weber, K.)*
11:50-12:10	**1.4)** Direct-push hydraulic profiling in formations of moderate to high hydraulic conductivity *(Butler, J.; Liu, G.; Knobbe, S.; Reboulet, E.; Bohling, G.C.)*
12:10-12:50 ***Keynote***	**K2)** High-resolution hydrogeophysical characterization of the MADE site: Implications for transport modeling in heterogeneous media *(Dogan, M.; Van Dam, R.L.; Butler, J.;* ***Hyndman, D.W.****)*
12:50-13:50	*Lunch break and* ***technical exhibition***
13:50-14:30 ***Keynote***	**K3)** New in situ sensor developments and their application in sensor networks *(Behra, P.)*
14:30-16:50	**Session 2: Advances in direct push technology** (Butler, J.)
14:30-14:50	**2.1)** Boundary-breaking heavy metal XRF probe for efficient onshore & offshore high-resolution site characterization *(Martac, E.; Oppermann, A.; Neuhaus, M.)*
14:50-15:10	**2.2)** Abrasion of direct push probes: effects on instrument response using the example of DC resistivity probes *(Demuth, D.; Bumberger, J.; Paasche, H.)*
15:10-15:30	**2.3)** Field experience with low level MIP measurements *(Christy, T.M.; Pipp, D.)*
15:30-15:50	**2.4)** Transfer line concepts for the MIP *(Bumberger, J; Peisker, K., Goblirsch, T.; Dietrich, P.)*
15:50-16:10	**2.5)** Neutron-neutron measurements for pollution detection and control *(Nitsche, C.; Dietrich, P.; Buckup, K.)*
16:10-16:50	**K4)** Advances in nuclear magnetic resonance tools for subsurface

Keynote	characterization and monitoring *(Walsh, D.)*
16:50-17:20	*Coffee break*
16:50-18:30	**Company exhibition, poster session, GeoProbe special session**
18:30-20:00	*Conference buffet at Kubus foyer*

May 15, 2013

9:00-11:00	**Session 3: Geophysical site characterization I** (Dietrich, P.)	
9:00-9:40 ***Keynote***	**K5)** Persistence is a virtue: The value of long-term hydrogeophysical monitoring for characterizing near-surface hydrological processes *(Endres, A.)*	
9:40-10:00	**3.1)** Imaging of regions of preferential flow in aquifers using full-waveform inversion of crosshole ground penetrating radar *(Klotzsche, A.; van der Kruk, J.; Vereecken, H.)*	
10:00-10:20	**3.2)** Soil moisture characterization using a new full-wave, near-field antenna model: From laboratory to field applications *(Tran, A.P.; André, F.; Lambot, S.)*	
10:20-10:40	**3.3)** Joint inversion scheme with a fully adaptive strategy to adjust regularization and coupling constraints *(Heincke, B.; Moorkamp, M.; Jegen, M.; Chen, J.; Hobbs, R.)*	
10:40-11:00	**3.4)** A study on a potash mining waste dump using geophysical tomographical techniques *(Dünnbier, K.; Börner, F.; Schicht, T.)*	
11:00-11:30	Coffee break, **Company exhibition**	
11:30-13:10	**Session 4: Geophysical site characterization II** (Endres, A.)	**Session 5: Long term monitoring and simulation based site characterization** (Dietrich, P.)
11:30-11:50	**4.1)** Recent developments in large scale quantitative multi-layer inversion with calibrated multi-offset EMI systems *(van der Kruk, J.; von Hebel, C.; Mester, A.; Rudolph, S.; Altdorff, D.; Vereecken, H.)*	**5.1)** Progress in phytoscreening with heavy metals at contaminated sites *(Trapp, S; Algren, M.; Rein, A.)*
11:50-12:10	**4.2)** SQUID magnetometer based receivers for transient electromagnetics *(Stolz. R.; Chwala, A.; Schulz, M.; Schmelz, M.; Queitsch, M.; Linzen, S.; Bondarenko, N.; Meyer, M.; Meyer, H.-G.)*	**5.2)** Long-term monitoring of soil gases by means of a passive gas sampling system *(Plendl, H.; Kaiser, H.)*
12:10-12:30	**4.3)** Imaging two-dimensional distributions of hydraulic properties of unconsolidated sediments using surface-NMR *(Müller-Petke, M.; Dlugosch, R.; Günther, T.; Yaramanci, U.)*	**5.3)** Numerical investigation of shallow aquifer recharge using small-diameter, low-cost wells and infiltration basin *(Händel, F.; Liu, G.; Dietrich, P.; Liedl, R.; Butler, J.)*
12:30-12:50	**4.4)** On the use of cosmic-ray neutron sensing to measure soil moisture in cropped fields *(Rivera Villarreyes, C.A.; Baroni, G.; Oswald, S.E.)*	**5.4)** Coupled simulation of unsaturated and saturated nitrate distribution at aquifer scale *(Klammler, G.; Kupfersberger, H.; Rock, G.; Fank, J.)*
12:50-13:10	**4.5)** Estimating vadose zone hydraulic properties with the method of anchored distributions *(Over, M.W.; Wollschläger, U.; Osorio, C.A.M.; Ames, D.P.; Rubin, Y.)*	**5.5)** Characterization and geostatistical simulation of the heterogeneity of a shallow granular aquifer for the numerical modeling of flow and transport *(Paradis, D.; Tremblay, L.; Brunet, P.; Gloaguen, E.; Lefebvre, R.)*
13:10-14:00	Lunch break and **Company Exhibition**	
14:00-15:40	**Session 6: Watershed Characterization** (Hyndman, D.)	

14:00-14:40 ***Keynote***	**K6)** Hydrogeological characterization of spring catchments: Shedding light on the black box *(Birk, S.)*
14:40-15:00	**6.1)** Impacts governing PAHs contamination of sediments and suspended matter in river systems. *(Schwientek, M.; Rügner, H.; Beckingham, B.; Kuch, B.; Grathwohl, P.)*
15:00-15:20	**6.2)** Using reservoirs as monitors of catchments: online in-situ water quality monitoring in a german drinking water reservoir *(Rinke, K.; Kamjunke, N.; Tittel, J.; Friese, K., Bocaniov, S.)*
15:20-15:40	**6.3)** Characterization of a lowland headwater catchment by means of hydrodynamics, hydrochemistry and groundwater age dating *(Musolff, A.; Weise, S.M.; Fleckenstein, J.H.)*
15:40-16:00	*Coffee break*
16:00-17:30 ***Open Lecture***	***Managing groundwater beneath the agricultural landscape (Rudolph, D.L. - 2013 Darcy Lecturer)*** *(Dietrich, P.)*
17:30-18:30	***Company exhibition, poster session*** *Short meeting discussion paper: Direct push*
20:00	*Conference dinner (Bayerischer Bahnhof, registration required)*

May 16, 2013

9:00-11:00	**Session 7: Groundwater flow and interaction** (Butler, J,)
9:00-9:40 ***Keynote***	**K7)** Should we open Pandora's box? Characterizing stream-groundwater interactions from surface and subsurface perspectives *(Gooseff, M.)*
9:40-10:00	**7.1)** Data analysis for tracer experiments using shape-free deconvolution method on multiple scales *(Liao, Z.; Gritsch, M.; Lemke, D.; Ostenbrück, K.; Cirpka, O.A.)*
10:00-10:20	**7.2)** Determining groundwater-surface water exchange using multilevel temperature probes and information from the frequency response *(Schneidewind, U.; Vandersteen, G.; Anibas, C.; Schmidt, C.; Batelaan, O.; Wilczek, D.; Joris, I.; Bronders, J.; Seuntjens, P.)*
10:20-10:40	**7.3)** Artificial groundwater recharge – a tool to optimize drinking water supply in the Lower Mur Valley in Austria *(Fank, J.; Fank, A.)*
10:40-11:00	**7.4)** New technologies in hydraulic engineering – the usage of fiber optics *(Schwartz, A.; Großwig, S.; Pfeiffer, T.)*
11:00-11:30	*Coffee break*
11:30-12:50	**Session 8: Analysis of hydrological field experiments** (Fank, H.)
11:30-12:10 ***Keynote***	**K8)** Building on the three pillars of successful and efficient inversion: The role of cleverness, care, and computation in experimental design, instrumentation, and analysis *(Cardiff, M.)*
12:10-12:30	**8.1)** A new sequential procedure for hydraulic tomography combining an eikonal and a pilot point based inversion scheme *(Brauchler, R.; Jimenez, S.; Hu, R.; Hu, L.; Schmidt, S.; Bayer, P.; Ptak, T.)*
12:30-12:50	**8.2)** Heat tracer tomography – A new approach to characterizing aquifer heterogeneity *(Doro, K.O.; Cirpka, O.A.; Leven, C.)*
12:50-13:30	*Lunch break*
13:30-15:30	**Session 9: Thermal use of the shallow subsurface** (Dietrich, P.)
13:30-14:10 ***Keynote***	**K9)** Impact of temperature on groundwater hydrochemistry *(**Dahmke, A.**; Köber, R.; Jesußek, J.)*
14:10-14:30	**9.1)** Thermal parameter: Aquisition and characterisation of geologic properties – A 400 meter deep BHE in a karstic alpine marple aquifer *(Sass, I.; Lehr, C.)*

14:30-14:50	**9.2)** Geothermal subsurface characterization at regional scale: the Calabria Region case study (Southern Italy) *(Di Sipio, E.; Galgaro, A.; Destro, E.; Chiesa, S.; Giaretta, A.; Manzella, A.)*
14:50-15:10	**9.3)** Heat flow laboratory tests, numerical modeling and monitoring for the thermal use of the shallow subsurface *(Giordano, N.; Firmbach, L.; Comina, C.; Dietrich, P.; Kolditz, O.; Mandrone, G.; Vienken, T.; Watanabe, N.)*
15:10-15:30	**9.4)** Development of exploration and monitoring strategies for the sustainable thermal use of the shallow subsurface *(Vienken, T.; Schelenz, S.; Firmbach, L.; Dietrich, P.)*
15:30-15:45	**Closing remarks** (Dietrich, P.)
15:45-16:15	Short meeting discussion paper: Thermal use of the shallow subsurface

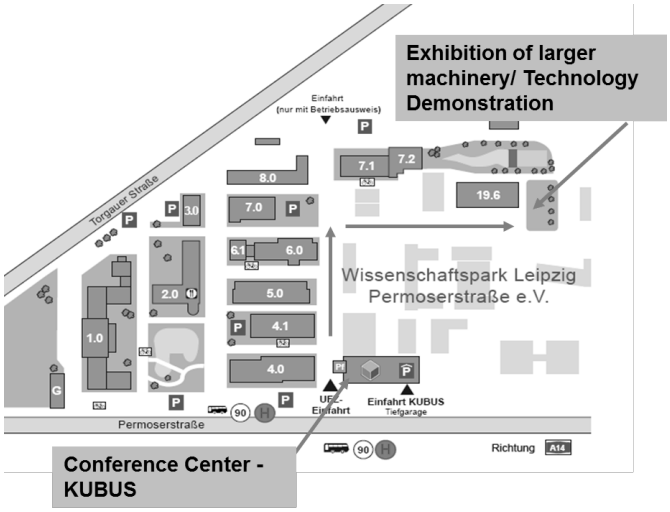
Detailed Program

Company Exhibition:

May 14, 2013 9:30- 20:00 (Foyer of the KUBUS)
May 15, 2013 9:00- 18:30 (Foyer of the KUBUS)

Technology Demonstration and Exhibition of larger machinery

May 14, 2013 12:50-13:50 (UFZ area)



Poster Exhibition:

May 14-16, 2013 (Foyer of the KUBUS)

Poster Session:

May 14, 2013 16:50-18:30 (Foyer of the KUBUS)
May 15, 2013 during breaks
May 16, 2013 during breaks

Keynote Speakers – 14th May

K1) Tom Lunne; Roi Santos
Norwegian Geotechnical Institute (NGI)

Geotechnical characterization using direct push technology – some new trends

Date: May 14, 2013
Time: 9:50-10:30

Direct push technology for geotechnical characterization involves the following aspects:
Deployment of the tools- to get them into the ground, *the tools* themselves – both in situ tests and sampling devices, *data acquisition and processing* and *interpretation* of the results in terms of soil parameters for foundation design or other geotechnical problems like slope stability.
The *deployment* method depends on whether the site to be investigated is onshore, nearshore or offshore. For onshore investigations deployment rigs are now available for all kinds of applications; like special rigs for investigated old railway embankments, for testing in walls of old tunnels. Another trend is to use rigs that can push tools continuously into the ground to increase efficiency and also quality of the data. Some rigs are even operated by a robot to allow only one person to man a rig. Nearshore investigations can in shallow waters be done from a jack up platform that is stationary relative to the sea bottom so that onshore rigs may be used. Alternatively floating deployment platforms similar to what is used for offshore investigations can be used. Offshore deployment techniques have also seen large recent innovations.
The *cone penetration test* (CPT) and especially with measurement of pore water pressure (CPTU) has seen increasing use and is gaining popularity worldwide. Add on tools, and especially the seismic cone and the seismic dilatometer are gaining in popularity and yield very useful results. Other add on devices include: nuclear density, electrical resistivity plus numerous sensors for mapping of contaminants in the soil.
Data acquisition has seen increasing use of digital data transfer and cordless systems, like sending signals acoustically through the rods are being more and more frequently used.
For interpretation of the results to get soil parameters for foundation design or other geotechnical problems it is an increasing need to extend correlations form pure clays and sands to more “difficult” soils like compressible calcareous sands, silty sands and chalk.

Tom Lunne has a BSc from Heriot-Watt University, Edinburgh and an MSc from University of California, Berkeley. He has been working at The Norwegian Geotechnical Institute (NGI) since 1971. He has led several R&D projects on in situ testing, with main emphasis on CPT/CPTU and interpretation of the results for foundation design; but other in situ tests like the pressuremeter, vane and dilatometer has also been studied. He has been involved with large soil investigations, mainly offshore, worldwide. He has contributing to ISO and other standards on in situ testing and sampling. He is lead author of the book: Cone Penetration Testing in Engineering Practice.
Roi Santos has a BSc from Vigo University, Spain, an MSc in Geophysics and Geotechnics from North Whales University and an MSc in Soil Mechanics from Imperial College London. He has been working at Gardline Geosciences since 2005. He has been involved in multiple large scale offshore site investigations around the world. He is currently leading the geotechnical consultancy department at Gardline, providing technical advice to the R&D and Site investigation teams.

K2) David W. Hyndman

Michigan State University

High-Resolution Hydrogeophysical Characterization of the MADE Site: Implications for Transport Modeling in Heterogeneous Media (Dogan, M.; Van Dam, R.L.; Butler, J.; Hyndman, D.W.)

Date: May 14, 2013
Time: 12:10-12:50

Solute transport through aquifers is primarily controlled by the spatial distribution of hydraulic conductivity (K). The sparse nature of K data commonly limits the accuracy of transport simulations using the classical advection-dispersion equation in heterogeneous deposits. Emerging solute transport models may provide reasonable representations of average plume behavior, but they do not replicate the extent or nature of observed concentration plumes. We demonstrate that a suite of novel high-resolution hydrologic and geophysical characterization methods can provide the necessary subsurface data to significantly improve flow and transport simulations through heterogeneous porous media. To this end, we combined 3D ground-penetrating radar (GPR) data with high-resolution K (HRK) data from direct-push profiles, at a heterogeneous fluvial deposit in northeastern Mississippi. The full-resolution GPR data cubes were used to generate 3D facies models, including major bounding surfaces, connectivity, as well as dip angles and directions. The HRK profiles, collected with Direct Push Geoprobe tools, provided information on the vertical distribution of hydraulic conductivity with 1.5 cm vertical resolution. Comparative analysis of the geophysical and drilling data reveals good correlation with the major facies boundaries. Hydrogeophysical data integration enabled us to construct hydrostratigraphic models of the heterogeneous deposits, providing a strong basis for flow and transport models that reasonably represent the measured extent of the tracer plumes with no calibration. This data provided a basis for transport simulations that much more accurately match tracer experiments in highly heterogeneous sediments than previous approaches.

Dr. Hyndman is a Professor and Chair of the Department of Geological Sciences at Michigan State University. Dr. Hyndman's research interests include developing novel methods to characterize the aquifers that store and transmit water supplies critical to human and ecological health, helping develop methods to clean contaminated aquifers using emerging technologies such as bioremediation, and quantifying the human impacts on changes in climate and land use on the water cycle. His research involves coupling novel models with high resolution field data to explore the physical, chemical, and ecological processes in natural and anthropogenically altered systems.

K3) Philippe Behra

Université de Toulouse; INPT, LCA (Laboratoire de Chimie Agro-industrielle); UMR 1010, ENSIACET, 4 allée Emile Monso, F-31030 Toulouse CEDEX 4, France, INRA; LCA (Laboratoire de Chimie Agro-industrielle), F-31030 Toulouse, France

New *in situ* sensor developments and their application in sensor networks

Date: May 14, 2013
Time: 13:50-14:30

Nowadays, for local observatory systems, the surveillance needs *in situ* monitoring with instruments which are autonomous from the point of view of energy and calibration for a period larger than 3 months, robust, precise, and small enough, in hostile and remote environments capable to communicate data set. Our main objective is to develop research in the domain on new physicochemical microsensors which have to focus on large range of concentrations of organic or inorganic compounds in complex heterogeneous matrices for dynamic speciation. A set of microsensors constitute a so-called microlaboratory. Each of them is designed and optimised for new analytical purpose, for on line analytical speciation, small enough for minimising local perturbation. The time for analysing has to be short enough and adapted to small volume of gas, aerosols, solids, colloids, or liquids (mainly waters). Finally, the microsensors have to be as cheap as possible.
In this project, the main goal is to design and develop new *in situ* systems such as new sensors and distributed sensors for measuring physicochemical (concentrations, pH, redox potential…) and physique (temperature, pressure, flow, conductivity…) parameters in order to bring a new dimension to the observation of natural system and its future. First, microfluidics is applied in order to fractionate suspended matter, colloidal and dissolved phases. Different ways are possible based either on diffusion concept or to hydrodynamic separation due to size effect of particles. Second, separation of species has to occur by means of chromatography, electrophoresis or a combination of both methods depending on species properties. Specific way can be also conceived depending on the shape of molecules by using cryptate molecules with dedicated pattern. The last part of analytic microsystem consists in the detector device which depends on the specificity of the compounds which have to be detected: *e.g.* microelectrodes or optical detector.Finally, new materials are designed to minimise (bio)fouling at the surface of microsystems. Electronics with low energy consumption has to be set on such a system for power supply and for telecommunication via a microemitter. This work is financially supported by FCS (Fondation STAE « Sciences et Technologies pour l'Aéronautique et l'Espace ») under the acronym "MAISOE" (Microlaboratoires d'Analyses In Situ pour des Observatoires Environnementaux).

Philippe Behra received his engineer degree in civil and rural technology (ENGEES, Strasbourg, France) in 1983, his Master degree in Fluid Mechanics in 1984 and his Ph.D. degree in water sciences and technologies from the University of Strasbourg in 1987. From 1988 to 1990, he worked on atmospheric chemistry as research fellow at EAWAG – ETH Zurich (CH) with Profs. Werner Stumm and Laura Sigg. From 1989-2000, he was research fellow at CNRS at the Institute of fluid mechanics (Strasbourg). Since 2000, he has been professor of analytical chemistry and environment chemistry in the "Laboratoire de chimie agro-industrielle" at the Institut National Polytechnique in Toulouse. The primary areas of his research are water chemistry and aquatic chemistry, reactive transport and reactivity at solid-gas-liquid interfaces (analytical chemistry and dynamic speciation applied to environmental systems; trace metals or metalloids, sensors…). He is leading a project on environmental microsensors and a think-tank on "instrumentation and environmental sensors". Ph. Behra is co-author of the textbook "Chimie des milieu aquatiques" (Dunod, Paris, 5th edition, fall 2013) and editor of a new textbook "chimie et environnement" (Dunod, May 2013). He was the chairman of the COST Action "Chemodynamics of ground waters". In 1992, he got the Körber European Science Prize, Hambourg (topic: The Spread and Transformation of Contaminants in Ground Water).

K4) Dave Walsh

Vista Clara Inc.

Advances in Nuclear Magnetic Resonance Tools for Subsurface Characterization and Monitoring

Date: May 14, 2013
Time: 16:10-16:50

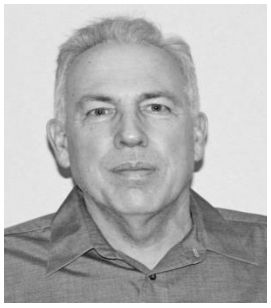
Nuclear magnetic resonance (NMR) measurements provide direct detection and measurement of water content and other fluids, and are sensitive to the physical, geochemical, and flow properties of the pore-scale environment in which the fluids reside. For example, in medical MRI, NMR measurement are routinely applied to provide high-resolution and in some cases real time 2D and 3D imaging of tissue contrast, heart function, blood flow, gas flow and diffusion within the lungs, and even functional activity in the brain. This richness and complexity of the NMR measurement, which entails manipulating hydrogen atoms and magnetic fields to produce coherent RF magnetic fields, has shown great value for practical uses in groundwater and environmental investigations.

NMR geophysical measurements are embodied in an increasing array of forms. The measurement generally requires a static magnetic field, which polarizes the hydrogen atoms and creates a bulk magnetic moment within the field, and a secondary magnetic field which is used to perturb the magnetization in the sample and enable detection of the induced magnetic field. The established measurement modes include NMR logging, which typically utilizes uses permanent magnets and low RF detection to perform measurements within inches of the borehole, and surface NMR (or “magnetic resonance sounding”) which uses large surface loops to perform NMR measurements in the Earth’s geomagnetic field. Emerging geophysical NMR measurement tools include small non-invasive and in-situ sensors for shallow soil moisture sensing, and permanently embedded in-situ NMR sensors.

Conventional applications of NMR groundwater geophysics are centered on aquifer characterization: measurement of water content, porosity, and estimation of permeability and bound/mobile water fractions. Oilfield NMR logging applications include reservoir characterization (permeability, porosity) and differentiating water, oil and gas. Emerging applications of NMR geophysics include characterization of soils for geotechnical purposes; investigations of ice and permafrost; direct detection of NAPLs in the near subsurface; long term monitoring of water content in the vadose zone; and monitoring bio-geochemical processes associated with contaminant remediation.

Dave Walsh is the founder and President of Vista Clara Inc. He is in his 16th year managing this small business in the field of geophysical research and instrument manufacturing. His significant contributions have been in the development of multi-channel surface NMR instrumentation and processing methods for groundwater investigations, development of small diameter low-cost borehole and direct-push NMR instruments for hydrological investigations, and the development of nuclear quadrupole resonance explosive detection systems. Dave Walsh received a B.S. degree in electrical engineering from Iowa State University in 1990, an M.S. degree in electrical engineering from the University of Arizona in 1993, and a Ph.D. degree in electrical engineering from the University of Arizona in 1997.

Keynote Speakers – 15th May



K5) Anthony L. Endres
University of Waterloo

Persistence is a Virtue: The Value of Long-Term Hydrogeophysical Monitoring for Characterizing Near-Surface Hydrological Processes

Date: May 15, 2013
Time: 9:00-9:40

An important attribute of hydrogeophysical techniques is their capacity to perform non-invasive time-lapse monitoring of complex near-surface hydrological processes. Most studies using time-lapse hydrogeophysical monitoring have been done for relatively short durations ranging from a day to several months. However, the nature of these processes can significantly vary over the annual cycle of near-surface conditions. Hence, time-lapse hydrogeophysical monitoring for periods of one or more annual cycles are critical for characterizing these longer term effects.
The hydrogeophysics group at the University of Waterloo has undertaken a number of field studies using high-resolution geoelectrical techniques (i.e., electrical resistivity tomography (ERT), ground conductivity meters (GCM) and high-frequency (i.e., 225-900 MHz) ground penetrating radar (GPR)) to intensely monitor several annual cycles of shallow soil moisture dynamics that occur in temperate climates. Our multi-year data sets clearly demonstrate the capacity of these hydrogeophysical methods to characterize the evolution of near-surface hydrological processes over the annual cycle, as well as their response to variation in hydrological processes between contrasting annual cycles (e.g., wet versus dry summer conditions). These data sets also allow us to observe the relationship between short duration events and seasonal trends.
In addition, these long-term data sets are ideal for comparing hydrogeophysical estimates of hydrological conditions with modeling predictions. We have found very good agreement between the hydrogeophysical measurements and modeling results for both unfrozen and frozen conditions, indicating that long-term hydrogeophysical monitoring has a potentially important role in hydrologic model calibration. This role for long-term hydrogeophysical monitoring is particularly significant for winter processes. Seasonal freeze-thaw processes are major components of the hydrological cycle in mid-latitude regions during periods of sub-zero (ºC) atmospheric conditions and are difficult to monitor on the field-scale using traditional techniques such frost tubes. Our results clearly demonstrate the capacity of long-term hydrogeophysical monitoring for quantitatively characterizing these processes.

Anthony L. Endres received his B.Sc. (1977) from Michigan Technological University, his M.Sc. (1979) from Texas A&M University and his Ph.D. (1991) from the University of British Columbia. In 1992-1993, Professor Endres was awarded an NSERC Postdoctoral Fellow. Between 1994 and 1999, he held academic and research positions at Boston College, University of Waterloo and University of Western Australia. Since 1999, he has been a faculty member in the Department of Earth & Environmental Sciences at the University of Waterloo. His research interests are focused on the application of hydrogeophysical techniques to the monitoring of near-surface hydrological processes. This work is aimed at establishing a comprehensive framework for using hydrogeophysical-derived information to further the understanding and quantitative characterization of shallow vadose zone processes, such as evapotranspiration, freeze-thaw cycles, groundwater recharge and nutrient transport, beyond the knowledge obtained through the use of conventional monitoring techniques. Professor Endres is currently an Associate Editor for the Journal of Hydrology.

K6) Steffen Birk
University of Graz

Hydrogeological characterization of spring catchments: Shedding light on the black box

Date: May 15, 2013
Time: 14:00-14:40

Many springs are situated in mountainous terrain and thus their catchments are often difficult to access and hardly equipped with monitoring wells. As a consequence, prediction of flow and transport phenomena in spring catchments frequently relies on black-box models that represent empirical input-output transfer functions. Such model predictions, however, are prone to risk of failure if conditions change beyond the range considered in the calibration. Improving our understanding of flow and transport processes in spring catchments and incorporating this knowledge in more process-oriented (though possibly still lumped-parameter) modeling approaches represents one important step toward more reliable predictions. The development and application of such "grey-box" models requires an adequate hydrogeological characterization of the spring catchment under consideration. This presentation focuses on characterization techniques that can be readily applied in the absence of wells, such as the analysis of hydrographs or water temperatures recorded at a spring.
The analysis of spring responses, in general, is complicated by the fact that they may be controlled by both recharge conditions and aquifer properties. In this regard, the hydrograph recession during drought periods may be considered advantageous, since it appears to be unaffected from recharge. While this is true for the long-term recession, theoretical considerations reveal that a recharge event may still exert influence on the subsequent recession over periods ranging from days to weeks. Discriminating between the effects of recharge and those of aquifer properties within this early recession period thus remains a challenging task.
The temperature of spring waters represents one parameter that is potentially strongly influenced by aquifer properties, since temperature variations are damped by the thermal interaction between water and rock. Short-term variations of water temperatures indicate a flow component with short residence time and large-diameter conduits within the aquifer. The lack of knowledge of recharge temperatures frequently complicates the quantitative interpretation of temperature variations recorded at springs. Nevertheless, the absence or existence of temperature variations can be interpreted using a thermal time scale that represents an analytical estimate of the residence time required for damping temperature signals in an aquifer. The example of the Lurbach-Tanneben karst system (Austria) demonstrates that this approach may provide insight into the aquifer characteristics, particularly, when combined with other methods, such as the analysis of the hydrograph recession.

Steffen Birk graduated in geoecology at the University of Karlsruhe (Germany) in 1998. He received a PhD in applied geology at the University of Tübingen (Germany) in 2001. After a research stay at the Kansas Geological Survey (USA) in 2001 he returned to the Center for Applied Geoscience at the University of Tübingen, where he completed the postdoctoral lecturer qualification (Habilitation) in 2006. Since 2006 he is employed as a professor of hydrogeology in the Institute for Earth Sciences at the University of Graz (Austria). His main area of research is karst hydrogeology, in particular the development of quantitative techniques for characterizing and modeling flow and transport processes in karst settings, such as the modeling tool CAVE (Carbonate Aquifer Void Evolution) or the Conduit Flow Process (CFP) for MODFLOW-2005. He was chair of the EGU Hydrological Sciences Sub-Division Committee on Groundwater from 2009 to 2013 and is currently member of the Austrian National Academy of Sciences' Committee on Geo-/Hydro-Sciences.

Open Lecture – 2013 Darcy Distinguished Lecturer

David Rudolph
University of Waterloo

Managing Groundwater beneath the Agricultural Landscape

Date: May 15, 2013
Time: 16:00-17:30

Agricultural land use represents the largest nonpoint source threat to groundwater quality on a global scale. As a result of decades of fertilizer application and surface spreading of animal manure, chronic increases in nutrient concentrations have been documented in both private and municipal well systems. The occurrence of pathogenic microbes in groundwater supply wells has also been associated with agricultural practices at the land surface. Beneficial management practices (BMPs) designed to reduce the risk of groundwater quality impacts in agricultural environments are being implemented worldwide, yet very little data are available to assess the performance of these BMPs.

The complexities associated with variable mass loading to the water table will be explored, considering regional recharge distributions. The role of the vadose zone in controlling subsurface redistribution, and as an archive of past land-use activities, will also be considered relative to the legacy of agricultural impacts on groundwater quality. The performance of a regional-scale BMP program designed to reduce nutrient loading to the subsurface in the vicinity of an impacted municipal groundwater supply system will be evaluated based on more than a decade of field monitoring evidence. The utility of a targeted in situ denitrification approach designed as a remedial strategy to temporarily augment the BMP program in the vicinity of the municipal wells will be addressed based on the results of field experiments.

Finally, the potential influence of extreme climatic variability on the mobility of nutrients and microbial species in agricultural environments will be explored relative to aquifer and well vulnerability.

David L. Rudolph, Ph.D., PE, a geological engineer, is a professor in the Department of Earth and Environmental Sciences and cross-appointed to the Department of Civil and Environmental Engineering at the University of Waterloo. He specializes and teaches in the areas of regional hydrogeology and groundwater protection and management.
Rudolph's areas of research activity include field investigation and numerical modeling related to groundwater flow and contaminant transport with a focus on regional groundwater flow systems, recharge dynamics, and vadose zone processes. Specific research applications have focused on assessing the impacts on water quality from agricultural land-use practices. He works extensively in areas related to the regional management of groundwater resources and he has participated with municipal authorities both nationally and internationally — primarily throughout Latin America — in the development of groundwater protection and management strategies.
In addition, Rudolph heads a nationwide research team working on prioritizing risk to water quality from various agricultural practices and evaluating performance of beneficial management practices or BMPs. He recently served as executive director of the Water Institute at the University of Waterloo. Rudolph has also served as a member on NGWA's Scientists and Engineers Division Board and was the 2010 recipient of NGWA's M. King Hubbert Award for contributions to the field of hydrogeology.
He graduated from the University of Manitoba, and received his M.Sc. and Ph.D. from the University of Waterloo in hydrogeology. Rudolph has been chosen as the 2013 NGWREF Darcy Lecturer.

Keynote Speakers – 16th May

K7) Michael Gooseff
Pennsylvania State University

Should We Open Pandora's Box? Characterizing Stream-Groundwater Interactions from Surface and Subsurface Perspectives

Date: **May 16, 2013**
Time: **9:00-9:40**

Stream-groundwater interactions have been widely recognized as being critical to supporting aquatic ecosystems and good water quality by creating gradients of conditions in the shallow subsurface that produce optimal conditions for biogeochemical cycling. The physical characterizations of this exchange, controls on exchange, and generation of predictive models of exchange have challenged hydrologists for the past several decades. Here we will explore new techniques to quantify exchange from information gathered at the surface, namely novel approaches to stream tracer experiment interpretations, and from the subsurface, namely new observations of stream water movement through the subsurface using geophysical techniques. A new interpretation of stream solute transport processes involves the deconvolution of the tracer breakthrough curve to determine mass fraction (and therefore water fraction) that is transported via advection and dispersion, and the mass fraction that experiences transient storage.When combined with tracer mass balance approaches, these are complemented with determination of the mass fractions of water that represent gross gains to and losses from the channel. It is the transient storage and gross gain and loss mass fractions that interact with the subsurface. The advantages of this stream-based approach include 1) the interpretation is free of model parameter sensitivity and identifiability problems, and 2) mass fraction comparisons are interpreted as being reach-representative. Some disadvantages of the surface-focused approaches are that they do not provide information about where stream-groundwater interactions occur along a reach, and the timescale and spatial extent of gross losses are not quantifiable. The use of electrical resistivity methods during tracer experiments provides information to discriminate flowpaths in the subsurface in cross-sections along electrode transects.This technique then overcomes the limitations of the solely tracer-based approach by providing a characterization of subsurface heterogeneity in flow path extent.These results can then be used to develop more accurate representations of the subsurface system that interacts with streams, and the potential to discriminate biogeochemical hotspots in the subsurface.

Michael Gooseff earned his B.C.E. degree at Georgia Institute of Technology in 1996 and then his M.S. and Ph.D. in Civil Engineering at University of Colorado in 1998 and 2001. He was a postdoctoral scholar at Oregon State University in 2002 and has since been on the faculty of Utah State University, Colorado School of Mines, and since 2007, Penn State University. His research focuses on processes by which hydrology, hydraulics, and solute transport and fate influence the function and structure of watersheds, streams, and ecosystems. His lab conducts research related to stream-groundwater interactions, hyporheic exchange, stream and hyporheic restoration, and climate change in polar and temperate regions. They focus on both field experiments/monitoring and numerical modeling to uncover new knowledge about how natural systems function, and how they respond to change. He has active research programs in the Alaskan Arctic, Antarctica, and Pennsylvania.

K8) Michael Cardiff
University of Wisconsin-Madison

Building on the three pillars of Successful and Efficient Inversion: The role of cleverness, care, and computation in Experimental Design, Instrumentation, and Analysis

Date: May 16, 2013
Time: 11:30-12:10

Joint inversion represents a technique by which data collected with multiple methods (e.g., hydraulic and geophysical) and at multiple scales can be considered as a whole to perform characterization. When implemented appropriately, joint inversion can take advantage of different measurements' strengths and support scales to develop subsurface models that have reduced uncertainty and increased predictive accuracy. However, naïve collection and analysis of multiple data types can also lead to increased field and computational workloads with minimal additional benefits and, in the worst case, can produce nonsensical characterization results.
One commonality of joint inversion approaches to aquifer characterization is that they rely heavily on computation. This can be seen as a benefit, in the sense that computational power shows continuous improvement and is often "cheap" relative to field effort. However, while both serial and parallel computational capabilities are continually improving and becoming more accessible for practical use, computational power is not a panacea, and the ability to use high-powered computational resources will not, by itself, make joint inversion practical or successful. In addition to computational capabilities, the role of cleverness and care in joint inversion should not be under-stated. By "cleverness", I mean the use of data collection strategies, instrumentation capabilities, and inversion approaches that are designed a priori to reduce workloads, minimize duplication of effort, and limit the effect of data errors. By "care", I mean the continuous re-examination of assumptions employed when collecting and analyzing data.
In this presentation, I will examine a selected set of approaches to experimental design, instrumentation, and data analysis (joint inversion) that have been presented in the literature; I will then discuss these approaches in terms of their benefits, drawbacks, and feasibility for practical application. In addition, I suggest a few novel paradigms for hydrogeophysical data collection and analysis that may provide important information for aquifer characterization and long-term monitoring. Lastly, I will provide some perspective on future directions in research and synthesis that will lead to more careful, clever, and computationally efficient applications of joint inversion.

Michael Cardiff received his B.A. degree in Mathematics and Geology, with high honors in Mathematics, from Oberlin College in 2001. After working in environmental consulting for 3 years, he returned to academia and received both his MS (2005) and PhD (2010) from Stanford University in Civil and Environmental Engineering, with a focus in aquifer characterization and inverse methods. From 2010 to 2012 he was a postdoctoral researcher at Boise State University, implementing hydraulic tomography methods at the Boise Hydrogeophysical Research Site (BHRS), a hydrogeophysical research test-bed. In September 2012, he was hired by the University of Wisconsin-Madison as an Assistant Professor in Geology, to fill the seat vacated by recent emeritus Prof. Mary Anderson. He holds joint appointments at several other UW-Madison departments as well, including Geological Engineering (GLE), and Limnology and Marine Sciences (LMS). Dr. Cardiff's research interests lie in developing large-scale methods for characterizing hydrologic systems, and particularly in the "fusion" of multiple data types in order to improve hydrologic models.

K9) Andreas Dahmke
Christian-Albrechts-University (Kiel)

Impact of temperature on groundwater hydrochemistry (Dahmke, A.; Köber, R.; Jesußek, J.)

Date: May 16, 2013
Time: 13:30-14:10

Subsurface heat storage in terms of building climatisation and storage of excess solar thermal energy has become a meaningful subject to recent energy management concepts. However, for administrative guideline elaboration and their integration into the European Water Framework Directive reliable findings about the influences of heating on ground water quality are required. As shallow subsurface heat storage in Germany is mainly subject to urban areas, transferable knowledge, particularly of the influence of temperature on subsurface redox systems, including contaminants such as LHKW and BTEX, is essential.
The presentation will quantify changes in main solution constituent concentrations due to a temperature increase, studied in column experiments. The results point out, that redox systems and their associated microbial populations sensitively react on subsurface temperature increase. If and how far these effects can be utilized to actually combine contaminated aquifer remediation with subsurface heat storage in urban areas is another subject of the talk.

Prof. Dr. Andreas Dahmke: Department für „Applied Geology“, Institute for Geosciences at the Christian-Albrechts-University (Kiel)
Key activities: Groundwater remediation, Impact of energy- and mass storage /sequestration in the subsurface on groundwater systems, in particular heat storage in aquifers, CCS

Company Exhibition

The company exhibition and demonstration will take place on May 14-15. 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 14, 2013 May 15, 2013	9:30- 20:00 9:00 18:30

1. Terra direct GbR
2. SENSYS Sensorik & Systemtechnologie GmbH
3. imw - Innovative Messtechnik Dr. Weiss
4. Envi - Environmental Mechanics AB
5. Allied Associates Geophysical Ltd.
6. A.P. van den Berg Ingenieursburo bv
7. Geoprobe Environmental Technologies s.a.
8. Geotomographie GmbH
9. IRIS Instruments
10. IGM GmbH
11. UFZ
12. Umwelt- und Ingenieurtechnik GmbH Dresden

Exhibition of larger machinery/Technology demonstrations (UFZ area)	May 14, 2013	12:50-13:50 (during Lunch Break)

1. Geotechnik Heiligenstadt GmbH
2. SENSYS Sensorik & Systemtechnologie GmbH

Nr	Company	Contact	Website	Phone
1	**Terra-Direct GbR**	*Andreas Berndsen, Klaus Faiß*	www.terra-direct.com	+49 7474 957791
2	**SENSYS Sensorik & Systemtechnologie GmbH**	*Wolfgang Süß*	www.sensys.de	+49 33631 59650
3	**imw - Innovative Messtechnik Dr. Weiss**	*Dr. Hansjörg Weiß, Birgit Weiß*	www.im-weiss.de	+49 7071 55 19 20
4	**Envi - Environmental Mechanics AB**	*Ulf Elmgren, Per Llunggren*	www.envi.se	+46 322 670330
5	**Allied Associates Geophysical Ltd. (AAGL)**	*Dr. Susanne Kathage*	www.allied-associates.co.uk www.allied-germany.de	+44-1582-606 999 +49-2861-8085 648 +32-478-336 815
6	**A.P. van den Berg Ingenieursburo bv**	*Eddy Kuiper, Mark Woollard*	www.apvandenberg.com	+31 513 63 1355
7	**Geoprobe Environmental Technologies s.a./n.v.**	*Fabian De Weirdt, Tom Christy*	www.geoprobe.be	+32 67 442541
8	**Geotomographie GmbH**	*Thomas Fechner*	www.geotomographie.de	+49 2631 778135
9	**IRIS Instruments**	*Orlando Leite, Jean Bernard*	www.iris-instruments.com	+ 33 2 38 63 81 00
10	**IGM**	*Hans-Martin Schuler*	www.igm-geophysik.de	+49 75 51 40 77

11	**UFZ**	*Susanne Ebitsch*	www.ufz.de	+49 341 235 1033
12	**Umwelt- und Ingenieurtechnik GmbH Dresden**	*Thomas Schneider*	www.uit-gmbh.de	+49 351 8864673
TH	**Geotechnik Heiligenstadt GmbH**	*Thomas Weiz*	www.geotechnik.com	+49 3606 55400

Allied Associates Geophysical Ltd. (AAGL)

with Offices in UK / Germany / Belgium

Website: www.allied-associates.co.uk/www.allied-germany.de
Phone: +44-1582-606 999
+49-2861-8085 648
+32-478-336 815

Allied Associates Geophysical Ltd. (AAGL) is recognized as the foremost sales, 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 more than 20 years of experience, Allied Associates now operates with 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.

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Allied Associates will present the new Multi Frequency EM Instrument (GF CMD Mini / Explorer), GSSI Dual Frequency GPR System as well the well-established 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.

z

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The CPT factory

A.P. van den Berg
Postal address A.P. van den Berg:
P.O. Box 68
8440 AB Heerenveen
The Netherlands
Street address A.P. van den Berg:
IJzerweg 4
8445 PK Heerenveen
The Netherlands
Telephone: +31(0)513 63 13 55
Fax: +31(0)513 63 12 12
E-mail: info@apvandenberg.com

A.P. van den Berg is a medium-sized company operating on an international basis. The head office is based in Heerenveen, The Netherlands and currently employs 55 innovative, highly educated and motivated persons.

The main activity of A.P. van den Berg is designing and supplying advanced equipment for onshore, offshore and near shore in situ soil investigation (Cone Penetration Testing: CPT). A.P. van den Berg does so for almost 45 years. A.P. van den Berg provides a complete range of tools including thrust systems that are available separately as well as mounted on a frame or vehicle, (digital) data acquisition systems and deep water soil samplers. The operator himself decides how these systems are integrated in the specific applications. A.P. van den Berg is in this area very flexible.

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Environmental Mechanics AB
Kungegårdsgatan 7
441 57 Alingsås
Sweden

Phone: +46 322 670330
Email: info@envi.se
Sales: sales@envi.se
Website: http://www.envi.se/

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Geotomographie GmbH

Am Tonnenberg 18
56567 Neuwied
Germany

Website: www.geotomographie.de
Email: info@geotomographie.de

Geotomographie GmbH located in Neuwied/Germany is a geophysical instrument making company focusing on borehole seismic equipment to carry out seismic tomography testing, crosshole testing and downhole testing. Geotomographie integrates shallow borehole technology and design into customer friendly solutions. We offer training to our clients world-wide. Quite simply, we want to help engineers to make their field jobs easy and to provide best quality data to their clients.
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S-Wave Source BIS-SH

Hydrophone String BHC4

P-Wave Source SBS42

Geotechnik Heiligenstadt GmbH

Aegidienstrasse 14

37308 Heilbad Heiligenstadt

Website: www.geotechnik.com

Tel. 03606/55400

Fax 03606/554040

Email info@geotechnik.com

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
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- 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.

imw - Innovative Messtechnik Dr. Weiss

General Agency of Solinst, Canada Ltd.

Vogtshaldenstr. 47, 72074 Tübingen, Germany

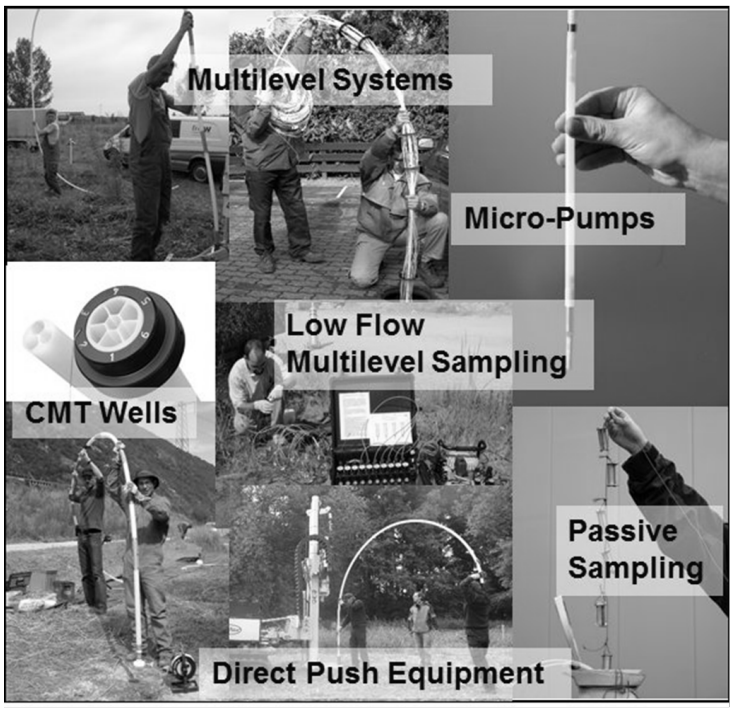
Website: www.im-weiss.de

Phone: +49 (0)7071 55 19 20

Fax: +49 (0)7071 55 15 98

Email: h.weiss@im-weiss.de

The company ***imw – Innovative Messtechnik Dr. Weiss***, Tübingen, Germany, provides service and technologies for innovative sampling, measurement and monitoring the quality of surface and ground water. Due to the permanent technology transfer and ongoing cooperation with leading research institutions in the applied environmental geosciences line, the know-how stays up to date. imw acts as an interface between applied research and industry in order to bring new and thoroughly tested measuring and sampling technologies on the market. Our range of innovative products includes Water Monitoring Instruments which are designed to obtain surface or ground water samples, continuous or manual water level measurements and recordings of concentrations of various water parameters. The data collected can be used to estimate hydraulic conductivity and other aquifer conditions; to monitor potable water recharge areas; and to monitor tailings ponds, dewatering activities and water supply levels of mines. imw equipment is used to monitor ground water for general site investigations and for contaminant plume monitoring. imw offers different kinds of Multilevel Sampling Systems especially for Direct Push Monitoring, like the CMT Multilevel System and the Lost Pump System. We also provide Passive Sampling Systems for time-integrated sampling of different organic chemicals dissolved in water. As a general agency of Solinst Ltd., Canada 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.



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- **Multilevelsystems**
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IRIS INSTRUMENTS

1, avenue Buffon - BP 6007 – 45060 ORLEANS cedex 02 – France

Contact: Orlando LEITE
Website: iris-instruments.com
Phone: + 33 2 38 63 81 00,
Fax: + 33 2 38 63 81 82
Email: iris@iris-instruments.com,

IRIS INSTRUMENTS provides a wide range of geophysical instruments for environmental, groundwater, geotechnical and mining applications:

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- Multi-Frequency EM Profiling system with 3D receiver (PROMIS)
- Nuclear Magnetic Resonance system for groundwater detection (NUMIS type)

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Products and devices for environmental monitoring systems

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- Multi Sensor Module
- CTD-probe
- Water level recorder for the monitoring of ground and surface water

Measuring technique for the quantification of stream-aquifer interactions especially
- Temperature lances
- Heat Pulse Measuring System to identify the flow rate

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- Individual research up to networks and early warning systems

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- With especially double needle technology
- e.g. for Greenhouse Gas Monitoring applications
- soil gas sampling systems

Vibration monitoring system, consisting of:
- Geophone
- Data logger with data transmission
- Alarm monitoring functionality with storage of events in high resolution

Selected Project references/Networks

21 stations for stability of construction site monitoring during construction activities in the former open pit lignite mine

- Sensors: Geophone, Pore Water Pressure, Water Level, Soil Water Suction
- Combined with data transmission technique
- Widely wireless application
- Alarm function with complex parameter matrix

Measuring systems – WESS – competence cluster "Water-Earth System Science"

- Each system with approx. **90 data points**
- Soil- and meteorological parameters
- Network technology with data transmission
- Soil Moisture, Soil Moisture Tension, Temperature, Wind Speed, Wind Direction, Net-Radiation, Precipitation, rH, T

UMWELTLEISTUNGEN
Umwelt- und Ingenieurtechnik GmbH Dresden
Postfach 80 01 40, 01101 Dresden, Deutschland
Zum Windkanal 21, 01109 Dresden, Deutschland

Telefon: +49 351 88646-82
Fax: +49 351 8865774
E-Mail: vertrieb@uit-gmbh.de
Internet: www.uit-gmbh.de

SENSYS GmbH

Rabenfelde 5, 15526 Bad Saarow, Germany

Website: www.sensys.de
Phone: +49 (33631) 59650
Fax: +49 (33631) 59652
Mobile: +49 (171) 2788485
Email: wsuess@sensys.de

Manufacturer of non-invasive geomagnetic and electromagnetic surveys systems

Based in Germany, SENSYS is specialized in the development and production of non-invasive geomagnetic and electromagnetic survey systems for various onshore and offshore applications.The product range varies from handheld magnetometer devices with one to five probes to vehicle or vessel towed multi-channel systems with up to 32 magnetometer probes. These systems allow for detection in depths of up to 4 m, depending of the size of the object that is to be located.

Especially for surveys in urban environments, SENSYS introduced active multi coil systems to filter out surface noise caused by pavements and infrastructure. Thus objects and structures in depths up to 2.5 m can be revealed. SENSYS was founded in 1990 by Dr. Andreas Fischer. Ever since he is leading the company with passion, creativity and the right sense for smart solutions. Over the years he established a solid and well experienced team of developers and engineers who present a comprehensive and innovative team taking care of customers needs.

SENSYS is increasingly growing and aims to assure the full product life cycle by keeping competence, knowledge and experience in-house. Thus SENSYS assures highest level of quality and know-how in all its products.

Putting the customer into focus, SENSYS not only distributes its systems around the world, but also offers its customers the rental of all systems as well as support and training during their work in the field.

For information on SENSYS products and services please contact: Wolfgang Suess (Sales Manager)

5-Channel Magnetometer System MAGNETO® MXPDA

Underwater 3-Axis Magnetic Field Sensor FGM3D/100 UW

Iron Locator SBL10

Terra-Direct GbR

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Terra direct

Products & Services

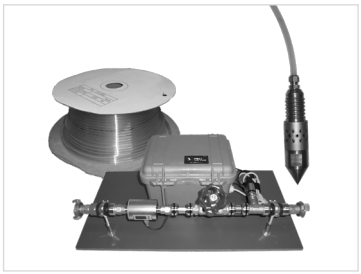
Hospach 1, 72401 Haigerloch, Germany

Website: www.terra-direct.com
Phone: ++49 7474 957791
Fax:++49 7474 957793
Email: info@terra-direct.com

Terra-direct GbR is a German company specialized in direct push techniques. Terra-direct combines development, mechanical and electronic design, programming and manufacturing under one umbrella. The company provides several products and services for different direct push techniques.

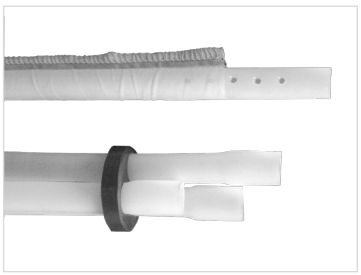
Some products:


DP Slugtest

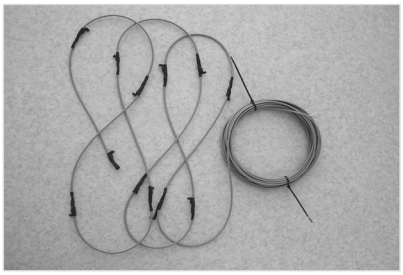

DP Injectionlogging


DP Geoelectric


lowflow sampling


micro well


water sampling


temperature measurement


DP BACTRAP®

Services

If there are questions in probing or measuring, don't hesitate and contact one specialist in solving direct push questions by phone +49 7474 957791 or email at info@terra-direct.com.

Participants

(registered by May 1, 2013)

Name		Country	Institution
Behra	*Philippe*	France	Université de Toulouse; INPT, LCA (Laboratoire de Chimie Agro-industrielle); UMR 1010, ENSIACET, INRA; LCA
Bernard	*Jean*	France	IRIS Instruments
Berndsen	*Andreas*	Germany	Terra-direct GbR
Birk	*Steffen*	Austria	University of Graz
Bocaniov	*Serghei*	Germany	Helmholtz-Centre for Environmental Research - UFZ
Brauchler	*Ralf*	Switzerland	ETH Zurich
Bumberger	*Jan*	Germany	Helmholtz Centre for Environenmental Research - UFZ
Cardiff	*Michael*	United States	University of Wisconsin-Madison
Christy	*Thomas*	United States	Geoprobe Systems
Dahmke	*Andreas*	Germany	Christian-Albrechts-University (Kiel)
De Weirdt	*Fabian*	Belgium	Geoprobe Environmental Technologies
Di Sipio	*Eloisa*	Italy	Institute for Geosciences and Earth Resources
Dietrich	*Peter*	Germany	Helmholtz Centre for Environenmental Research - UFZ
Dünnbier	*Karolin*	Germany	TU Berlin
Endres	*Anthony L.*	Canada	University of Waterloo
Elmgren	*Ulf*	Sweden	Environmental Mechanics AB
Faiß	*Klaus*	Germany	Terra-direct GbR
Fank	*Johann*	Austria	JOANNEUM RESEARCH Forschungsgesellschaft mbH
Fechner	*Thomas*	Germany	Geotomographie GmbH
Firmbach	*Linda*	Germany	Helmholtz Centre for Environmental Research - UFZ
Fischer	*Steffen*	Germany	Georg-August-Universität Göttingen
Flechsig	*Christina*	Germany	Universität Leipzig
Giordano	*Nicolò*	Italy	Earth Science Department - The University of Torino
Gooseff	*Michael*	United States	Pennsylvania State University
Grau	*Thomas*	Germany	Helmholtz Centre for Environmental Research - UFZ
Greve	*Morgens H,*	Denmark	Aarhus University
Haaken	*Klaus*	Germany	Steinmann-Institute, University of Bonn
Händel	*Falk*	Germany	TU Dresden / Helmholtz Centre for Environmental Research - UFZ
Hausmann	*Jörg*	Germany	Helmholtz Centre for Environmental Research - UFZ

Name		Country	Institution
Heincke	*Björn*	Germany	GEOMAR
Heitmann	*Rainer*	Germany	Fugro Consult GmbH
Hyndman	*David W.*	United States	Michigan State University
Jimenez	*Santos*	Switzerland	ETH Zurich
Kaiser	*H.*	Germany	KaiserGEOconsult GmbH
Kathage	*Susanne*	Germany	Allied Associates Geophysical Ltd.
Klammler	*Gernot*	Austria	JOANNEUM RESEARCH Forschungsgesellschaft mbH
Kogseder	*Astrid*	Austria	blp Geoservices gmbh
Knadel	*Maria*	Denmark	Aarhus University
Kuiper	*Eddy*	Netherlands	A.P. van den Berg
Lefebvre	*Rene*	Canada	INRS, Centre Eau Terre Environnement
Lehr	*Clemens*	Germany	Geotechnik Lehr
Leite	*Orlando*	France	IRIS Instruments
Leven-Pfister	*Carsten*	Germany	University of Tübingen | Center for Applied Geoscience
Liao	*Zijie*	Germany	University of Tübingen
Ljunggren	*Per*	Sweden	Environmental Mechanics AB
Lorentsson	*Hitomi*	Sweden	Stena Metall AB
Lunne	*Tom*	Norway	Norwegian Geotechnical Institute (NGI)
Mannschatz	*Theresa*	Germany	Helmholtz Centre for Environmental Research – UFZ
Martac	*Eugen*	Germany	Fugro Consult GmbH
Martini	*Edoardo*	Germany	Helmholtz Centre for Environmental Research – UFZ
Møller	*Mads Georg*	Denmark	Orbicon
Müller-Petke	*Mike*	Germany	Leibniz Institute for Applied Geophysics
Musolff	*Andreas*	Germany	Helmholtz Centre for Environmental Research – UFZ
Nitsche	*Claus*	Germany	BGD GmbH
Over	*Matthew*	United States	University of California, Berkeley
Paasche	*Hendrik*	Germany	Helmholtz Centre for Environmental Research – UFZ
Patzelt	*Arno*	Germany	Terrana Geophysik
Pipp	*Dan*	United States	Geoprobe Systems
Plendl	*H.*	Germany	ISU- Plendl GmbH
Premstaller	*Michael*	Austria	Premstaller Geotechnik
Rein	*Arno*	Germany	Technische Universität München (TUM)
Rinke	*Karsten*	Germany	Helmholtz-Centre for Environmental Research – UFZ

Name		Country	Institution
Rogiers	*Bart*	Belgium	SCK•CEN & KU Leuven
Rudolph	*David*	Canada	University of Waterloo
Santos	*Roi*	Norway	Norwegian Geotechnical Institute (NGI)
Sauer	*Uta*	Germany	Helmholtz Centre for Environmental Research – UFZ
Schelenz	*Sophie*	Germany	Helmholtz Centre for Environmental Research – UFZ
Schneider	*Thomas*	Germany	Umwelt- und Ingenieurtechnik GmbH Dresden
Schneidewind	*Uwe*	Belgium	Flemish Institute for Technological Research NV- VITO
Schröter	*Ingmar*	Germany	Helmholtz-Centre for Environmental Research – UFZ
Schuler	*Hans-Martin*	Germany	IGM GmbH
Schütze	*Claudia*	Germany	Helmholtz-Centre for Environmental Research - UFZ
Schwartz	*Anne*	Germany	GESO GmbH Jena
Schwientek	*Marc*	Germany	Water - Earth System Science" (WESS)
Simpson	*David*	Belgium	AGT - Groundwater Consultants
Stolz	*Ronny*	Germany	IPHT Jena e.V.
Süß	*Wolfgang*	Germany	SENSYS Sensorik & Systemtechnologie GmbH
Tran	*Anh Phuong*	Belgium	Universite catholique de Louvain
van der Kruk	*Jan*	Germany	Forschungszentrum Jülich
Vienken	*Thomas*	Germany	Helmholtz Centre For Environmental Research - UFZ
Walsh	*Dave*	United States	Vista Clara Inc.
Weiß	*Birgit*	Germany	imw - innovative Messtechnik Dr. Weiss
Weiß	*Hansjörg*	Germany	imw - innovative Messtechnik Dr. Weiss
Weiz	*Thomas*	Germany	Geotechnik Heiligenstadt GmbH
Wiese	*Bernd*	Germany	Deutsches Geoforschungszentrum, Potsdam - GFZ
Wilczek	*Daniel*	Belgium	Flemish Institute for Technological Research NV-VITO
Woollard	*Mark*	Netherlands	A.P. van den Berg

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The DFG is the self-governing organisation for science and research in Germany. It serves all branches of science and the humanities. In organisational terms, the DFG is an association under private law. Its membership consists of German research universities, non-university research institutions, scientific associations and the Academies of Science and the Humanities.
The DFG receives the large majority of its funds from the states and the Federal Government, which are represented in all Grants Committees. At the same time, the voting system and procedural regulations guarantee science-driven decisions.

FH-DGG

Contact:
FH-DGG-Geschäftsstelle
Dr. Ruth Kaufmann-Knoke
Kastanienweg 11
67434 Neustadt/Weinstr.
Germany

E-mail: geschaeftsstelle@fh-dgg.de
Website: www.fh-dgg.de

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.

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

Fachsektion Hydrogeologie

in der Deutschen Gesellschaft für Geowissenschaften

Die Fachsektion Hydrogeologie hat den Zweck, die Kommunikation und Zusammenarbeit von Fachleuten verschiedener Disziplinen, die sich der Erforschung und Nutzanwendung des Grundwassers widmen, zu fördern. Die Fachsektion Hydrogeologie begreift sich als Forum für Wissenschaft und Praxis in der Hydrogeologie.

Zu den Aufgaben der Fachsektion Hydrogeologie gehören insbesondere

- die Durchführung und Förderung von Tagungen und Weiterbildungsveranstaltungen zu Hydrogeologie und benachbarten geowissenschaftlichen Teildisziplinen
- die Verbreitung fachlicher Informationen, insbesondere die Herausgabe der Zeitschrift **Grundwasser**
- die Zusammenarbeit mit fachlich verwandten Vereinigungen des In- und Auslandes, die Mitarbeit an hydrogeologisch relevanten Standards, Regeln und Arbeitsmaterialien.

Herausgabe der Zeitschrift **Grundwasser** mit Beiträgen aus Wissenschaft und Praxis sowie mit aktuellen Nachrichten.

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FH-DGG-Tagung 2014

Grundwasser trifft Boden und Energie, 28.05. - 31.05.2014 in Bayreuth

Weiterführende Informationen unter: *www-fh-dgg.de*

Fortbildungsveranstaltungen 2013

29.05. – 01.06.2013 (Bad Soden-Salmünster)
Angewandte Grundwassermodellierung III

22.07. – 25.07.2013 (Greifswald)
Mathematische Verfahren für Hydrogeologen

04.09. – 06.09.2013 (Münster)
Planung und Bemessung von Erdwärmesondenanlagen

30.09. – 01.10.2013 (Bochum)
Hydraulische Methoden

10.10.2013 (Karlsruhe)
Hydrogeologie der Festgesteine

20.11. – 23.11.2013 (Bad Soden-Salmünster)
Angewandte Grundwassermodellierung I

Kontakt:

FH-DGG-Geschäftsstelle
Dr. Ruth Kaufmann-Knoke

Kastanienweg 11
67434 Neustadt

Telefon:
+49 6321 484784
Fax:
+49 6321 484783
E-Mail:
geschaeftsstelle@fh-dgg.de

Helmholtz Centre for Environmental Research

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

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

University of Tübingen

The **Department of Geosciences** at the University of Tübingen includes more than 25 professorships from the general fields of geology, mineralogy, geography, environmental sciences, and archaeology. It is thus one of the largest departments of its kind at German universities. The research topics within the Department of Geosciences are manifold and include in the field of Environmental and Applied Geology studies of water-cycle components, biogeochemical reactions and transformations, environmental pollution of water, air and soil as well as aspects of water treatment, remediation of contaminated groundwater and sediments, and protection of soils and water.

Observation and monitoring at the UFZ

Global change is changing our environment: but where and how exactly? What are the exact local and regional impacts of climate change? Is the filtering function of soils for groundwater impaired? Are soils becoming less arable? Are plants and animals relocating to new habitats? For more precise answers to these questions data collected over a longer period of time is lacking, which would enable changes to be documented and estimates of future developments to be made. Scientists now want to close this gap, by examining the effects of climate and land use change on terrestrial ecosystems over longer temporal and different spatial scales. For this, we are developing and using innovative methods as well as measuring and sensoring devices that allow a more efficient collection of environmental and climate data – with experiments, long-term observation platforms on the ground, as well as with the help of aircraft and satellites from the air and from space. This does not only relate to cycles of water and matter or the composition and function of organisms in communities. We are also investigating the impacts on the economy and society.

Within the context of the Helmholtz project TERENO(www.tereno.net) that involves six Helmholtz Centers, four observatories are in operation: in the northeast German lowlands, in the Eifel and the Lower Rhein, in the area of Leipzig-Halle and in the Alps. Almost an entire spectrum of relevant environmental data is being collected here and analyzed using the most modern measuring techniques, by means of geophysics, and remote sensing. In addition to climate data this also includes observations of water and soil quality, biodiversity and atmospheric interactions. The long-term measurements serve to investigate the exchange and feedback processes in the system “soil-vegetation-climate”, in order to assess the impacts of climate change and to develop process-orientated forecast models. The UFZ climate exploration facility in Bad Lauchstaedt (a large-scale test facility of climate change), as well as MOBICOS (an observation platform especially for watercourses) will also play a specific role here. Furthermore, the research platform MOSAIC of the UFZ unites innovative mapping and monitoring technologies, enabling a high-resolution investigation of complex underground structures. In the future other observatories are planned in the Mediterranean area that will be particularly affected by climate change. These are all to become part of a European network of observatories. Our goal is to gain a better understanding of the impacts of climate and land use change on the environment and to develop requirements for better forecasts and adaptation strategies.

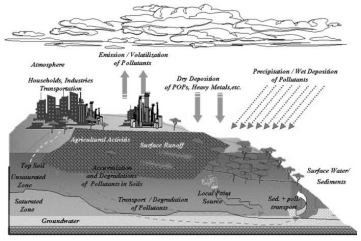
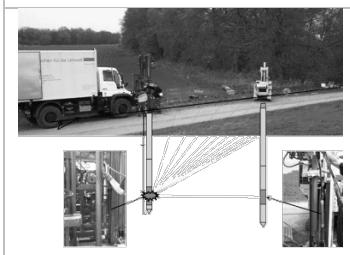
Source: *UFZ Concise - Research for the environment (16 pages, published November 2011)*

Department Monitoring and Exploration Technologies

Nowadays, humankind more and more uses and alters the shallow subsurface. Especially in densely populated regions, a better understanding of environmental processes in the soil and ground water in view of resource management and life quality plays a big role. Because natural systems are normally very heterogeneous and complicated, their investigation and assessment on a spatial and temporal scale needs great efforts and still is often possible to only some extent.
To meet the rising requirements for environmental research, the Department Monitoring and Exploration Technologies develops unique concepts and strategies to adequately and extensively model natural systems.
An efficient and comparatively fast investigation and assessment of environmental questions could be achieved by the combination of different methods from various research areas, such as geophysics, hydrogeology, Direct Push, remote sensing and biodiversity research.

Working Groups at the Department Monitoring- und Exploration Technologies:

	***AG 1 : Direct Push and hydrogeological measurement methods*** • Further development of methods for investigating near surface areas by means of Direct Push and hydrological field methods
	***AG 2 : Geophysics*** • Further development and evaluation of geophysical methods in the context of the investigation of soil, groundwater and biodiversity • Coordination of the research platform MOSAIC
	***AG 3 : On-site analytic processes*** • Development of analytical tools for on-site analysis and their application in environmental monitoring and for investigations of estimating transport in and between environmental compartments
	***AG 4 : TERENO and soil processes*** • Hydropedological and soil physical studies, development and provision of concepts for the pedosphere-hydrosphere interface, integrated and multiscale long-term monitoring of terrestrial environmental compartments

	***AG 5 : System analysis & Geotechnics*** • Investigation and observation of environmental systems using different methods and combinations of methods
	***AG 6 : Sensor and Systems Engineering*** • Development of concepts and realization of application study of wireless ad-hoc sensor networks • Further development of novel and existent Direct Push sensor systems • Investigation of innovative measuring concepts in the field of electromagnetic sensor technology
	***AG 7 : Data Integration and Parameter Estimation*** • Multivariate analyses for probabilistic integration of multi-method data bases • Geoscientifically constrained extrapolation of sparse data • Non-linear joint inversion concepts, i.e. for geophysical model generation • Optimization of geophysical surveying and processing strategies for information return maximization

For more information: www.ufz.de/met
Contact: Prof. Dr. Peter Dietrich *(peter.dietrich@ufz.de,* ++49-341-235-1281*)*

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

The Helmholtz-Centre for Environmental Research - UFZ has established the research platform MOSAIC for the purpose-oriented, rapid site characterization that is a prerequisite for the understanding and the solution of environmental and hydrogeological problems. MOSAIC stands for „Model Driven Site Assessment, Information and Control“ and comprises mobile modular data acquisition units for adaptive and modelling-based field investigations. The emphasis is laid upon the multi-scale observational design that allows measurements from high resolution point to field scale. Through this unique design, MOSAIC serves as a link between the different observatories. Therefore it is deployed on mobile vehicles containing geophysical measuring techniques, borehole logging, hydrogeological and geotechnical equipment, as well as mobile field analytical devices.
The identification of relevant system parameters and detailed knowledge of the geometry of subsurface structures are the base for the development and evaluation of models for the description of natural systems. Against this background, exploration and monitoring technologies must be addressed to meet the challenges which arise from the discrepancy between process scale and exploration scale, the temporal variability of process, the deterministic and stochastic heterogeneity of natural systems, and the dimensions of the investigated system.
The realization of MOSAIC took place in order to enlarge the abilities and the competences of the Helmholtz Centre for Environmental Research - UFZ in the field of investigation and observation of extensive natural and anthropogenically influenced systems. The major objectives and aims of the MOSAIC research platform are the following:

- MOSAIC provides a state-of-the-art and beyond combination of mobile exploration and monitoring systems for the characterization of environmental and hydrological systems. Application examples are water resources management, the management of contaminated megasites, the geotechnical evaluation of building ground, as well as upcoming challenges triggered by land use changes and use of the shallow subsurface for energy storage in the framework of the energy transition.
- MOSAIC can be applied for the high resolution 3D characterisation of the shallow subsurface of sites with a size of up to square kilometres. Examples include the combination of methods with different spatial resolution, development and evaluation of adaptive problem-oriented site investigation strategies as well as of new technologies, and the development of effective methods for the determination of site specific soil parameter relationships.
- MOSAIC is a broad research platform for model supported, near surface assessment and forges a connection between scientists from different fields. The platform is open to other Helmholtz institutes as well as universities in order to integrate technologies into research projects. It fosters and supports interdisciplinary research as well as technology development and transfer.

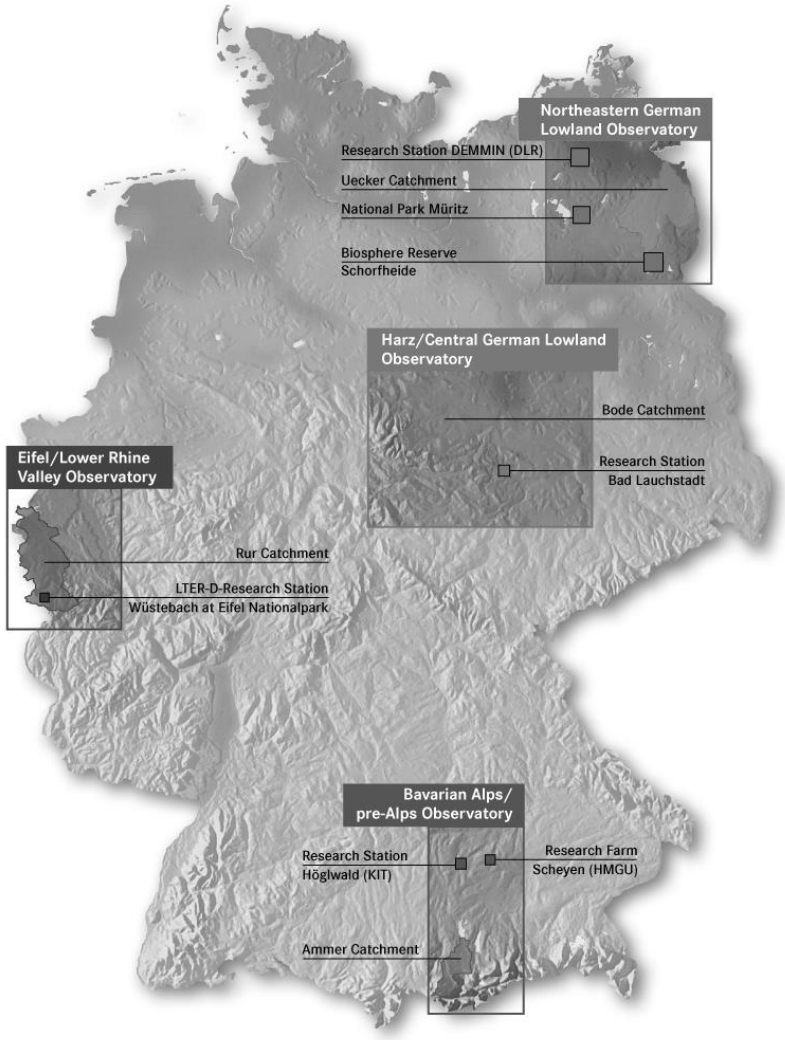
The text is an extract from the brochure “The Helmholtz Association Earth Observatory Network”
Contact: Peter Dietrich - mosaic@ufz.de

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

TERENO – a National Earth Observation Network

The United Nations' Intergovernmental Panel for Climate Change (IPCC) regularly publishes reports on the current state of climate knowledge. However, long-term changes that have been and will be triggered by global change cannot be assessed with any degree of accuracy as numerous environmental processes have yet to be adequately understood. In particular, we have yet to understand how individual environmental systems, key processes and feedback effects work in detail. On the one hand, local parameters affect the overall system, on the other hand global environmental variables and feedbacks play an important role in highly complex local environmental systems. In addition, there is a lack of data series collected over longer time periods. Such data are the key to recording long-term regional changes and developing regionally effective adaptation and mitigation strategies.



Map of Germany Map of Germany, indicating the locations of the four selected TERENO observatories (Zacharias et al., 2011)

It is against this background that the Helmholtz Association launched the TERENO (TERrestrial ENvironmental Observatories) initiative in 2008. TERENO spans an integrated Earth observation network of observatories across Germany that extends from the North German Lowlands to the

Bavarian Alps, with a focus on particularly sensitive regions. An interdisciplinary and long-term research programme aims to catalogue and research the long-term ecological, social and economic impact of global change at regional level. For example, the programme monitors changes in the hydrosphere, biosphere, pedosphere, lower atmosphere and anthroposphere over various spatial and temporal scales. The project is scheduled to run for 15 years and is supported by six Helmholtz Research Centers which provide the basis for cooperation projects with universities and other research organisations.

TERENO partners have set up four regional “terrestrial observatories” in regions representative for Germany: Eifel/ Lower Rhine Valley, Harz/Central German Lowland, Bavarian Alps/pre-Alps and Northeastern German Lowland (see map). Existing research stations and activities in these regions have been integrated into the observatories. All four observatories are equipped with a combination of in-situ measuring instruments, as well as ground-based and airborne remote sensing techniques. These include measuring systems for the determination of regional precipitation, micrometeorological eddycovariance systems, sensor networks, as well as monitoring systems for the quantification of water, matter and energy flows. Further infrastructure measures include high capacity data processing and communication systems to guarantee fast access to the environmental data sets collected. Furthermore, TERENO partners are developing new sensor and monitoring concepts, as well as models that can also be applied in areas less well-equipped with measuring technologies.

The text is an extract from the brochure “TERENO – Finding local solutions for global change”. For further details see the full brochure which is available online at www.tereno.net.

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

Zacharias S., Bogena H., Samaniego L., Mauder M., Fuß R., Pütz T., Frenzel M., Schwank M., Baessler C., Butterbach-Bahl K., Bens O., Borg E., Brauer A., Dietrich P., Hajnsek I., Helle G., Kiese R., Kunstmann H., Klotz S., Munch J.C., Papen H., Priesack E., Schmid H.P., Steinbrecher R., Rosenbaum U., Teutsch G., Vereecken H. (2011) A network of terrestrial environmental observatories in Germany. Vadose Zone J 10:955-973.

Open-path Fourier-transform infrared spectroscopy (OP-FTIR)

The application of large-scale optical remote sensing (ORS) methods offers one approach for the comprehensive monitoring of atmospheric trace gas concentrations in complex natural and urban landscapes. Ground-based ORS techniques has become intensively used for the identification and quantification of fugitive pollutants or greenhouse gases from point sources as well as spatially extended emissions. Especially active and passive open path FTIR spectroscopy is suited for the broadband detection of gaseous emissions of chemical agents.

OP-FTIR spectroscopy allows a remote multi-component analysis based on significant infrared absorbance patterns of chemical agents. Numerous types of molecules (e.g. CO_2, H_2O, CH_4, NH_3) have unique signatures (absorption bands) in the spectral wave number range considered from 700 – 4000 cm^{-1} (equates wavelengths 2.5 – 14.3 µm in MWIR and LWIR region). IR-radiation measured by the spectrometer contains information on spectral background signatures, the pollutant cloud and the atmosphere. The detector responds to the compound's concentration variation, averaged over the entire sample path length. With selected instrumentation arrangements, a single OP-FTIR device is able to rapidly sample in different directions, thereby covering a wide area.

In general, there are two measurement set ups – passive and active OP-FTIR spectroscopy. Passive OP-FTIR spectroscopy is based on the spectral analysis in the 700 –1300 cm^{-1} wave number range of ambient IR radiation. Numerous chemical compounds have a typical IR signature in this fingerprint region, where no artificial IR source is needed. For collecting these passive measurements we use a BRUKER RAPID (Remote Air Pollution Infrared Detector) device. Active OP-FTIR spectroscopy needs an artificial broadband IR source, which helps excite molecular vibration modes in higher wave number ranges up to 4000 cm^{-1}. This application plays an important role, especially for the identification of organic traces gases and high resolution quantification of greenhouse gases. The active measurements can be carried out in mono- or bi-static operation modes with optical path lengths of several 100 m. For our measurements, we used a BRUKER EM27 device in bi-static mode, where IR source and detector are separated by optical paths of lengths up to 300 m.

The objective of our work is the development of rapid and mobile monitoring tools for remote detection of atmospheric compounds relevant to the climate caused by natural and industrial sources. The passive as well as the active techniques need to be adapted for real-time field applications to obtain information on the target gases and their spatial distribution with the aim to quantify fugitive emissions at biogas plants, to monitor the air quality in urban and industrial systems, to image the distribution of emission of CO_2 in the vicinity of natural degassing sites, and to identify emissions sources at sites with different land use.

Contact: Dr. Claudia Schütze (claudia.schuetze@ufz.de, ++49-341-235-1059)

The memorial for the forced labourers in Leipzig during National Socialism

During World War II Leipzig was one of Germany's most important armament industry centres. In 1944, more than 100.000 men and women, concentration camp prisoners and prisoners of war, worked as forced labourers in the factories of Leipzig.

At that time, the industrial company Hugo Schneider Ag (Hasag) was located on the grounds of the today's UFZ (Centre for Environmental Research). The company switched from the production of lamps to the armament industry – munition, grenades and the well-known bazooka („Panzerfaust“) were produced here.

Due to a shortage of workers in the Nazi era the Hasag company started to employ forced labourers from 1939 forth – polish prisoners of war, polish civilists, and later people from all occupied territories. They were deported from their homes and taken to German work camps. Many of them were women who had to live and work under inhumane conditions, many prisoners were Jews, some were Sinti and Roma. Most of them came from Poland or the Soviet Union.

The living conditions in the labour camps were devastating. Due to the lack of adequate health care and a minimum of essentials, such as nutrition, clothing and hygiene, the forced labourers were in a poor state. Insufficient accomodation in the overcrowded barracks as well as increased violence to which the prisoners were defencelessly exposed, led to a high number of deaths.

The Hasag company exploited more than 10.000 forced labourers on these grounds where the UFZ is located today. Thereby it's one of the biggest profiteers of slave work during National Socialism.
Today there is a small memorial to the forced labourers of that time. The exhibition shows mechanisms and types of forced labour, especially the inconceivably difficult living conditions of the women who were brought to Leipzig as slave workers.

Opening times: Tuesday – Thursday 10am – 6pm

The memorial place

Forced labourers from the Netherlands

Hasag main building

(Bildrechte Sammlung Gedenkstätte für Zwangsarbeit Leipzig)

Social Program

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Welcome Reception

Date: May 13, 2013
Time: 18:00-20:00
Place: Moritzbastei Leipzig.

The Welcome Reception is open to all conference participants. You have the opportunity to meet the other conference participants at a very famous location in Leipzig, the **"Moritzbastei"**. The Moritzbastei is a well known cultural centre located in a historic fortification in the center of Leipzig. 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.moritzbastei.de/de/startseite

Buffet

Date: May 14, 2013
Time: 19:00-21:30
Place: *Foyer Leipziger KUBUS (Free of charge)*

Conference Dinner

Date: May 15, 2013
Time: 20:00-22:00
Place: *Bayerischer 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: €10 Euros. Registration is required.
Further information: http://www.bayerischer-bahnhof.de/old/index.php4?target=english

Welcome to Leipzig

Media, Trade Fair and University City!

Leipzig is one of the biggest cities in Central Germany and with its 530,000 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.*

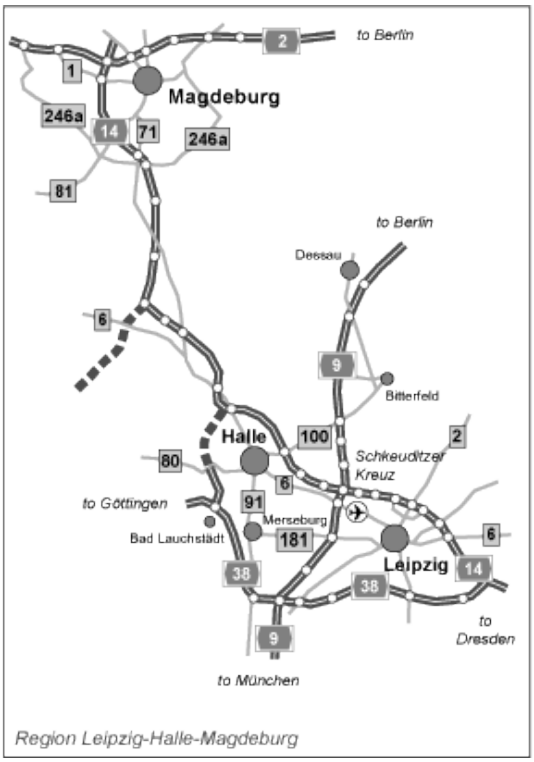
Animal Park

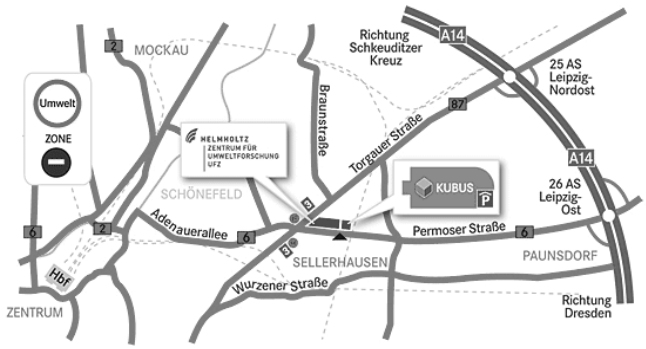
*Central **Stadium** and sports complex*

Important information for your stay

How to reach UFZ Leipzig

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





By car

On A14 motorway take exit "Leipzig-Ost" and head for Leipzig Stadtzentrum/City Centre. Follow Permoserstraße up to the underground parking sign for conference Leipziger KUBUS on right hand side. Leipzig has an "environmental protection zone". Vehicles must have a green badge in order to be permitted entering the city zone.

By tram

From Leipzig Central Station to UFZ: please take tram no. 3 (direction "Taucha/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 €15. The fare from Leipzig-Halle Airport is about €45.

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).

As a participant of NovCare 2013 you will receive a free ticket for public transport. This ticket is valid from May 13-16, 2013. Please show this ticket together with the conference names tag on request. Please note that this ticket is only valid within Leipzig. To the airport you have to buy a separate ticket.

For others: Single tickets cost €1.60 for up to four stops and €2.30 for longer trips; day passes are €5.50. Recommended is to buy a 4 journey-ticket €8.80. 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 basic amount of €2.50 and a €2.10 km-rate (1. und 2. km), then it’s €1.50 per kilometre (day rate).

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 7800; Paul-List-Straße 27) Hospital and clinic.

Your way to the Conference Dinner at Bayerischer Bahnhof

Please use the public transport. You will find the restaurant Bayerischer Bahnhof near the stop Bayrischer Platz. From UFZ: Please take tram no. 3 (direction “Knautkleeberg”) to stop "Goerdelerring", platform 1 (about 14 min, 8th stop). Then change to platform 2, tram no. 9 (direction “Markkleeberg-West”) to stop Bayrischer Platz (about 8 minutes, 5th stop). From there you will already see the historical site.

Abstracts - Oral Presentations

Session 1: Direct push site characterization (May 14, 10:50-12:50)

1.1) CPT-based Direct Sensing as high quality tool for reliable high resolution site characterization – experiences throughout Europe

Martac, E.[1]; Oppermann, A.[1]

[1]*Fugro Consult GmbH, Volkmaroderstr. 8c, 38104 Braunschweig, e.martac@fugro.de*

Keywords: CPT probe, Direct Sensing sensors, high resolution site characterization

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Cone Penetrometer Testing (CPT) is a worldwide known geotechnical investigation method to determine soil and groundwater characteristics. Fugro has developed a variety of penetrometers, probes and samplers which are hydraulically pushed into the subsurface soil to obtain physical and chemical data. Lightweight detachable CPT units are offered for difficult access sites as well as large trucks and all-terrain vehicles with weights in the range 15 to 30 tonnes to provide penetration reaction. For environmental data collection, the CPT cone is basically used as an adapter to the screening sensors which provides subsurface stratigraphy through tip resistance and sleeve friction logs. The standard CPT mounted inclinometer cone records the deviation from the vertical with and as an option the dynamic pore water pressure.
Applying Direct-sensing probes in combination with in-situ investigations have turned into powerful tools for the investigation of subsurface contamination, identification of hydraulic properties and exploration of natural resources. Using MIP, LIF, X-Ray, HPT sensors on a CPT basis either as standalone sensors or as combined MIP-HPT-CPT probe proved to have outstanding capabilities when it comes to detection of contaminants in soil and groundwater (MIP: Membrane Interface Probe), determining hydraulic conductivities (HPT: Hydraulic Profiling Tool) and providing information about structure and setting of the subsurface (CPT: Cone Penetration Test) subsequently or simultaneously in just one push. For example, so far several separate pushes were necessary to acquire the needed amount and volume of data. The new combined MIP-HPT-CPT-probe joins three sensors of high demand in one compact probe-tip and sets a basis for a faster, more economical and efficient work progress.
The presentation shows several advantages of using the CPT based Direct Sensing environmental investigation technique through examples and experiences gathered throughout Europe.

1.2) Multi-scale aquifer characterization and groundwater flow model parameterization using direct push technologies

Rogiers, B.[1,2]; Vienken, T.[3]; Batelaan, O.[2,4,5]; Gedeon, M.[1]; Mallants, D.[6]; Huysmans, M.[2,4]; Dassargues, A.[2,7]

[1]*Institute for Environment, Health and Safety, Belgian Nuclear Research Centre (SCK•CEN), Boeretang 200, BE-2400 Mol, Belgium. brogiers@sckcen.be; mgedeon@sckcen.be*
[2]*Dept. of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200e - bus 2410, BE-3001 Heverlee, Belgium.*
[3] *Dept. of Monitoring & Exploration Technologies, UFZ- Helmholtz Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany. thomas.vienken@ufz.de*
[4]*Dept. of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Pleinlaan 2, BE-1050 Brussels, Belgium. mhuysman@vub.ac.be*
[5]*School of the Environment, Flinders University, GPO Box 2100, Adelaide SA 5001, Australia. okke.batelaan@flinders.edu.au*
[6]*Groundwater Hydrology Program, CSIRO Land and Water, Waite Road - Gate 4, Glen Osmond SA 5064, Australia. dirk.mallants@csiro.au*
[7]*Hydrogeology and Environmental Geology, Dept. of Architecture, Geology, Environment and Civil Engineering (ArGEnCo) and Aquapole, Université de Liège, B.52/3 Sart-Tilman, BE-4000 Liège, Belgium. alain.dassargues@ulg.ac.be*

Keywords: Cone penetration tests, hydraulic direct push tools, heterogeneity, model performance

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Groundwater flow and contaminant transport models are used to support decision making regarding waste disposal options, sites contaminated by surface or subsurface sources, or to develop and test cost-effective groundwater remediation schemes. Such models are influenced by different sources of uncertainty, including those due to spatial variability in aquifer and aquitard properties including hydraulic conductivity (*K*). However, quantifying spatial variability in *K* remains challenging. Classical drilling techniques for shallow heterogeneous unconsolidated sedimentary deposits involving continuous coring are expensive and time-consuming, especially when the area of interest exceeds several tens of km².

Alternative techniques such as direct push technologies use hydraulic rams, supplemented with vehicle weight, or high-frequency hammering, to advance small-diameter tools into the subsurface. These tools are typically used for cost-effective geotechnical characterization of unconsolidated deposits; recent developments also allow for hydraulic characterization. The depth of investigation is up to ~40 m, depending on the tools used (i.e applied load) and sediment properties (friction). Up to now, only a limited number of studies document using this type of data to parameterize regional groundwater flow models. To fill this gap, this study aims at parameterizing a regional groundwater flow model using data from various types of direct push technologies.

We discuss the characterization of an area (~60 km²) near the nuclear zone of Mol/Dessel (Belgium), using various direct push technologies. Most of the measurements are concentrated in an area of 200×400 m². The data include 265 cone penetration tests (CPTs), 113 pore pressure dissipation tests (PPDTs), 17 direct push injection logs (DPIL), 6 hydraulic profiling tool (HPT) logs and 19 direct push slug tests (DPST). Resulting *K* values, either calculated or estimated, and the corresponding spatial variability are compared with that of borehole and outcrop studies.

The benefit of using standard CPT data for the parameterization of an aquitard at the study site has previously been shown. The approach is now applied to the aquifer units and incorporates new direct push data for the entire upper ~40 m of the hydrogeological domain. The effect of the 3D heterogeneous hydraulic conductivity field on the performance of the groundwater flow model is discussed; the value of the different direct push technologies is equally addressed.

1.3) Case Studies Using the Combined MIP-HPT Tool

Christy, T.M.[1]; McCall, W.[1]; Pipp, D.[1]; Terkelsen, M.[2]; Christensen, A.[3]; Weber, K.[3]

[1]*Geoprobe Systems, 1835 Wall St., Salina, KS 67401 USA, christyt@geoprobe.com, mccallw@geoprobe.com and pippd@geoprobe.com*

[2]*Capital Region, Denmark, Kongens Vaenge 2, 3400 Hilleroed, Denmark, mte@regionh.ck*

[3]*NIRAS A/S Sortemosevej 19, DK-3450 Alleroed, Denmark, agc@niras.dk*

Keywords: VOC Investigation, MiHpt, Permeability, Groundwater Contamination.

Geoprobe recently developed the MiHpt probe which is a combination of the membrane interface probe (MIP) and the hydraulic profiling tool (HPT). The system provides a log of total VOC contamination versus depth with the use of up to four GC detectors. Simultaneously, water is injected from the HPT screen into the formation at approximately 300ml/min. The system provides a log of the pressure required to inject the water and the flow rate. Additionally, the MiHpt probe includes an electrical conductivity (EC) dipole that yields a log of bulk formation EC. This data can be used to understand contaminant distribution and how the formation lithology is influencing contaminant migration. Results of field investigations with the MiHpt system performed in Salina, Kansas, USA and Skuldelev, Denmark will be reviewed.

Comparison of the sample results at the TCE site in Salina, KS found good correspondence between the fine-grained soil sample results and the MiHpt detector responses. At this site the EC and HPT logs corresponded nicely, both indicating a primarily fine grained formation. The HPT logs effectively located a permeable zone for groundwater sampling. The groundwater sample result reveals high TCE levels in the restricted permeable zone. A cross section with the EC and XSD detector logs indicate that the more permeable zone along the top of the bedrock contact is influencing contaminant migration along with bedrock surface topography. The cross section also suggests that VOCs in the vadose zone may be migrating ahead of the groundwater plume.

Contaminants at the Skuldelev site included PCE and degredation products of TCE, cis- and trans-DCE and vinyl chloride. The coarse-grained saturated soil samples analyzed from the Skuldelev, DK site corresponded poorly with the MiHpt detector responses. However, groundwater samples collected over the same depth intervals as the soils correspond well with the MiHpt detector responses. Loss of groundwater from the saturated cores appears to have resulted in loss of contaminants. Review of logs and soil cores revealed that EC did not clearly identify the clay till. Conversely, HPT pressure did increase in this low permeability material. A cross section with the HPT pressure and XSD detector logs suggests that the groundwater plume is migrating along a paleo-stream valley cut into the underlying glacial till.

In summary, the MiHpt probe provided useful and valuable information on VOC contaminant distribution at both sites. Cross sections of the EC or HPT pressure logs and detector responses provided valuable insight into formation and permeability influence on contaminant migration.

1.4) Direct-push hydraulic profiling in formations of moderate to high hydraulic conductivity

Butler, J.[1]; Liu, G.[1]; Knobbe, S.[1]; Reboulet, E.[1]; Bohling, G.C.[1]

[1]*Kansas Geological Survey, University of Kansas, Lawrence, KS 66047*

Keywords: direct-push technology, hydraulic-conductivity profiling, flow-loss correction.

Spatial variations in hydraulic conductivity (K) are a primary control on solute movement in groundwater. Characterization of these variations, however, has proven to be difficult. Over the last two decades, significant progress has been made in utilizing direct-push (DP) technology to characterize K variations in shallow unconsolidated settings. The Direct-Push Injection Logger (DPIL) was designed to provide high-resolution (cm-scale) information about relative variations in K. Water is injected continuously through a screened port while the probe is advanced and the pressure response is monitored behind the screen. The profile of the ratio of injection rate to pressure (DPIL ratio) reflects vertical variations in K. Since the DPIL only provides qualitative K information, methods are needed for transforming DPIL ratios into K estimates. These methods typically involve correlations with nearby K data, which can introduce considerable uncertainty into the transformed K estimates. The High-Resolution K (HRK) tool was designed to reduce this uncertainty by co-locating the high-resolution DPIL profiling with the direct-push permeameter tool. The collocation of K estimates obtained from DPP hydraulic tests with the high-resolution DPIL-ratio data allows the DPIL profile to be directly transformed into *K* estimates through a calibration procedure. In a previous project at the MADE site, we used an HRK tool with an upper DPIL-K limit of 10 m/d, which was primarily imposed by frictional losses caused by the small diameter of the DPIL injection tubing. Although increasing the tubing diameter allowed use of higher injection rates, those higher rates resulted in significant nonlinear flow losses that greatly exceeded the formation pressure responses. In order to assess and correct for these flow losses during DPIL profiling and thereby increase the upper K limit of the HRK, we have developed an approach based on the step drawdown test procedure commonly used to characterize well losses in high-capacity pumping wells. Flow losses are characterized in pre- and post-profiling calibrations, as well as at two to three depth intervals during probe advancement, and then removed from the DPIL data. The removal of these line losses allows the DPIL-K limit to be extended upward by a factor of six (60 m/d), thus increasing the utility of the tool in permeable settings. The modified HRK approach was applied in a coarse sand and gravel aquifer at a field site located in the floodplain of the Kansas River. The results of that application demonstrate that this method can be used to characterize K in heterogeneous aquifers at a profiling resolution and speed that has not previously been possible.

Session 2: Advances in direct push technology (May 14, 14:30-16:50)

2.1) Boundary-Breaking Heavy Metal XRF Probe for Efficient Onshore & Offshore High-Resolution Site Characterization

Martac, E.[1]; Oppermann, A.[1]; Neuhaus, M.[1]

[1]*Fugro Consult GmbH, Volkmaroderstr. 8c, 38104 Braunschweig, e.martac@fugro.de*

Keywords: heavy metal CPT probe, ED-XRF sensor, high resolution site characterization

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Toxic heavy metals in ground- and marine water respectively in soil and marine sediments are global problems which rise growing threats to the environment. There are many different industrial sources of heavy metal contamination. The up to date applied series of investigation and remediation methods and tests, without the achievement of an acceptable remediation status or success, qualify often many onshore and offshore sites as typical case studies for unsolved environmental issues. Remediation efforts usually reveal unknown source areas, the contaminant mass are typically not be well defined and the end of the remediation process is not expected within a measurable time horizon. The unsolved need for efficient screening devices able to provide onsite in-situ quick and reliable estimations of heavy metal contents led our research efforts to the development of a new direct sensing probe able to tackle such issues.

In order to deal efficiently with the in-Situ evaluation of heavy metal contents in soil and marine sediments, a revolutionary CPT-based investigation probe was developed originally in USA (Austin AI) and, based on an exclusive contract throughout Europe, is presently under further development and use by Fugro Consult GmbH. The probe does not use a radioactive source. Instead, a small X-ray tube is powered inside the probe, making it safe for commercial use. The new probe uses an ED-XRF (Energy Dispersive X-Ray Fluorescence) Sensor and, due to the ability to be connected to a CPT probe, is able to perform a continuous logging of heavy metal concentration and lithology versus depth. The ED-XRF detector provides high quality signals calibrated against certified SRM standards and allows a quantitative detection of heavy metals in the subsurface with a simultaneous CPT-logging of geological and chemical subsurface properties. During the several onshore field tests performed in Germany, Fugro proved the probe's ability to in-Situ measure concentrations of As, Cd, Pb, Hg, Cr, Fe, Mn, Ni, Cu, Zn. Digital signals recorded while pushing down the probe into the underground are able to provide a precise 3D delineation of metal containing layers as support for on-site decision-making. Based on metallic content related thresholds, estimations of the spatial extension and of total metallic content within the investigated volume are provided. The newly developed probe could definitively serve not only as screening device but as instrument for long term monitoring of the eventual success of different remediation options tested at the site as well. Using the XRF heavy metal probe under a CPT environment opens a variety of Direct Sensing combinations related to lithology, hydraulics and contaminant investigation.

2.2) Abrasion of direct push probes: effects on instrument response using the example of DC resistivity probes

Demuth, D.[1,2]; Bumberger, J.[1]; Paasche, H.[1]

[1]*Helmholtz Centre for Environmental Research – UFZ, Permoserstr. 15, 04315 Leipzig, Germany*

[2]*Now at: VACOM Vakuumkomponenten und Meßtechnik GmbH, Gabelsberger Str. 9, 07749 Jena, Germany*
hendrik.paasche@ufz.de

Keywords: Direct push, direct current, simulation, experimental design

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Direct push based exploration of near surface unconsolidated sediments offers valuable high-resolution information about vertical heterogeneity. While conventional borehole logging techniques have to cope with the presence of borehole casing and significantly disturbed backfill regions between sensor and formation to be probed, direct push technology enables a more direct contact to the probed formations. This goes along with enormous mechanical stress and abrasion of direct push probes compared to probes operated in boreholes. This problem applies to a wide variety of direct-push based exploration tools, i.e. cone penetration tests with tip resistance requiring detailed knowledge about shape and size of the tip sensor. Here, we investigate the instrument response of two different DC resistivity probes for different stages of aging going along with abrasion of the tools surface.
The two most common designs of DC resistivity probes utilize either four ring electrodes or point-like electrodes present on one or two opposite sides of the probe. To our knowledge, there is no systematic evaluation of different probe designs available. We begin our investigations with a lab experiment using new probes under controlled conditions. Next, we set up a numerical simulation in COMSOL emulating the laboratory experiment. Taking the high similarity of lab measurement results and numerically modeled results as indication for the validity of our geometrical and numerical implementation of the probes in COMSOL, we begin to alter the conditions in our numerical experiment. We pay particular attention to the impact of abrasion effects clearly visible on heavily utilized probes and compare the robustness of the different probe designs. Albeit going beyond the scope of our study, our work indicates the potential of numerical simulations for optimized probe design and the development of technical improvements required to build more robust direct push probes.

2.3) Field Experience Using Low Level MIP Measurements

Christy, T.M.[1]; Pipp, D.[1]

[1] *Geoprobe Systems, 1835 Wall St., Salina, KS 67401 USA*
christyt@geoprobe.com

Keywords: VOC Investigation, MIP, Low Level MIP, Groundwater Contamination, High Resolution Site Characterization.

The Membrane Interface Probe (MIP) has become a common tool for subsurface site investigation in many countries. It is used for logging the position and relative concentration of Volatile Organic Compounds (VOC's) in the subsurface.
A new form of MIP has been developed that is effective in lowering the detection limit of standard MIP technology by approximately one order of magnitude. This technology, referred to as "Low Level MIP", utilizes a pulsed flow of carrier gas to the down-hole MIP membrane to return higher concentration VOC samples to the MIP detector system. An added benefit of this system of analyzing MIP permeate gas is that the resultant VOC detection peaks are narrower and the detector background signal more stable, resulting in an improved signal to noise ratio.
This technology has the effect of expanding the utility of MIP for mapping dissolved contaminant plumes. A standard MIP system that could reasonably detect 500 ppb of a dissolved VOC in a response test could be expected to readily detect 50 ppb following the application of a Low Level MIP control system.
This presentation will summarize the operational theory of Low Level MIP and will describe the altered gas flow control system of Low Level MIP along with the practical aspects of setting up and applying this system in the field. Example Low Level MIP logs from contaminated sites will be shown and compared with standard MIP logs. Case studies will also be shown comparing Low Level MIP measurements with co-located soil and groundwater samples at both hydrocarbon and chlorinated VOC sites.

2.4) Transfer Line Concepts for the MIP

Bumberger, J.[1]; Peisker, K.[1]; Goblirsch, T.[1,2]; Dietrich, P.[1]

[1]*Helmholtz Centre for Environmental Research, Department Monitoring and Exploration Technologies, Permoserstraße 15, 04318 Leipzig, Germany, jan.bumberger@ufz.de*
[2] *Universität Leipzig, Faculty of Economics and Management, Information Systems Institute, Grimmaische Straße 12, 04109 Leipzig, Germany*

Keywords: Direct-Push, in-situ measurement, MIP, transfer line

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An analytical direct-push sensor system for the in-situ measurement of Volatile Organic Compounds (VOC) including a matter extraction is the Membrane Interface Probe (MIP). This direct-push sensor system is in principle an in-situ thermal desorption device with a membrane inlet system and a transmission system (so called transfer line) that transport desorbed compounds to the surface. At the surface, the compounds can be analyzed on-line in real time with analytical detection systems. Since the introduction of these MIP system the open market, they are have often used as a standard tool in both commercial and R&D applications.
One of the most important problems using the MIP under field conditions is the transmission system. In principle, the transfer line continuously transports all incoming substances up to the surface, but results yielded after using the complete MIP system under field conditions have indicated that separation effects of the substances (carry-over effect) occur. In the presentation, the concepts to the using different materials and improvements in the transfer characteristics by heating are presented and compared using a coupled mobile mass spectrometer. Furthermore, a new concept using a triggered sampling with two transfer lines are presented for an additional sampling behind the membrane inlet system to overcome the carry-over effect. Finally, an overview of the future possibilities of the MIP system and further development is given.

2.5) Neutron-Neutron measurements for pollution detection and control

Nitsche, C.[1]; Dietrich, P.[2]; Buckup, K.[3]

[1]*BGD Boden- und Grundwasserlabor GmbH – GICON Firmengrupper, Tiergartenstraße 48, 01219 Dresden*

[2]*UFZ Helmholtz-Zentrum für Umweltforschung GmbH, Permoserstraße 15, 04318 Leipzig*

[3]*DBM Hohenwarther Str. 2, 39126 Magdeburg*
cnitsche@bgd-gmbh.de

Keywords: Neutron technique, hardware and software development, response and sensitivity, application

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At abandoned waste sites and chemical spill sites organic pollutants represent the main contaminant for soil and ground water. One crucial difference regarding the impact sources is the water solubility; contaminants might be dissolved in water or present in phases (dense non-aqueous phase liquid, DNAPL or light non-aqueous phase liquid, LNAPL). Until recently, no measuring method was available, which clearly distinguished between these two conditions. Even the neutron-neutron logging, established in the fields of well examination or exploration of deposits, was insufficient because of the limited radiation sources.
New approaches to environmental studies are enabled by the use of low frequency neutron pulse sources. Emitted neutrons of 14 MeV allow the recording of decay curves, which are analyzed for the presence of different compounds under various conditions. Recording the full decay of the emitted neutrons, the intensity of the neutron field in a high degree depends on the presence of organic components in any variation. The hardware may be modified for different applications like neutron logs, water quality monitoring and surface measurements. In consequence the software modules are designed for the tasks, requested to be solved.
The potential of the neutron technique was studied on real sand models for different organic materials, but also under real conditions on polluted sites.
It was established, that hydrocarbons increase neutron count rate, while chlorinated components decrease it. Therefore even on the character of the pollution might be judged.
Furthermore the multichannel design of the hardware makes it possible to investigate the radial distribution of the components to differ between concentrations within the well or in the formation.
By various experiments there were established relations between the neutron response and concentration values for different lithology like sand, silt and marvels. It applications are the detection of dissolved pollutants and pollutants present in phases, such as BTEX, mineral oils and volatile halogenated hydrocarbons. The depth dependent measurements in conjunction with the instant graphical evaluation enabled a flexible and efficient phase and plume investigation and monitoring. The measurements require an inner diameter of approximately 40 mm of the well or canal (also combined with direct push operations). For the first time, BTEX, mineral oils, and volatile halogenated hydrocarbons, which are present in complex contaminations, can be detected as dissolved in water or being present in phase.

Session 3: Geophysical site characterization I (May 15, 9:00-11:00)

3.1) Imaging of regions of preferential flow in aquifers using full-waveform inversion of crosshole ground penetrating radar

Klotzsche, A.[1]; van der Kruk, J.[1]; Vereecken, H.[1]

[1]*Forschungszentrum Jülich, Agrosphere, IBG-3, a.klotzsche@fz-juelich.de*
j.van.der.kruk@fz-juelich.de

Keywords: Ground Penetrating Radar, Full-waveform Inversion, preferential flow, aquifer

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High resolution and precise characterization of aquifers is needed to improve the understanding of flow and solute transport processes. Decimeter scale and high contrast structures caused by changes in the porosity or clay content can have a dominant effect on hydraulic processes within an aquifer. Such heterogeneities or layering in aquifers can be related to preferential flow paths or impermeable clay lenses. Crosshole ground penetrating radar is able to provide shallow subsurface electrical properties viz. dielectric permittivity and electrical conductivity and has proven a powerful tool to map and characterize aquifers due to the method's high resolution and sensitivity to porosity and soil water content. Ray-based methods, which incorporate only a small part of the measured signal in the inversion such as first arrival travel times and first cycle amplitudes, are not able to detect such layers due to their limited thickness. In contrast, the crosshole GPR full-waveform inversion, which considers the entire waveform or significant parts thereof, is able to resolve decimeter scaled high resolution images and can detect high contrast layers. Compared to the ray-based inversion, the results from the full-waveform inversion show images with significantly higher resolution. Several examples show that high permittivity layers caused by an increase in porosity can act as an electromagnetic low-velocity waveguide and are indicating possible zones of preferential flow within the aquifer. The waveguide trapping causes anomalously high amplitudes and elongated wave trains to be observed for a transmitter within the waveguide and receivers straddling the waveguide depth range. The excellent fit of amplitudes and phase between the measured and modeled data confirms the presence of the zone of preferential flow. Moreover, a novel amplitude analysis is developed that explores these maxima and minima positions of the trace energy spectra and shown to be able to identify low-velocity waveguides and their boundaries from measured data only. The full-waveform inversion results were evaluated with logging data and the presence of a zone of preferential flow was confirmed.

3.2) Soil Moisture Characterization using a new Full-wave, Near-field Antenna Model: From Laboratory to Field Applications

Tran, A.P.[1]; André, F.[1]; Lambot, S.[1]

[1]*Université catholique de Louvain, Croix du Sud 2 box L7.05.02, 1348 Louvain-la-Neuve, Belgium*
phuong.tran@uclouvain.be

Keywords: soil moisture, ground-penetrating radar, near-field antenna modeling, full-wave inversion

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Knowledge of the temporal and spatial variations of soil moisture at different scales is essential for environmental and agricultural research and engineering. In that respect, there is an urgent demand for developing novel techniques to quantitatively characterize this key variable. Over this last decade, ground-penetrating radar (GPR) has known an increasing interest to provide soil moisture data with a high spatial resolution at the field scale. Among existing approaches that translate raw GPR data into soil moisture, full-wave inverse modeling is particularly accurate as it uses all the information contained in the GPR data and minimizes estimation errors resulting from poor model adequacy. However, this approach is not straightforward due to difficulties in modeling the antenna as well as antenna – medium coupling. We recently developed an intrinsic modeling approach for near-field GPR data in which the antenna is modeled by an equivalent set of infinitesimal electric dipoles and characteristic, frequency-dependent, global reflection and transmission coefficients. Using 3-D Green's functions as exact analytical solutions of Maxwell's equations for simulating electromagnetic wave propagation in the soil, this new modeling approach is computationally efficient. In this study, we present results of the full-wave near-field antenna model to retrieve soil moisture from GPR data in both laboratory and field conditions. The GPR data were collected from both frequency and more widely used time domain GPRs. Radar measurements over a sand subject to a range of water contents provided water content estimates in close agreement with reference gravimetric measurements. The fit between measured and modeled GPR data was also very good. In field conditions, a good agreement was also found between GPR soil moisture estimates and Theta Probe measurements, although some discrepancies where observed, which were attributed to the local soil variability and different characterization scales of the instruments. Furthermore, the time-lapse GPR measurements reflected well the temporal dynamics and spatial distributions of soil moisture with respect to topography and rainfalls. The proposed modeling approach is relatively fast and shows great promise for noninvasive digital soil mapping. It is worth noting that the validity of the near-field radar model being theoretically independent of frequency and antenna type, the approach also applies to electromagnetic induction (EMI).

3.3) Joint inversion scheme with a fully adaptive strategy to adjust regularization and coupling constraints

Heincke, B.[1]; Moorkamp, M.[2]; Jegen, M.[1]; Chen, J.[1]; Hobbs, R.[3]

[1]*Geomar, Kiel, Germany, E-mail: bheincke@geomar.de*

[2]*University of Leicester, Department of Geology, United Kingdom*

[3]*University of Durham, Department of Earth Sciences, United Kingdom*

Keywords: Join inversion, coupling strategies

Joint inversion strategies for geophysical data have become increasingly popular since they allow to combine complementary information from different data sets in an efficient way. However, for joint inversion algorithms that use methods that are sensitive to different parameters it is important that they are not restricted to specific survey arrays and subsurface conditions. Hence, joint inversion schemes are needed that 1) adequately balance data from the different methods, 2) adjust the strengths of the regularization and coupling constraints such that convergence is not disturbed, 3) consider adequately the different resolution powers and convergence behaviors/paths of the used methods and 4) use links between the parameter models that are suited for a wide range of applications.

Here, we combine MT, seismic tomography and gravity data in a joint inversion scheme that accounts for these critical issues. Data from the different methods are inverted separately and are joined through constraints accounting for parameter relationships. An advantage of performing the inversions separately (and not together in one matrix) is that no relative weighting between the data sets is required. To avoid that the convergence behavior of the inversions is profoundly disturbed by the regularization and coupling, the strengths of the associated constraints are re-adjusted at each iteration. As a criterion to control the adaption of the regularization/coupling strengths we use a more general version of the well-known discrepancy principle. It is based on the assumption that the regularization parameters vary approximately linearly with the (normalized) change of the objective function for few successive iterations.

Adaption of the coupling strengths makes the joint inversion scheme also applicable to subsurface conditions for which assumed relationships are only a rough first order approximation. In these cases the coupling between the different parameters is automatically reduced if for some structures the true rock property relationships differ significantly from the assumed relationships (e.g. atypical density-velocity behavior of salt). Furthermore, our joint inversion setup can be easily combined with the structural coupling strategy from Günther&Rücker (2006). This means both petrophysical and structural information are considered in our joint inversion scheme simultaneously.

We have tested our scheme on different synthetic 2-D models associated with a range of applications. We observe that the adaption of the coupling strengths makes the convergence of the inversions very robust, that the normalized data misfits for all methods are close to 1.0 and that the final results are close to the true models. Finally, we show first results from applying our inversion scheme to real 2-D seismic, magnetotelluric and gravity data collected offshore the Faroe Islands to resolve potential sediments underneath basalt flows.

3.4) A study on a potash mining waste dump using geophysical tomographical techniques

Dünnbier, K.[1]; Börner, F.[1]; Schicht, T.[2]

[1] Technische Universität Berlin, FG Angewandte Geophysik, Ernst Reuter Platz 1, BH 1-1, D-10587 Berlin, karolin.duennbier@tu-berlin.de

2K-UTEC AG Salt Technologies, Abteilung Geophysik, Am Petersenschacht 7, D-99706 Sondershausen

Keywords: potash waste dump, petrophysics, spectral induced polarization

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The chosen test site is the waste dump of a potash mine situated in Thüringen near Bleicherode, Germany. The mine has been productive since 1903 extracting first potassium and rock salt, later Bischofite. Nowadays, it is a backfilling mine. Salt mining activities often lead to large mining dumps with a height of more than 100 m. The interior of such mining dumps is characterized by subsidence, leaching and material conversion which can compromise their stability. To understand their interior is therefore important as they can become a hazard to human and environment.

The objective of the presented research project is to develop a combination of geophysical and petrophysical methods for the characterization of the potash mining dump material. It includes tomographic methods such as geoelectrics and seismics as well as ground penetration radar (GPR), spectral induced polarization (SIP) and nuclear magnetic resonance (NMR) methods. The resulting geophysical models should detect and display weak areas due to for example abnormal strengths, hydraulic permeability and water content. The project aims to give the operating company a tool to characterize the different areas of the potash waste dump. The result could help the company to decide wether to reuse the material (backfill material for stabilization of salt mines) or to cover the waste dump.

A series of preliminary geophysical field measurement methods were used on-site and evaluated on their usability. The electrical survey for example presented good results depending on penetration depth and soil moisture at the ground surface. Many samples were taken for further investigation of the still poorly investigated material from different parts of the site. Different petrophysical parameters such as seismic velocities, dielectric permittivity, T2-relaxation time and complex conductivity were identified and associated with the soil characteristics and mineralogical composition.

Session 4: Geophysical site characterization II ***(May 15, 11:30-13:10) (Double session)***

4.1) Recent developments in large scale quantitative multi-layer inversion with calibrated multi-offset EMI systems

van der Kruk, J.[1]; von Hebel, C.[1]; Mester, A.[1]; Rudolph, S.[1]; Altdorff, D.[1]; Vereecken, H.[1]

[1]*Forschungszentrum Jülich, Agrosphere, IBG-3, j.van.der.kruk@fz-juelich.de*

Keywords: Electromagnetic Induction, Quantitative Multi-layer Inversion

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Electromagnetic induction (EMI) systems enable the non-invasive spatial characterization of soil structural and hydrogeological variations, since the measured apparent electrical conductivity (ECa) can be related to changes in soil moisture, soil water, clay content and/or salinity. Due to the contactless operation, ECa of relatively large areas, i.e. field to (small) catchment scale, can be measured in comparable short times. A multi-coil EMI system, that embeds one electromagnetic field transmitter and various receivers with different offsets, enables the simultaneous measurement of different sensing depths. In principle, a better vertical characterization of the subsurface is possible, when quantitative measurement values are obtained. However, mostly qualitative values are obtained due to external influences like the operator, GPS, cables or other metal objects. To obtain quantitative ECa values, the measured EMI apparent conductivities are calibrated using a linear regression approach with predicted apparent conductivities obtained from using a Maxwell-based full-solution forward model using inverted electrical resistivity tomography (ERT) data as input. The calibrated apparent conductivities enable a quantitative multi-layer-inversion to resolve for the electrical conductivity of certain layers. To invert for a large scale three-layer model, a one-dimensional (1D) shuffled-complex-evolution inversion scheme is parallelized and implemented on the JUROPA - supercomputer. The results of several large scale EMI surveys carried out at the TR32 and TERENO test sites will be shown and compared with other information, such as Rapid Eye images and soil sensor networks.

4.2) SQUID magnetometer based receivers for transient electromagnetics

Stolz, R.[1]; Chwala, A.[1]; Schulz, M.[1]; Schmelz, M.[1]; Queitsch, M.[1]; Linzen, S.[1]; Bondarenko, N.[2]; Meyer, M.[2]; Meyer, H.-G.[1]

[1]*Institute of Photonic Technology, A.-Einstein-Str. 9, D-07745 Jena, Germany*

[2]*Supracon AG, An der Lehmgrube 11, D-07751 Jena, Germany*

Keywords: Transient electromagnetics, magnetic field sensors, electrical conductivity, SQUID

One of the widely used methods for characterization of subsurface conductivities is transient electromagnetics (TEM). This method allows a wide range of detection depth – from shallow to very deep features. Especially in mineral exploration conventional sensors like induction coils are not appropriate for deep structures, highly conductive or targets under conductive overburden. Here, receiver systems based on LTS SQUID sensors are a valuable tool for exploring difficult targets because of their extremely high sensitivity. Measurements with the developed systems are demonstrated on many targets of different geological and climatic conditions. The new systems proofed to be reliable and did outperform conventional induction coils. The contribution highlights the main features of the system and describes some examples from mineral exploration.
There is potential for other electromagnetic methods like MT, AMT, AFMAG, and MIP for future applications.

4.3) Imaging two-dimensional distributions of hydraulic properties of unconsolidated sediments using surface-NMR

Müller-Petke, M.[1]; Dlugosch, R.[1]; Günther, T.[1]; Yaramanci, U.[1]

[1]*Leibniz Institute for Applied Geophysics (LIAG), Hannover, Mike.Mueller-Petke@liag-hannover.de*

Keywords: NMR, water content, hydraulic conductivity

The sensitivity of nuclear-magnetic resonance (NMR) to hydraulic properties such as water content (θ) and hydraulic conductivity (K) is one of the key advantages of this technology. The development of surface-NMR, i.e., the application of NMR using large surface loops allows imaging the sub-surface in a non-destructive manner. We present two recent innovations in the field of surface-NMR.

Firstly, instrumentation and data analysis of surface-NMR has recently moved on from 1d soundings to 2d surveys, opening the method to a larger field of hydrological applications. However, interpretation of 2d data sets is still commonly restricted to image θ, the water content distribution in the sub-surface. We present a robust 2d inversion scheme, based on the qt-inversion scheme (Müller-Petke and Yaramanci, 2010), which jointly inverts for water content and relaxation time; two key parameters to derive hydraulic conductivity. Thus, the presented approach not only gains structural and lithological information, but also allows characterizing the subsurface. A challenging problem for a 2d inversion is the size of the inverse problem both in the model and data domain. We use irregular meshes and mono-exponential relaxation times minimizing the number of free parameters in the model domain and gate integration to minimize the size of the data domain.

Secondly, the prediction of K has been performed primarily in sandstones. In hydrogeological applications, however, unconsolidated material is more prevalent. Compared to sandstones, unconsolidated sediments can show pore sizes up to several millimeters. The known (semi-)empiric relations to estimate K from NMR have been applied for unconsolidated material, but the underlying assumptions are not valid for large pores. We present a new model, called Kozeny-Godefroy model (KGM) that improves the prediction of K for grain sizes up to gravel. KGM is based on tube-shaped pores both for hydraulic flow (after Kozeny, 1927 and Carman, 1938) and NMR relaxation times including large pore systems (after Godefroy et al., 2001).

We present results from a 2d field case imaging the hydraulic properties of a buried glacial valley and the sorrounding material.

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4.4) On the use of Cosmic-Ray Neutron Sensing to measure soil moisture in cropped fields

Rivera Villarreyes, C.A.[1]; Baroni, G.[1]; Oswald, S.E.[1]

[1] *Institute of Earth and Environmental Science, University of Potsdam, Karl-Liebknecht-Strasse 24-25, 14476, Potsdam, Germany; crivera@uni-potsdam.de*

Keywords: integral soil moisture detection; ground albedo neutron sensing; calibration; vegetation

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The Cosmic-ray Neutron Sensing (CRS), as well known as Ground Albedo Neutron Sensing (GANS), is a innovative measurement technique for soil moisture at the small catchment and field scale, filling the gap between point-scale measurement and remote sensing. Its approach is based on the crucial role of hydrogen, compared to other landscape materials, as moderator of natural, fast neutrons, which are detected above-ground by a CRS probe. However, any other source of H besides soil moisture, also affects the CRS signal. This study is focused on understanding the role of vegetation, especially seasonal crops, on the CRS-derived soil moisture.

Field activities were carried out in a farmland at Bornim (Brandenburg, Germany) cropped with sunflower in 2011 and winter rye in 2012. The experimental setup was designed to calibrate the CRS against classical FDR point-scale measurements by three different calibration approaches. Calibration periods were defined by choosing different growing stages of sunflower and winter rye. Results showed a correlation of calibration parameters to different crop periods and crop types. Moreover, it was not possible to identify a single set of calibration parameters for perfectly fitting FDR soil moisture jointly in periods of sunflower and winter rye cover. On the other hand, our observations suggest that CRS signals could be adjusted by single crop properties or by computing expected neutrons fluxes based on measurements without crop cover.

This study shows that there is need of understanding the CRS signal under different crop covers better to be able to further improve soil moisture estimations. Moreover, further applications of the cosmic-ray neutron sensing method such as hydrological modeling, may require the use of correction factors to take into account bias of CRS signals in cropped fields.

4.5) Estimating Vadose Zone Hydraulic Properties with the Method of Anchored Distributions

Over, M.W.[1]; Wollschläger, U.[2]; Osorio, C.A.M.[3]; Ames, D.P.[3]; Rubin, Y.[1]

[1]*University of California, Berkeley, Department of Civil and Environmental Engineering, 628 Davis Hall, Berkeley, CA, USA, 94720, mattover@berkeley.edu*

[2]*UFZ-Helmholtz Centre for Environmental Research, Department Monitoring & Exploration Technologies, Permoserstr. 15, 04318 Leipzig, Germany, ute.wollschlaeger@ufz.de*

[3]*Brigham Young University, Department of Civil and Environmental Engineering, 242J Clyde Building, Provo, UT, USA, 84602, dan.ames@byu.edu*

Keywords: Vadose zone, inverse modelling

Modeling of water flow in variably saturated soil requires knowledge of the soil hydraulic properties. These are the water retention curve and the hydraulic conductivity function. These nonlinear relationships are most often described by the Mualem/van Genuchten parameterization. While permitting a closed set of governing equations, these semi-empirical models are limited by having some parameters that do not have a direct physical meaning. As such, the hydraulic properties can be specified by using catalog data or by calibrating the hydraulic parameters using field measurements such as soil moisture content or the soil water potential. One of the primary goals of this study is to apply the Method of Anchored Distributions (MAD) to estimate the unsaturated hydraulic properties of a natural soil profile using example data from the Grenzhof Site (SW Germany). In addition, we use MAD to assess the impact of the different combinations of measurements on the uncertainty in the estimate of the soil hydraulic properties. The differences are quantified by comparing the complete probability density function (PDF) of each of the Mualem/van Genuchten model parameters. A second research question is to find the minimum amount of water content states to use in the MAD analysis before there is significant information loss in the parameter PDFs. The time series of water content data from the Grenzhof Site was collected with time domain reflectometry. All simulations of water flow were performed using HYDRUS 1-D software and parametric uncertainty was analyzed using MAD software.

Session 5: Long term monitoring and simulation based site characterization (11:30-13:10) (double session)

5.1) Progress in Phytoscreening with Heavy Metals at Contaminated Sites

Trapp, S.[1]; Algreen, M.[1]; Rein, A.[2]

[1] *Technical University of Denmark, Department of Environmental Engineering, Miljøvej building 113, DK-2800 Kgs. Lyngby, Denmark., Phone: +45 45251696 Fax: +45 45932850, E-mail:mann@env.dtu.dk, sttr@env.dtu*

[2] *Technische Universität München, Chair of Hydrogeology, Arcisstr. 21, 80333 Munich, Germany, Phone: +49 8928925869, Fax: +49 8928925852, Email: arno.rein@tum.de*

Keywords: Subsurface contamination, Plant uptake, Monitoring, Heavy metals, Tree coring

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Phytoscreening for subsurface pollution is a rapid low-tech method to delineate plumes in groundwater and to find pollution hot-spots. In particular for chlorinated solvents, the success of this method has been repeatedly demonstrated. In 2011, guidelines for sampling and analysis were published by TASK [1]. The success for other substances is less obvious. Results for BTEX will be presented by Rein et al. Earlier studies on the feasibility of screening with heavy metals for subsurface pollution yielded significant results only for some heavy metals and some tree species [2]. New results from Danish sites give a clearer picture.
Samples were taken willow and poplar trees from one strongly, one moderately and one slightly polluted test site and from three reference sites and analyzed for heavy metals and toxic elements by inductively coupled plasma atomic emission spectroscopy (ICP-OES). Wood from willow and poplar tree species had similar background concentrations at 0.5 mg kg^{-1} for cadmium (Cd), 1.6 mg kg^{-1} for copper (Cu), 0.4 mg kg^{-1} for nickel (Ni) and 25 mg kg^{-1} for zinc (Zn). Concentrations of chromium (Cr) and lead (Pb) were below or close to detection limit. Concentrations in wood from the highly polluted site were significantly elevated, compared to references, in particular for willow. The conclusion from these results is that tree coring could be used successfully to identify strongly heavy metal polluted soil for Cd, Cu, Ni, Zn, and that willow trees were superior to poplars, except when screening for Ni. Extraction efficiencies were best for willows and Cd, but below 0.5 % over ten years, and below 1 ‰ in ten years for all other heavy metals.

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5.2) Long-term monitoring of soil gases by means of a passive gas sampling system

Plendl, H.[1]; Kaiser, H.[1]

[1]*Von-Mieg-Str. 3 Heindelstraße 21 97082 Würzburg 91056 Erlangen*

Keywords:

In connection with the examination and monitoring of a contaminated site located in a former quarry and today partly covered, the knowledge of mobile soil gases is of particular significance.
Status quo of the abandoned site: On the one hand there is a problem with methane and the dangers for human beings as well as surrounding buildings resulting from it. On the other hand sludge pits of unknown size lie on the edge of the landfill body which were sealed against the remaining part of the landfill. Over decades liquid wastes from cesspits and interceptors as well as chemical wastes (e.g. residual substances arising from dry-cleaners) were disposed there. These materials have become heavily compressed over the past years and cannot be distinguished from solid rock in gravimetric tests. The remaining pore space of the cohesive soil is saturated to a great extent.
Task: During the investigations the inventory of harmful substances and the concentration of gaseous substances in the sludge pits have been determined as well as the different plume compartments. During the after-care of the disposal site the long-term effects of the harmful substances have to be monitored in order to recognize dangerous situations in time to implement counter measures.
Investigation methods: For the monitoring a sampling system is required which, once installed, can be used repeatedly. It should also enable a verifiable sampling in a respectively water saturated soil, thus yielding a basis for reliable analysis results. The passive gas sampling system GASSYS has been chosen which consist of a membrane tube permeable to a number of gases but not to water. The membrane tube has been successfully used for industrial purposes since thirty years and can be divided into several segments. The segments enable a vertically differentiated recording of gaseous substances. The diameter of GASSYS is approximately 20 mm and can be installed by the drilling of small holes. The GASSYS installed in hand sludge or on its edges have been regularly used for several years and yield a precise picture of the distribution of gaseous substances inside the pits as well as their extension both vertically and laterally.
Results: Inside the sludge pits partly extremely high concentrations of low boiling, very mobile gaseous substances with a high toxic potential were found. For example chloroethene concentrations of 90 g /m³ were recorded. The data are verifiable (even across different laboratories) and supply an interesting picture of the degradable process of various harmful substances. The passive gas sampling system performed by GASSYS has been proved successful and considerably enlarges the range of the methods commonly applied.

5.3) Numerical investigation of shallow aquifer recharge using small-diameter, low-cost wells and infiltration basin

Händel, F.[1,2]; Liu, G.[3]; Dietrich, P.[2,4]; Liedl, R.[1]; Butler, J.[3]

[1]*Institute for Groundwater Management, Technische Universität Dresden, Bergstraße 66, D-01069 Dresden, Germany*

[2]*UFZ, Helmholtz Centre for Environmental Research, Department Monitoring and Exploration Technologies, Permoserstraße 15, D-04318 Leipzig, Germany*

[3]*Kansas Geological Survey, University of Kansas, 1930 Constant Avenue, Lawrence, KS 66047-3724, USA*

[4]*University of Tübingen, Center of Applied Geoscience, Sigwartstraße 10, D-72076 Tübingen, Germany*

Keywords: Aquifer Storage and Recovery, Direct-Push, Artificial Recharge

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Scarcity of potable water has reached to a critical level all around the world. To overcome the temporal inequality of demand and availability of water resources, Aquifer Storage and Recovery is increasingly used. Commonly for shallow infiltration, recharge methods like surface infiltration basins and trenches are applied. However, these have significant disadvantages, like enhanced clogging, evaporation, and an increased need of land use. Therefore, a new method for artificial recharge using shallow small-diameter wells is investigated. Such wells can be installed by Direct Push (DP) and water is allowed to infiltrate into aquifers by natural gravity, so that their installation and operation costs are very low. Within this work this method is compared numerically to a surface infiltration basin. Scenarios were delineated to evaluate the newly proposed technique including parameter analyses, screen lengths variation and enhancement of the homogenous aquifer by hydrogeological layering. Results of two-dimensional, axisymmetrical models for the DP wells show the dependency of infiltration capacities on the parameters mentioned. The study aquifer is departed into an unsaturated zone of 12 m and saturate zone of 8 m. The horizontal hydraulic conductivity significantly influences steady-state infiltration rates, which can occur after short times, especially when infiltration is merely applied into the unsaturated zone. In contrary, van Genuchten parameters are less important. With regard to differing screen lengths, infiltration capacity can be maximized by using a fully penetrating DP well of 20 m. However, maximum infiltration rates per screen length decrease with increasing penetration into the saturated zone, which results in largest infiltration rates per screen lengths for a DP well of 12 m length. To reproduce the infiltration by a basin a three-dimensional model was created. The comparison of both infiltration methods shows that a small number of 2“ shallow wells of 12 m lengths can be used to recharge water at the same infiltration rate as a 60 m^2 basin. Finally, to evaluate both systems under more realistic conditions layered heterogeneity is included into the models based on a site-specific distribution of hydraulic conductivity. When a layer of low hydraulic conductivity is present, the infiltration capacity of surface basins is significantly reduced while the adverse impacts on the wells can be minimized by extending the screen below the layer.

5.4) Coupled simulation of unsaturated and saturated nitrate distribution at aquifer scale

Klammler, G.[1]; Kupfersberger, H.[1]; Rock, G.[1]; Fank, J.[1]

[1]*Joanneum Research Graz, RESOURCES – Institute for Water, Energy and Sustainability, Elisabethstraße 18/II, 8010 Graz, Austria, Phone: +43 316 876 1492, Email: gernot.klammler@joanneum.at*

Keywords: groundwater recharge; nitrate/nitrogen flux; aquifer/regional scale modeling; agriculture, nitrogen fertilization

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The shallow aquifer *Westliches Leibnitzer Feld*, Austria, with an area of approx. 45 km² is a significant resource for regional and supraregional drinking water supply for more than 100,000 inhabitants, but the region also provides excellent agricultural conditions. This dual use implicates conflicts (e.g. non-point source groundwater pollution by nitrogen leaching), which have to be harmonized for a sustainable coexistence and a good drinking water quality.
At the aquifer scale, numerical models are state-of-the-art tools to simulate the behavior of groundwater quantity and quality and serve as decision support system for implementing groundwater protecting measures. Due to required input data for modeling at larger scales is not available in detail, appropriate methods (e.g., a stochastic crop rotation tool for representing real agricultural land-use) have been developed and implemented. While fully and iteratively coupled simulation models consider feedback between the saturated and unsaturated zone, sandy soil conditions and groundwater tables beneath the root zone allow a unidirectional sequential coupling of the calibrated unsaturated water flow and nitrate transport model SIMWASER/STOTRASIM with FEFLOW for the investigation area *Westliches Leibnitzer Feld*.
Considering separated inputs of water and nitrogen into groundwater out of surface water bodies, agricultural, residential and forested areas, first simulation results match observed groundwater tables, but underestimate nitrate concentrations in general (N-fertilization rates are based on legal regulations). Thus, multiple scenarios assuming higher nitrogen inputs at the surface are simulated to converge with measured nitrate concentrations. These scenarios include assumptions concerning higher N-fertilization rates for arable land (because existing legal regulations are not policed), higher atmospheric N-deposition (assuming 30 kg N/ha/a on average) and also fertilization of lawns in residential areas (N-fertilization rates according to recommentations given by different commercial products). Moreover, also climate change scenarien have been used for driving the unsaturated and saturated model compound and effects of predicted climate on groundwater quantity and quality are simulated at aquifer scale.
The results indicate that N-input into the aquifer *Westliches Leibnitzer Feld* is strongly dominated by contributions from the surface. The method used is found to be an appropriate method for modeling at the aquifer scale, but to derive groundwater protecting agricultural managing practices (including recommendations for max. N-fertilization rates) the main N-sources at the surface need to be quantified (and not assumed). Therefore, future work will also focus on field measurements of the integrated total nitrogen input from the atmosphere (including dry and wet deposition as well as nitrogen assimilated directly by plant leaves) and on in situ investigations of N-fertililzation of lawns in residential areas by means of lysimeters.

5.5) Characterization and geostatistical simulation of the heterogeneity of a shallow granular aquifer for the numerical modeling of flow and transport

Paradis, D.[1,2]; Tremblay, L.[2]; Brunet, P.[2]; Gloaguen, E.[2]; Lefebvre, R.[2]

[1]*Geological Survey of Canada, 490 rue de la Couronne, Quebec City, QC, Canada G1K 9A9*

[2]*Institut national de la recherche scientifique, Centre Eau Terre Environnement (INRS-ETE), 490 rue de la Couronne, Quebec City, QC, Canada G1K 9A9 rene.lefebvre@ete.inrs.ca*

Keywords: direct push (CPT/SMR), multiple point geostatistics, gradual deformation, model verification

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Predictive assessment of issues related to contaminant remediation and management requires the development of representative numerical models of groundwater flow and mass transport. This communication provides an overview of the application of a workflow involving steps needed to develop such representative numerical models: site characterization, data integration, and numerical model development and verification. The study was carried out in Saint-Lambert-de-Lauzon, Quebec, Canada, on a 12 km^2 sub-watershed surrounding an old decommissioned landfill emitting landfill leachate, which is managed by natural attenuation. The aquifer is a shallow 10 to 20 m thick assemblage of sand and silt, which is highly heterogeneous and anisotropic due to its littoral depositional environment. Field characterization involved the combined acquisition of indirect continuous data (laterally and vertically) with high resolution direct point data that were used to constrain and correlate with indirect data. Three types of field methods were employed: 1) surface geophysics (radar GPR; electrical resistivity ER); 2) direct-push methods with a geotechnical drilling rig (cone penetration test with soil moisture resistivity CPT/SMR; full-screen well installation); and 3) borehole operations, including high resolution hydraulic tests and geochemical sampling. Significant efforts were dedicated to the acquisition of high vertical resolution and continuous hydraulic data: 1) 15-cm interval packer slug tests, 2) improvement in the interpretation of borehole flowmeter surveys; 3) development of a new vertical interference slug test providing vertical hydraulic conductivity (K_v) as well as horizontal hydraulic conductivity (K_h) and specific storage (Ss), and 4) consideration of anisotropy in the interpretation of hydraulic tomography carried out with slug tests. The mechanical (sleeve stress, tip stress, pore pressure) and geophysical (bulk electrical resistivity, permittivity) measurements of the CPT/SMR were used to recognize hydrofacies (HF), which are sediments with distinct hydraulic properties, and to predict hydraulic properties (K_h, K_v and porosity n), thus providing a large data set that could form the basis for geostatistical simulation of HF and hydraulic properties. To do so, a learning machine approach was developed to define site-specific hydro-geophysical relationships in order to predict granular aquifer hydraulic properties from CPT/SMR. The main algorithms used for training are semi-supervised fuzzy clustering and relevant vector machines (RVM) for classification and regression. Various scenarios of aquifer heterogeneity were simulated from HF data generated from the CPT/SMR along a 2D section using the Multiple Point Geostatistics (MPG) algorithm IMPALA. Vertical head profiles were then extracted from the flow simulations carried out on typical continuous and discontinuous geostatistical realizations. To assess the capacity to reproduce the original heterogeneous distribution of HF from the extracted head profiles, inverse simulations using the gradual deformation method (GDM) were used. The verification of the numerical model was also done using geochemical tracers and tritium-helium groundwater ages.

Session 6: Watershed Characterization (May 15, 14:00-15:40)

6.1) Impacts governing PAHs contamination of sediments and suspended matter in river systems.

Schwientek, M.[1]; Rügner, H.[1]; Beckingham, B.[2]; Kuch, B.[3]; Grathwohl, P.[1,3]

[1]*Water Earth System Science (WESS) Competence Cluster, Keplerstr. 17, 72074 Tübingen, Germany*

[2]*Center of Applied Geoscience, Eberhard Karls University of Tübingen, Hölderlinstr. 12, 72074 Tübingen, Germany*

[3]*Institute of Sanitary Engineering, Water Quality and Solid Waste Management, University of Stuttgart, Bandtäle 2, 70569 Stuttgart, Germany*

Keywords: PAHs, catchment, sediment pollution, suspended matter, stream network

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River sediments often act as sinks for hydrophobic organic pollutants. They may accumulate over longer time periods and then eventually be re-suspended causing raised concentrations of pollutants in the water column and additional stress for aquatic organisms. Sampling of sediments for the evaluation of pollutant contents is elaborate and only provides point information. Here, it is hypothesized that suspended matter transported in the water column is in chemical equilibrium with the river's sediments and, thus, integrates the contamination of sediments in the whole stream network.

This study shows results of a monitoring campaign of total concentration of polycyclic aromatic hydrocarbons (PAHs) and suspended particles in water samples in adjacent catchments in southern Germany with similar geology and climate but different degrees of urbanization. Defined linear relationships between total concentrations of PAHs in water and the amount of suspended solids were obtained indicating predominance of particle-facilitated transport. The slopes of these regressions correspond to the average contamination of suspended particles (C_{sus}) and thus comprise a very robust measure of sediment pollution in a river. Furthermore, the results show, that C_{sus} is distinct in the different catchments and that the degree of pollution is not directly coupled to the population density of the catchment but is represented by the number of inhabitants per total flux of suspended particles. This concept may be transferred to regions with a lack of measurements to estimate the pollution of sediments and suspended matter in rivers.

6.2) Using reservoirs as monitors of catchments: online in-situ water quality monitoring in a german drinking water reservoir

Rinke, K.[1]; Kamjunke, N.[1]; Tittel, J.[1]; Friese, K.[1], Bocaniov, S. [1]

1 UFZ-Helmholtz Centre for Environmental Research, Department Lake Research, Permoserstr. 15, 04318 Leipzig, Germany, karsten.rinke@ufz.de

Keywords: *Land-water interactions, Watersheds, Dissolved organic carbon, Short-term dynamics, Reservoir management*

Reservoirs are very tightly connected to their catchments as water residence time in the water body is comparatively low and all solutes and matter exported from the watershed pass through the reservoir. Reservoirs can, therefore, be viewed as sentinels of their catchments and a detailed monitoring of reservoir systems informs about biogeochemical and hydrological processes at the catchment scale. We developed a comprehensive online monitoring system at Rappbode reservoir, the largest drinking water reservoir in Germany, and its inflows. The Rappbode Reservoir Observatory comprises of a set of online-sensors for the measurement of physical, chemical, and biological variables and is complemented by a biweekly limnological sampling schedule. Measurement stations are deployed at the four major inflows into the system, at the outlets of all pre-reservoirs, as well as in the main reservoir. The newly installed monitoring system serves both, scientific monitoring and process studies as well as reservoir management. Particular emphasis is paid to the monitoring of short term dynamics and many variables are measured at high temporal resolution (measurement interval 15 minutes). A major water quality issue at Rappbode Reservoir is the increasing concentration of dissolved organic carbon (DOC) because high loads of DOC interfere with the processing technology in the drinking water plant. Rising levels of DOC are observed in several surface waters in the northern hemisphere and indicate a globally changing mobilization of DOC from soils. Among others, a major aim of the observatory is the identification of key events of DOC mobilization and the environmental setting under which these pulses of DOC are generated. This information is needed for improving the existing reservoir management and for serving as an early warning system for the drinking water plant. As an example, we quantitatively documented a flood event which mobilized high loads of dissolved organic carbon and changed the characteristics of the receiving reservoir from eutrophic (i.e. algae dominated) to dystrophic (i.e. dominated by humic substances and low algal biomass) within a few days.

6.3) Characterization of a lowland headwater catchment by means of hydrodynamics, hydrochemistry and groundwater age dating

Musolff, A.[1]; Weise, S.M.[2]; Fleckenstein, J.H.[1]

[1] *UFZ – Helmholtz-Centre for Environmental Research, Department Hydrogeology, Permoserstr. 15, 04318 Leipzig, Germany*

[2] *UFZ – Helmholtz-Centre for Environmental Research, Department Catchment Hydrology, Theodor-Lieser-Str.45, 06120 Halle, Germany*

Keywords: headwater catchment, $^{3}H/^{3}He$ dating, nitrate, groundwater surface

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Increased nutrient fluxes from catchments to the receiving surface waters affect water quality and the health of aquatic ecosystems. This especially holds true for intensely managed lowland catchments with high agricultural inputs of agrochemicals. Since nutrient, in particular nitrate, inputs peaked in the 1980s, recent release by slowly flowing groundwater resources may be a result of a decades old legacy. There is a need to understand mobilization and timescale of nutrient export from lowland catchments with heterogenic, often glacially formed geological settings. Here we characterize a lowland headwater catchment using geological information from drilled boreholes, measurements of the groundwater head, groundwater sampling and $^{3}H/^{3}He$ age dating.

The study area is the gauged Sauerbach catchment north of the Harz mountains, Germany. Large parts of the catchment are agriculturally used. The Sauerbach has a length of 1.1 km from spring to the gauging station and drains a surface area of 1.4 km^2. The area is characterized by Mesozoic fractured siltstones, forming a lower aquifer overlain by Mesozoic sandstones, forming an upper aquifer. On top of these sedimentary rocks unconsolidated clays and patchy sands and loess are distributed. For this study, we use water level data from nine observation wells equipped with automated loggers. Water samples were taken from the wells and the spring over the course of 2 years and analyzed for dissolved oxygen (DO) and major ions along with nitrate. From all of the wells and from the spring ^{3}He (copper tubes) and ^{3}H samples were taken and interpreted in terms of apparent groundwater ages.

Hydrogeological evaluation of the rocks and sediments from the nine boreholes and evaluation of the groundwater levels show that only the upper aquifer is connected to the Sauerbach streambed. Groundwater from the lower aquifer is not contributing to surface water flow within the catchment boundaries. Thus, the hydrogeological structure in the Sauerbach area leads to an improper integration of water flow at the catchment outlet. Upper groundwater as well as spring water is characterized by oxic conditions and high nitrate concentrations. In the lower aquifer nitrate and oxygen concentrations are significantly lower and at some wells even completely absent. The groundwater exhibits a span of apparent $^{3}H/^{3}He$ ages from 30 years to recent. With an age of about 10 years, the Sauerbach spring water shows that the current nitrate export is not an old legacy but a result of nutrient inputs from the last decade. Thus, there is a potential that measures implemented now may have a positive effect on the water quality within a relatively short timeframe.

This research was supported by TERENO (Terrestrial Environmental Observatories). We thank Jürgen Sültenfuß from Bremen University for performing the ^{3}He analyses.

Session 7: Groundwater flow and interaction (May 16, 09:00-11:00)

7.1) Data Analysis for Tracer Experiments Using Shape-Free Deconvolution Method on Multiple Scales

Liao, Z.[1,2]; Gritsch, M.[1]; Lemke, D.[2]; Ostenbrück, K.[2]; Cirpka, O.A.[1,2]

[1] *University of Tübingen, Center for Applied Geoscience, Hölderlinstr. 12, 72074 Tübingen, Germany.*

[2] *Water Earth System Science (WESS) Competence Cluster.*

Keywords: tracer experiments, resazurin-resorufin system, travel time distribution, shape-free inference,sorption

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Stream-tracer tests are a well-established technique to quantify transports in streams undergoing hyporheic exchange. Common tracer tests, using only a conservative tracer, however, suffer from the ambiguity of several processes having similar effects on the breakthrough curves. The joint analysis of the conservative tracer fluorescein (Fluo), a linearly decay reactive tracer resazurin (Raz), and its reaction product resorufin (Rru) provides insights into in-stream transport, hyporheic exchange, metabolic activity and sorption properties of the system. Due to the fact that Raz transforms exclusively in the hyporheic zone, the Raz-Rru system is used for detecting the strength of the exchange between the channel and the hyporheic zone. Adsorption is also included in the model, and a shape-free deconvolution method is implemented for estimating unconventional hyporheic travel time distributions.

We present and compare three tracer tests at different scales: (1) column experiments at a length of 30 cm; (2) a gravel-bar experiment at a length of 2 m; and (3) a stream tracer test at a length up to 1210 m. The main objective is to estimate the travel-time distribution (1) through the column, (2) from the river to the observation well, and (3) within the hyporheic zone, together with other transport and reactive parameters describing two-site sorption, and linear transformation processes of the reactive tracers. The transformation from Raz to Rru also acts as a proxy of metabolic activity in the system. The shape-free deconvolution approach allows the chance to uncover some unconventional patterns of the travel-time distributions, where the parametric functions fail to fit the long tail of the breakthrough curves, especially in the case of the stream tracer test.

This presentation focuses on the conceptual model assumptions and mathematical description of the reactive-transport system at hand.

7.2) Determining Groundwater-Surface Water Exchange Using Multilevel Temperature Probes and Information from the Frequency Response

Schneidewind, U.[1,2]; Vandersteen, G.[3]; Anibas, C.[4]; Schmidt, C.[5]; Batelaan, O.[4,6]; Wilczek, D.[1]; Joris, I.[1]; Bronders, J.[1]; Seuntjens, P.[1,2,7]

[1]*VITO – Flemish Institute for Technological Research, Environmental Modeling Unit, Mol, Belgium, uwe.schneidewind@vito.be,+32.14336761, 2Ghent University, Department of Soil Management, Gent, Belgium*

[3]*Vrije Universiteit Brussel, Department of Fundamental Electricity and Instrumentation, Brussels, Belgium*

[4]*Vrije Universiteit Brussel, Department of Hydrology and Hydraulic Engineering, Brussels, Belgium*

[5]*Helmholtz-Centre for Environmental Research-UFZ, Department of Hydrogeology, Leipzig, Germany*

[6]*Flinders University, School of the Environment, Adelaide, Australia*

[7]*University of Antwerp, Department of Bioscience Engineering, Antwerp, Belgium*

Keywords: Streambed temperature measurements, groundwater-surface water exchange flux, temperature modeling

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In recent years it has become practice in water management to consider groundwater and surface water as coupled parts in the same system. This has led to intensive research into groundwater-surface water interactions. A focus of this research has been the delineation and quantification of groundwater-surface water exchange fluxes or vertical Darcy velocities.
One indirect way to quantify these fluxes is through the use of time series of streambed temperature in analytical or numerical models, the majority of which apply forward modeling techniques that do not allow for assessing parameter uncertainty. Several solutions to the 1D heat transport equation in a semi-infinite half-space exist that make use of the sinusoidal components of the diurnal temperature fluctuations between different depths within the streambed. However, these solutions are limited regarding their use of data in the frequency domain.
To deal with these limitations, we propose a solution to for the 1D case based on the determination of the frequency response function between the input temperature at a point z_0 and the temperature at a position z for a given vector containing information regarding thermal and hydraulic parameters as well as sediment properties. To obtain this frequency response function and its uncertainty, we propose to apply the Local Polynomial Method, which uses information regarding the randomness of the input data and the spectral smoothness. With the frequency response function and its uncertainty we can then apply a maximum-likelihood estimator based on non-linear least-squares optimization techniques. This type of estimator allows us to determine model quality and parameter estimate uncertainty. Optimized parameters can then be back transformed from the frequency domain to the time domain where they hold information regarding the vertical exchange fluxes. The methodology was verified on streambed temperature data obtained with multilevel temperature probes at a reach of the Slootbeek, a small sidearm of the River Aa in Belgium. Riverbed composition varied spatially from areas with mainly coarse-grained sand and gravel to areas with high organic matter content.

7.3) Artificial Groundwater Recharge – a tool to optimize drinking water supply in the Lower Mur Valley in Austria

Fank, J.[1]; Fank, A.[2]

[1]*Joanneum Research Graz, RESOURCES – Institute for Water, Energy and Sustainability, Elisabethstraße 18/II, 8010 Graz, Austria, Phone: +43 316 876 6001, Email: johann.fank@joanneum.at*

[2]*Waterboard "Grenzland Südost", Bahnhofstraße 20a, 8350 Fehring*

Keywords: groundwater recharge; groundwater flow modeling; groundwater monitoring; groundwater nitrate concentration

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The project deals with the improvement of drinking water abstraction in the Lower Mur Valley. On the one hand the valley aquifers represent an outstanding reservoir for drinking water supply, but on the other hand the available areas and soils are perfect for intensive agricultural landuse. This results in an increased nitrogen input into the groundwater.

In the year 2004 best quality groundwater resources were developed in the wetlands of the river Mur in the communities of Fluttendorf / Donnersdorf. In 2006 two out of these four newly constructed wells exceeded the critical value of nitrate of 50 mg/l. Detailed researches confirmed a connection with the agricultural landuse in high terraces. An immediate decrease of nitrogen fertilization would improve the situation in about 20 years, because of the specifics of the soils and the residence time of nitrate in the soils.In order to find a short- and middle-term solution the Waterboard Grenzland Südost was given the permission to increase their consensus for the wells Fluttendorf 2 and Donnersdorf 1, as well as to build an artificial groundwater recharge facility, where water with lower nitrate concentration will be infiltrated into the aquifer. This water is mixed with the local groundwater and thereby the nitrate concentration at the abstraction wells will be lowered. The investigations to get the permission has been done by numerical modeling of groundwater flow and solute transport.

The artificial groundwater recharge facility has been built during the winter months of 2010/2011. The effectiveness of the artificial groundwater recharge facility was monitored between July 2011 and December 2012. A monitoring program with hydrological measurements, samplings and chemical analysis in 15 sampling points was created. This data was statistically evaluated and interpreted afterwards.

The results of the three monitoring phases are extremely positive. No side effects like impact on domestic wells in Fluttendorf were determined and the reduction of nitrate was higher than estimated. The reduction is around 50 % with the groundwater levels of the monitoring period.

Monitoring results will be used to calibrate a coupled numerical groundwater flow and nitrate transport model including the interaction between atmosphere, soil and groundwater as well as the interaction of surface water systems and the groundwater system.

7.4) New technologies in hydraulic engineering – the usage of fiber optics

Schwartz, A.[1]; Großwig, S.[1]; Pfeiffer, T.[1]

[1]*GESO GmbH Jena, www.geso.eu, info@geso.eu*

Keywords: fiber optics, hydraulic engineering

In our society, especially in Germany, the importance of environmental protection is increasing day by day. One aspect is the environmentally friendly energy exploration. Usually the production of for example solar or wind power does not occur at the places of high need of energy. Therefore transport and storage of energy is one of the central topics in our society. One possibility to save energy are pumped-storage power stations. But loss of water can occur at the upper reservoir due to uncontrolled drainage. Localisation and repair of leakages may help towards using energy in an environmentally friendly way. Fibre optical measurement technique, taking advantage of the thermal properties of water, is one possibility to observe the compactness of an upper reservoir in a pumped-storage power station. It has successfully been initiated in several hydraulic construction projects.
Some heavily used dams are observed using fibre optical temperature measuring technique. Especially the dam of a seasonal stringed accumulation lake is highly exposed. Recognizing damages very early it would be necessary to observe the building. The differences between dry and wet regions of the dam are shown in the data. Two dams are monitored at regular intervals and the results show the moisture of the building.
Another monitored building equipped with fibre optical temperature sensors is the upper basin of a ship lift. Already while building the ship lift the impermeability of the upper basin is observed at different construction stages. Also the groundwater level is monitored at different places to observe if water is lost in the upper basin. The fibre optical measurement technique enables locating the leakage with an accuracy of one meter Therefore, a reconstruction will take less time and lower costs and have only limited effect on the shipping traffic.

Session 8: Analysis of hydrological field experiments (May 16, 11:30-12:50)

8.1) A new sequential procedure for hydraulic tomography combining an eikonal and a pilot point based inversion scheme

Brauchler, R.[1]; Jimenez, S.[1]; Hu, R.[2]; Hu, L.[1]; Schmidt, S.[2]; Bayer, P.[1]; Ptak, T.[2]

[1]*ETH Zurich, Department of Earth Sciences, Sonneggstrasse 5, 8092 Zurich, Switzerland*

[2]*Geoscientific Centre, University of Göttingen, Goldschmidtstraße 3, 37077 Göttingen, Germany*

Keywords: Hydraulic tomography; eikonal solver; pilot points; tracer testing

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Hydraulic tomography is promoted as a method, which allows for the characterization of the spatial variations of hydraulic parameters with an accuracy and resolution needed for the prediction of solute transport in the subsurface. Although the number of hydraulic tomography field studies is continuously increasing in the last five years, which documents the transition of hydraulic tomography as theoretic concept to a robust field method, there exist only a limited number of studies utilizing transport experiments to validate the reconstructed hydraulic parameter fields.

In this study we introduce an inversion scheme, based on the transformation of the flow equation into a form of the eikonal equation, with an inversion based on pilot points. We reconstructed the diffusivity and specific storage distribution utilizing an eikonal solver, displaying a rough picture of the hydraulic subsurface heterogeneity. This information was used to set-up a pilot point based inversion framework. Therefore, local reliability of the diffusivity and specific storage distribution was determined using singular value decomposition of the matrix, composing the lengths of the calculated trajectories. This information, in addition to the diffusivity and specific storage values, was used by an unsupervised learning algorithm to define a basic hydrofacies. The hydrofacies were implemented into the pilot point based inversion framework using the graph theory to determine the relationships among the pilot points. This can be described with an adjacency matrix utilizing Tikhonov regularization. The high computational effort was encountered with parallel computing and subspace regularization.

The new sequential procedure for hydraulic tomographic was tested at a well-characterized sand and gravel aquifer located in the Leine River valley near Göttingen, Germany. The data base for the hydraulic inversion consists of 30 transient pressure response curves recorded in a tomographical array between two wells. The suite of tomographic short-term pumping tests was designed in a way that field work can be completed within one day.

The inversion scheme was validated by a forced gradient tracer test performed between the same wells used for the hydraulic tomographic investigations. Thereby, two fluorescence tracers were injected in two different depth of the aquifer and the breakthrough curves were recorded in the observation well over the whole thickness of the aquifer. The interpretation of the tracer test results reveals that the subsurface transport is dominated by a high conductive layer close to the bottom of the aquifer, which is reconstructed by the tomographic inversion schemes with a high spatial resolution and accuracy.

8.2) Heat Tracer Tomography – A New Approach to Characterizing Aquifer Heterogeneity

Doro, K.O.[1]; Cirpka, O.A.[1]; Leven, C.[1]

[1]*Center for Applied Geoscience, University of Tübingen, Hölderlinstrasse 12, 72074, Tübingen, Germany*

Keywords: thermal tracer testing, tracer tomography, subsurface investigation, aquifer heterogeneity, flow and transport

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The application of hydrogeological testing techniques in a tomographic layout has the potential to provide detailed information on aquifer heterogeneity. We have developed a new technique using heat as a tracer in tomographic experiments. The tomographic experiments are applied in the 6 m-thick heterogeneous sandy gravel aquifer formation at the Lauswiesen test site (Tübingen, Germany). Heat tracer tomography involves the injection of heat as a tracer at different depth sections into the aquifer, and the measurement of temperature time series at different locations for each individual injection phase. Acquired temperature time series can be combined and inverted to obtain a tomogram of aquifer hydraulic and thermal parameters. In this work, we utilized a three-level injection system with the tracer always being injected in the middle level. For each single tracer test, about 10 m^3 of warm water at 20°C are injected into the aquifer, which had an undisturbed temperature of about 10.8°C, for 2.5 hours, and measuring the temperature time series in three dimensions within a 10 m × 10 m cube. The results show that a temperature change with peak breakthrough of up to 3.5°C can be measured within a distance of about 5m from the source with temperature change returning to background values after 46 hours. In addition, results of temperature breakthrough are compared to conservative-solute tracer experiments. In this work, we demonstrate the use of heat as groundwater tracer and present initial results of the successful development and application of heat tracer tomography in characterizing aquifer heterogeneity at field scale. The relative ease of measurement, and the fact that heat can be introduced and temperature change measured inexpensively in a repeatable form makes heat a suitable tracer for the development and field application of tracer tomography.

Session 9: Thermal use of the shallow subsurface (May 16, 14:10-15:30)

9.1) Thermal Parameter: Acquisition and characterisation of geologic properties – A 400 metre deep Bhe in a karstic alpine marble aquifer

Lehr, C.[1]; Sass, I.[1]

[1]*Technische Universität Darmstadt - Institute of Applied Geosciences*

Keywords: Distributed Temperature Sensing, Inverse Modeling, Effective Thermal Coductivity, Groundwater Flow

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To dimension a geothermal array it is necessary to explore the geophysical and geologic qualities of the subsoil. At the following example the project engineering of a prospective geothermal array is shown from the investigation up to the execution planning.
The investigation was executed in the following steps:

- Drilling and recording of the geologic profile.
- Mounting of a Duplex BHE and fiberglass hybrid cable into the borehole
- Measurement of the thermal reaction progress by means of Optical-Frequency-Domain-Reflectometry with a spatial depth resolution of 0.5 m (1.64 ft.).
- Determination of the rock-physical parameters using inverse modeling (best fit).
- Detection of ground water flow by analyzing the measured geophysical parameters.
- Calculation of the Darcy flow in as ground water-leading identified horizons by means of Peclet number analysis.
- Use of the measured data in a simulation for the conceptual design of the prospective geothermal array.

For the geothermic investigation a 400m (1312 ft.) deep drilling was established and equipped with 50 mm (1.97 in.) duplex BHE. With the mounting of the BHE a fiberglass hybrid cable was inserted as a loop parallel to the shanks of the BHE.
The built in hybrid cable carries along a copper cable as a heating wire beside the fiberglass. A controller measures the resistivity of the copper leader during heating phase and holds by adaptation of the voltage and the amperage the applied electric power steady. The undisturbed temperature of the subsoil and the temperature rise of the system are recorded by means of Optical-Frequency-Domain-Reflectometry measurement (OFDR). A temperature depending optical spectrum phase shift of the Raman parts (Stokes and Antistokes) enables the calculation of the temperature at its place of origin. The evaluation of the recorded temperature curves follows Kelvin's line source theory. For every measuring point along the hybrid cable the effective thermal conductivity of the surrounding rock can be determined thus. Due the high local resolution of the resulting profile of conductivities can be differentiated in areas with mainly conductive and areas of convective influenced heat transfer. By knowledge of these both parts and its parameters the incident of groundwater flow on the BHE can be calculated (Peclet number analysis/ Darcy velocity).
Results: With the help of the ascertained geophysical and hydraulic rock parameters solid rock, cleavages and karst cavity could be identified. Also the undisturbed ground temperature, the effective thermal conductivity and areas with different geothermal gradients and the groundwater velocity in cleaved and caveated rocks could be determined.
Beside the shown use temperatures of from -200 (-328 °F/73.15 K) to 400 °C (752 °F/ 673.15 K) can be measured with the Optical-Frequency-Domain-Reflectometry measurement (OFDR). Thus data from high temperature systems can be also won as a live stream from down hole.

9.2) Geothermal subsurface characterization at regional scale: the Calabria Region case study (Southern Italy)

Di Sipio, E.[1]; Galgaro, A.[1,2]; Destro, E.[1]; Chiesa, S.[3]; Giaretta, A.[1]; Manzella, A.[4]

[1] *Institute of Geosciences and Earth Resources IGG-CNR, Via Gradenigo 6, 35131 Padova, Italy, Tel: +390498279123, eloisa.disipio@gmail.com*

[2] *Department of Geosciences, University of Padua, Via Gradenigo 6, 35131 Padova, Italy*

[3] *Institute for the Dynamics of Environmental Processes IDPA-CNR, Dalmine, Via Pasubio, 5 - 24044, Dalmine(BG), Italy*

[4] *Institute of Geosciences and Earth Resources IGG-CNR, Pisa, Via Moruzzi 1, 56124, Pisa, Italy*

Keywords: shallow geothermal energy, geo-exchange potential map, thermal conductivity, Southern Italy

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Renewable energy sources are becoming worldwide attractive solutions for clean and sustainable energy needs. In details, geothermal energy is one of the most promising due to the available high potential and is multiple uses. However, there are still several challenges to a profitable use of the earth's heat.

The successful implementation of low enthalpy geothermal systems, (borehole heat exchangers - BHE, ground source heat pump systems - GSHP, groundwater heat pump systems - GWHP) operating in the heating-cooling mode, requires, among others, a better characterization of thermal and petrophysical properties of subsoil. The direct determination of these parameters is essential for optimizing the exploitation of low temperature geothermal resources.

In fact, the thermal conductivity of materials is one of the main input parameters in geothermal modeling since it directly controls the steady state temperature field and is a reference value to validate data obtained by indirect control methods applied in situ (geoelectrical soundings, magnetotelluric method …).

Aims of this study are, on the one hand, to provide original rock thermal conductivity values useful for the evaluation of low enthalpy resources at regional or local scale; on the other to produce a digital cartographic tool able to synthesize the thermal properties of the subsoil, easily accessible and upgradeable and useful for territorial planning and environmental control.

In this regard, in the framework of VIGOR Project, the Calabria Region (Southern Italy) has been selected as case study. Several samples (about 90), representative of the main geological units, have been collected all over the territory. Thermal properties tests were carried out both in dry and wet conditions, using a thermal device, operating following the Modified Transient Plane Source method. The measured thermal conductivity values have been validated by comparison with data published in the international literature. Then, to consider the influence of the entire stratigraphic sequence on thermal conductivity parameters, a geostatistical analysis of the available lithostratigraphic data has been performed by developing of specific routines working into MATLAB environment, called "Modalstrata". In this way, a comprehensive low enthalpy geothermal subsurface characterization of Calabria has been obtained.

9.3) Heat flow laboratory tests, numerical modeling and monitoring for the thermal use of the shallow subsurface

Giordano, N.[1]; Firmbach, L.[2]; Comina, C.[1]; Dietrich, P.[2,3]; Kolditz, O.[4]; Mandrone, G.[1]; Vienken, T.[2]; Watanabe, N.[4]

[1] *Department Earth Science - University of Torino (Via Valperga Caluso 35, 10125 – nicolo.giordano@unito.it)*

[2] *UFZ- Helmholtz Centre for Environmental Research, Department Monitoring & Exploration Technology*

[3] *University of Tubingen, Centre for Applied Geoscience, Institute for Geosciences*

[4] *UFZ- Helmholtz Centre for Environmental Research, Department Environmental Informatics*

Keywords: Heat propagation – Thermal properties – Shallow geothermal applications – Numerical modeling – Electric resistivity

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Determining the thermal characteristics of geologic media has numerous applications for low enthalpy geothermal systems design and monitoring. Despite the interest in the topic, there appears to be a scarcity of experimental data, most of the thermal properties evaluations being based on numerical simulations and back analysis. Therefore, we here present an on proper designed thermal box devoted to laboratory tests of heat propagation. This apparatus is able to monitor temperature and moisture conditions during a thermal flow specifically generated. This box has been used to characterize shallow subsurface materials for a on proper thermal use. Two distinct materials have been analyzed in order to evaluate changes in heat flow distribution due to differences in porosity and grain size distribution. The variation of electric resistivity has been moreover monitored during the experiments measuring with indirect geophysical measurements. A quantitative determination of the thermal properties, based on the use of empirical derived laws, has been used as a starting point for the construction of a numerical model simulating the heat propagation with OpenGeoSys (Kolditz et al., 2012).
Analogical data processing confirms that the induced heat flow propagates faster from dry to saturated conditions but is less dependent on intermediate water contents; a stronger increase in the heat propagation velocity has been obtained introducing a water flow effect. As far as the geophysical imaging is concerned, a good correlation between temperature and resistivity has been confirmed, especially at high saturation degrees. Numerical simulations performed with OpenGeoSys reached a good agreement with experimental data, enabling to determine and validate, with back-analysis processes, the thermal properties of the tested porous media.
Coupling laboratory measurements with resistivity indirect surveys and numerical modeling seems to have good potentiality as real site monitoring tools. This can bring to a reliable and accurate thermal property assessment of in-situ shallow soils, in order to design correctly borehole heat exchangers and underground thermal heat storage systems.

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9.4) Development of exploration and monitoring strategies for the sustainable thermal use of the shallow subsurface

Vienken, T.[1]; Schelenz, S[1].; Firmbach, L[1].; Dietrich, P.[1,2]

[1]*UFZ - Helmholtz Centre for Environmental Research, Germany*

[2]*University of Tübingen, Germany*

Keywords: shallow geothermal energy, aquifer thermal energy storage, exploration and monitoring, thermal resource management

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In consequence of the energy transition and following the international aim to reduce CO2-emissions the thermal use of the shallow subsurface has constantly increased. Frequently applied techniques include the exploitation of the shallow geothermal potential, e.g. using borehole heat exchangers, and aquifer thermal energy storage. The rising numbers of these systems that are installed to nowadays heat or cool entire residential neighborhoods or large industrial facilities has led to an emerging demand in research to assess and mitigate potential effects of the intensive thermal use of the shallow subsurface.
Potential effects are expected in regards of induced groundwater temperature changes with a resulting depletion of groundwater quality and the over-exploitation of the thermal potential with resulting reduction of system efficiency. In many cases, soil and groundwater processes are not directly observable and heat and mass transport by groundwater dispersion and convection may lead to a carryover of effects. Conflicting interests between thermal energy use and groundwater protection as well as conflicting use between thermal energy users are expected to arise especially in densely populated urban areas where the highest demand for the use of shallow thermal energy is located but exploitation is limited and, at the same time, groundwater vulnerability is at its highest. Until present, a sufficient thermal exploration and monitoring is performed only in rare cases. Planning and construction of systems mostly rely on literature values and simplified modeling assumptions.
However, a reliable site characterization and monitoring would greatly contribute to an increase in resource efficiency, costs reduction during installation and operation while reducing environmental impacts. Against this background, research must focus on the refinement of geothermal exploration, impact monitoring, and collection of data from laboratory and field experiments on different scales to assess and quantify the effects of the intensive thermal use of shallow subsurface. Research results must be used as basis for the development of a thermal resource management that provides guidelines and tools to ensure a sustainable thermal use of the shallow subsurface.

Abstracts - Poster Presentation

Nr:	Title	Keywords	Author(s)	*Institution(s)*
1	**Hydrogeophysical monitoring and modeling of freshwater injection in a hyper-saline aquifer**	Electrical resistivity tomography, saltwater, freshwater injection, numerical modeling, density-driven flow	Haaken, K.[1]; Deidda, G.P.[2]; Cassiani, G.[3]; Kemna, A.[1]; Deiana, R.[4]; Putti, M.[5]; Scudeler, C.[6]; Paniconi, C.[6]	*1 Geodynamics/Geophysics, Steinmann-Institute, University of Bonn, Bonn, Germany; haaken@geo.uni-bonn.de, kemna@geo.uni-bonn.de* *2 Dipartimento di Ingegneria Civile e Ambientale e Architettura, Università di Cagliari, Cagliari, Italy; gpdeidda@unica.it* *3 Dipartimento di Geoscienze, Università degli Studi di Padova, Padova, Italy; giorgio.cassiani@unipd.it* *4 Dipartimento di Beni Culturali (DBC), Università degli Studi di Padova, Padova, Italy; rita.deiana@unipd.it* *5 Dipartimento di Matematica, Università degli Studi di Padova, Padova, Italy; putti@dmsa.unipd.it* *6 INRS-ETE, Université du Québec, Québec City, Canada; carlotta.scudeler@gmail.com, claudio.paniconi@ete.inrs.ca*
2	**Advantages of combining ground-based remote sensing techniques with soil gas and geophysical measurements for atmospheric monitoring**	CO_2 leakages at surface, open path FTIR spectroscopy, geophysics, soil gas monitoring	Schütze, C.[1]; Sauer, U.[1]; Sandig, C.[1]	*[1]UFZ- Helmholtz Centre for Environmental Research, Persmoserstrasse 15, 04318 Leipzig; claudia.schuetze@ufz.de*
3	**The necessity of bidirectional pseudo-2D surface wave profiling for enhanced data evaluation of MASW method**	pseudo-2D shear-wave velocity profiling, MASW, forward and reverse profiling	Steinel, H.[1]; Hausmann, J.[1]; Werban, U.[1]; Dietrich, P.[1,2]	*[1]Helmholtz-Centre for Environmental Research - UFZ, Department Monitoring and Exploration Technologies, Permoserstrasse 15, 04318 Leipzig, Germany* *[2]Eberhard Karls University of Tübingen, Institute of Geosciences, Hölderlinstrasse. 12, 72076 Tübingen, Germany*
4	**Phytoscreening of subsurface pollution with organic compounds**	Subsurface contamination, Plant uptake, Monitoring, Indicator chemicals, Organic compounds	Rein, A.[1]; Algreen, M.[2]; Trapp, S.[2]	*[1] Technische Universität München, Chair of Hydrogeology, Arcisstr. 21, 80333 Munich, Germany, Phone: +49 8928925869, Fax: +49 8928925852, Email: arno.rein@tum.de* *[2] Technical University of Denmark, Department of Environmental Engineering, Miljøvej building 113, DK-2800 Kgs. Lyngby, Denmark., Phone: +45 45251696 Fax: +45 45932850, E-mail:mann@env.dtu.dk, sttr@env.dtu*
5	**Evaluation of a flux-weighing sampling device using a thermo flowmeter and tracer experiments**	Mass fluxes, thermo-flowmeter, sectional sampling system, depth-oriented concentrations	Gutiérrez Cirlos Maraña, A.[1]; Weiss, H.[2]; Halla, P.[3]; Leven, C.[1]	*[1]University of Tübingen, Center for Applied Geoscience, Hölderlinstraßse, 12, 72074 Tübingen, Germany* *[2]IMW Innovative Messtechnik Dr. Weiss, Vogtshaldenstraße 47, 72074 Tübingen, Germany* *[3]Berghof Analytik + Umweltengineering GmbH & Co. KG, Lilli-Zapf-Straße 32, 72072, Tübingen, Germany*

Nr:	Title	Keywords	Author(s)	*Institution(s)*
6	**Fiber optical temperature measuring technique – new opportunities in long-term monitoring of disposals and mine dumps**	fiber optics, hydraulic engineering	Schwartz, A.[1]; Großwig, S.[1]; Hurtig, E.[1];	*[1]GESO GmbH Jena, www.geso.eu, info@geso.eu*
7	**Geoelectrical soil characterization for hydrological modeling**	soil characterisation, geoelectrics, hydrological modeling	Mannschatz, T.[1,2]; Feger, K.H.[2], Dietrich, P.[1]	*[1]Helmholtz Centre for Environmental Research – UFZ, Department of Monitoring and Exploration Technologies, Leipzig, Germany* *[2]Dresden University of Technology, Institute of Soil Science and Site Ecology, Tharandt, Germany*
8	**Soil sampling strategies for VIS-NIR spectroscopy: A case study using conditional Latin Hypercube Sampling**	visible-near infrared spectroscopy, proximal soil sensing, sampling methods	Grau, T.[1]; Werban, U.[1]; Zacharias, S.[1]; Dietrich, P.[1]	*[1]UFZ – Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research, Permoserstraße 15, 04318 Leipzig, Germany*
9	**Calibration of EMI data based on different electrical methods**	electromagnetic induction, vertical electrical conductivity logging, electrical resistivity tomography,	Nüsch, A.K.[1]; Werban, U.[1]; Dietrich, P.[1,2]	*[1]Helmholtz Centre for Environmental Research, Department Monitoring and Exploration Technologies, Leipzig* *[2]University of Tübingen, Center of Applied Geoscience, Tübingen*
10	**Temperature variations in small diameter direct push monitoring wells and their implication on groundwater temperature monitoring**	temperature measurement, monitoring, borehole, casing, screening	Schelenz, S.[1]; Kreck, M.[1]; Dietrich, P.[1,2]; Vienken, T.[1]	*[1]UFZ - Helmholtz Centre for Environmental Research, Germany* *[2]University of Tübingen, Germany*
11	**Modelling strategies for the thermal management of shallow rural and urban groundwater bodies**	Heat Transport, Regional Modelling, Groundwater Heat Pump, Geothermal Energy	Händel, F.[1,3]; Epting, J.[2]; Huggenberger, P.[2]; Liedl, R.[1]; Dietrich, P.[3,4]; Fank, J.[5]	*[1]Institute for Groundwater Management, Technische Universität Dresden, Bergstr. 66, 01069 Dresden, Germany,* *[2]Applied and Environmental Geology, Environmental Sciences, Basel University, Applied and Environmental Geology, Environmental Sciences, Basel, Switzerland (jannis.epting@unibas.ch, +41 (0)61 267 2998),* *[3]Department Monitoring and Exploration Technologies, UFZ-Helmholtz Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany,* *[4]University of Tübingen, Center of Applied Geoscience, Sigwartstr. 10, D-72076 Tübingen, Germany,* *[5]JOANNEUM RESEARCH, Resources, Elisabethstr. 18/II, A-8010 Graz, Austria*

Nr:	Title	Keywords	Author(s)	*Institution(s)*
12	**Demand driven observation of soil moisture – A multi sensor approach**	soil moisture, monitoring design, multi sensor approach, geophysical measurements, remote sensing, meso-scale catchment	Schröter, I.[1]; Dietrich, P.[2]; Wollschläger, U.[3]	*[1] Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany, E-mail: ingmar.schroeter@ufz.de [2]Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany, E-mail: peter.dietrich@ufz.de [3]Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany, E-mail: ute.wollschlaeger@ufz.de*
13	**Hydraulic characterisation of the Stuttgart formation at the pilot test site CO2 storage, Ketzin, Germany, through analysis of four cross-hole pumping test by inverse modeling.**	Pumping test, permeability, inverse modeling, cross-hole, Ketzin	Otto, C.[1 2]; Wiese, B. [1]	*[1] GFZ Helmholtz Centre Potsdam GFZ German, Research Centre for Geosciences, Centre for Geological Storage, Telegrafenberg, D-14473 Potsdam, Germany [2] University of Potsdam, Institute of Earth and Environmental Science, Karl-Liebknecht-Str. 24-25 14476 Potsdam-Golm, Germany*
14	**Surface monitoring for coastal protection based on UAV imagery**	Remote sensing, UAV imagery, aerial surface monitoring, aerial photogrammetry	Schima, R.[1]; Niemeyer, F.[1]; Grenzdörffer, G.[1]; Bill, R.[1]	*[1]University of Rostock, Germany, Institute for Geodesy and Geoinformatics, Justus-von-Liebig-Weg 6, 18059 Rostock*
15	**Two-dimensional characterization of near-surface features in a filled oxbow channel using geophysical methods and soil sampling**	geomorphological characterization, combination of geophysical methods, joint interpretation, ERT, refraction seismic, MASW, GPR	Hausmann, J.[1]; Steinel, H.[1]; Kreck, M.[1]; Werban, U.[1]; Vienken, T.[1]; Dietrich, P.[1,2]	*[1]Dept. Monitoring and Exploration Technologies, Helmholtz-Centre for Environmental Research - UFZ, Permoserstrasse 15, D-04318, Leipzig, Germany [2]Center for Applied Geosciences, Tuebingen University, Hölderlinstrasse 12, D-72074 Tübingen*
16	**Combined mobile P-, S-wave tomography and direct push techniques for geotechnical site characterization**	Site characterization, direct push, mobile P- and S-wave tomography, particle swarm optimization	Hausmann, J.[1]; Rumpf, M.[2]; Paasche, H.[1]; Werban, U.[1]; Dietrich, P.[1,3]; Tronicke, J.[2]	*[1]Dept. Monitoring and Exploration Technologies, Helmholtz-Centre for Environmental Research - UFZ, Permoserstrasse 15, D-04318, Leipzig, Germany [2]Institute of Earth and Environmental Sciences, University of Potsdam, Karl-Liebknecht-Strasse 24, D-14476 Potsdam-Golm [3]Center for Applied Geosciences, Tuebingen University, Hölderlinstrasse 12, D-72074 Tübingen*
17	**Direct push based characterization of the near surface using in situ gained soil colours**	direct push, in situ soil colours, processing, colour surrogates, site characterization	Hausmann, J.[1]; Dietrich, P.[1,2]; Vienken, T.[1]; Werban, U.[1]	*[1]Dept. Monitoring and Exploration Technologies, Helmholtz-Centre for Environmental Research - UFZ, Permoserstrasse 15, D-04318, Leipzig, Germany [2]Center for Applied Geosciences, Tuebingen University, Hölderlinstrasse 12, D-72074 Tübingen*

Nr:	Title	Keywords	Author(s)	*Institution(s)*
18	**Optimal sampling and sample preparation for NIR-based prediction of field scale soil properties**	NIRS, PLS, optimal sampling, TOC, texture	Knadel, M.[1]; Peng, Y.[1]; Schelde, K.[1]; Thomsen, A.[1]; Deng, F.[1]; Humlekrog Greve, M.[1]	[1]*Dept. of Agroecology , Faculty of Science and Technology, Aarhus University, Blichers Allé 20, PO box 50, DK-8830 Tjele,*

1) Hydrogeophysical monitoring and modeling of freshwater injection in a hyper-saline aquifer

Haaken, K.[1]; Deidda, G.P.[2]; Cassiani, G.[3]; Kemna, A.[1]; Deiana, R.[4]; Putti, M.[5]; Scudeler, C.[6]; Paniconi, C.[6]

[1] *Geodynamics/Geophysics, Steinmann-Institute, University of Bonn, Bonn, Germany; haaken@geo.uni-bonn.de, kemna@geo.uni-bonn.de*

[2] *Dipartimento di Ingegneria Civile e Ambientale e Architettura, Università di Cagliari, Cagliari, Italy; gpdeidda@unica.it*

[3] *Dipartimento di Geoscienze, Università degli Studi di Padova, Padova, Italy; giorgio.cassiani@unipd.it*

[4] *Dipartimento di Beni Culturali (DBC), Università degli Studi di Padova, Padova, Italy; rita.deiana@unipd.it*

[5] *Dipartimento di Matematica, Università degli Studi di Padova, Padova, Italy; putti@dmsa.unipd.it*

[6] *INRS-ETE, Université du Québec, Québec City, Canada; carlotta.scudeler@gmail.com, claudio.paniconi@ete.inrs.ca*

Keywords: Electrical resistivity tomography, saltwater, freshwater injection, numerical modeling, density-driven flow

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A freshwater injection experiment was carried out in the hyper-saline aquifer underlying the Molentargius-Saline Regional Park located near Cagliari (Sardinia, Italy). Electrical Resistivity Tomography (ERT) monitoring was performed through five boreholes, which are positioned in a square with an 8 m long side and one borehole in the centre and with a depth of 20 m. All boreholes are equipped with a fully screened PVC pipe bearing externally twenty-four stainless steel cylindrical electrodes from 0.6 m to 19 m depth with 0.8 m separation. The water table is stable around -5.2 m from the ground surface. The sediments are mostly composed of sands with thin layers of silty sand, clayey sand and silty clay. Electric fluid logs recorded in the boreholes allowed to discriminate two zones, with a transitional layer in between: (a) from the water table to 7.5 m the water electrical conductivity is about 2 S/m; (b) below 12 m depth the water electrical conductivity reaches 18.5 S/m. In November 2011 we injected 19.4 m³ of freshwater in about 4 hours using a double packer system positioned in the central borehole, with an injection chamber located between 13.5 and 14.5 m below ground surface. The natural pressure gradient provided for an initial injection rate of 0.5 l/s; however, after about 1.5 h the injection rate immediately rose to a rate of about 2.75 l/s. Time-lapse ERT monitoring was achieved by measuring along two 2D ERT planes corresponding to the two square diagonals, thus involving three boreholes at a time for a total of 72 electrodes. A mixture of skip 0 dipole-dipole and bipole-bipole configurations was used in each acquisition. To define quantitative parameters controlling the plume behaviour, numerical modeling was carried out using a 3D density-driven mixed-FEM/FV aquifer simulator. The injection borehole is simulated with a high conductivity value since it appears as a preferential flow path and the injection is modeled by imposing higher pressure within the injection chamber nodes. Results at different times show a vertical upward migration of the freshwater body. The observed abrubt increase of the injection rate was simulated by a “de-clogging” of fine sediments within the packer material just around the injection chamber that was realized by increasing the hydraulic conductivity of the respective nodes after a certain time. The salt concentration values of the model domain at different time steps were converted into electrical conductivity by using Archies law and a 3D geoelectrical forward modeling was performed. The inverted images are compared with the observed ERT images.

2) Advantages of combining ground-based remote sensing techniques with soil gas and geophysical measurements for atmospheric monitoring

Schütze, C.[1]; Sauer, U.[1]; Sandig, C.[1]

[1]*UFZ- Helmholtz Centre for Environmental Research, Persmoserstrasse 15, 04318 Leipzig; claudia.schuetze@ufz.de*

Keywords: CO_2 leakages at surface, open path FTIR spectroscopy, geophysics, soil gas monitoring

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The development of an integrative hierarchical geophysical monitoring concept for the characterization of water and CO_2 fluxes is the main objective of the presented research work. Comprehensive information on driving impact factors, such as subsurface structures, meteorological conditions, and potential source variations, are necessary to analyze and interpret observed fluxes in the soil-vegetation-atmosphere system. The determination of these fluxes is of excert importance during monitoring of CO_2 migration and potential seepage at geological Carbon Capture Storage sites. As part of an integrative hierarchical monitoring concept, several methods and technologies from remote sensing (open-path Fourier-transform infrared (OP-FTIR) spectroscopy), regional measurements (geophysics and chamber based soil CO_2 flux measurement), and local in-situ measurements (Direct Push Technology) will either be combined or used complementary to one another.

A promising tool currently under development for the identification and quantification of emissions is Fourier transform infrared (FTIR) spectroscopy, which is used to determine spatial atmospheric gas distribution in the near-surface atmosphere. Passive remote sensing of vapor clouds by open-path FTIR (OP-FTIR) spectroscopy is based on the analysis of ambient infrared radiation in the low wave-number range (700 – 1300 cm^{-1}). Radiation measured by the spectrometer contains the spectral background signatures, the pollutant cloud and the atmosphere. The detector responds to the compound's concentration variation, averaged over the entire sample path length. With the selected instrumentation arrangement, a single IR detector is able to rapidly sample in different directions, thereby well suited for rapid observations of large areas (in the range of m^2 to km^2). The presented results indicate the necessity of combining OP-FTIR spectroscopy with other methods, including joint data interpretation to obtain reliable models of the investigated structures and processes associated with CO_2 migration and release. Sufficient geophysical techniques for meso-scale monitoring include geoelectrical and self-potential surveys. These methods are useful for characterizing fluid flow and transport processes in permeable near-surface sedimentary layers and can yield important information concerning CO_2 affected subsurface structures.

The presentation introduces examples of how to successfully deploy passive OP-FTIR spectroscopy to identify anomalous greenhouse gas concentrations along greater optical pathways. Results of measurements taken at a natural analogue site in the Czech Republic indicate that the hierarchical monitoring approach depicts a successful multidisciplinary modular concept to monitor physical and chemical processes taking place during CO_2 migration and seepage. The application of FTIR spectroscopy in combination with soil gas surveys and geophysical investigations results in a comprehensive site characterization, including the atmospheric and near-surface CO_2 distribution as well as driving subsurface structural features. Furthermore, it should be noted that interpretation of spectroscopic results requires the supporting determination of additional meteorological and soil-gas analyzing parameters.

3) The necessity of bidirectional pseudo-2D surface wave profiling for enhanced data evaluation of MASW method

Steinel, H.[1]; Hausmann, J.[1]; Werban, U.[1]; Dietrich, P.[1,2]

[1]*Helmholtz-Centre for Environmental Research - UFZ, Department Monitoring and Exploration Technologies, Permoserstrasse 15, 04318 Leipzig, Germany*

[2]*Eberhard Karls University of Tübingen, Institute of Geosciences, Hölderlinstrasse. 12, 72076 Tübingen, Germany*

Keywords: pseudo-2D shear-wave velocity profiling, MASW, forward and reverse profiling

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The application of non-invasive geophysical methods provides valuable information for the characterization of near-subsurface features. Suitable geophysical techniques can be utilized dependent on the investigation target and the environment of the study site to support geotechnical parameterisation approaches with 2D data.
In recent years, pseudo-2D shear-wave velocity profiling has become an important tool for the evaluation of vs-characteristics of the near-subsurface due to its relation to the stiffness distribution. The application of the Multichannel Analysis of Surface Waves (MASW) method provides information about the subsurface features drawn from the dispersive characteristics of the surface waves, here Rayleigh waves, along a linear array. The one-array dispersion curves are inverted into 1D-vertical velocity profiles. Then, by arranging these next to each other, a pseudo-2D S-wave velocity sections is generated. As a result, two-dimensional features interpretation can be applied to the data.
Contrary to seismic refraction surveys, the MASW method is not considerably restrained to methodical preconditions such as an increasing density and therefore velocity with depth (low velocity layer). MASW method, however, requires a critical examination of the geometrical parameters for data acquisition. These parameters are the source offset, the geophone spacing, the spread length, and the source interval. Generally, high amount of attention has to be paid to the geological set-up of the study site while planning a MASW survey.
So far, nearly all application-oriented studies perform pseudo-2D surface wave profiling only unidirectional. We recommend the performance of surface wave measurements as bidirectional surveys, i.e. in opposite directions applied on the same profile line, since this significantly improves data evaluation. Methodical uncertainties are connected to the localisation of the global surface wave response at the corresponding mid-spread position of the profile. For this reason, dipping layers and lateral variations may distort the flat-layered 1D assumption of surface wave inversion. The occurrence of lateral variations can however be clarified by such ‘check’ shots.
In this study, we performed two pseudo-2D MASW investigations. The Lauswiesen test site, close to Tübingen in Baden-Wuerttemberg and an abandoned river channel nearby Löbnitz in Saxony, both Germany, were chosen to test this approach. On both locations, we reveal the aforementioned effects and prove the necessity of forward and reverse profiling. The results of this study show that, in general, more attention should be paid to data evaluation.

4) Phytoscreening of subsurface pollution with organic compounds

Rein, A.[1]; Algreen, M.[2]; Trapp, S.[2]

[1] *Technische Universität München, Chair of Hydrogeology, Arcisstr. 21, 80333 Munich, Germany, Phone: +49 8928925869, Fax: +49 8928925852, Email: arno.rein@tum.de*

[2] *Technical University of Denmark, Department of Environmental Engineering, Miljøvej building 113, DK-2800 Kgs. Lyngby, Denmark., Phone: +45 45251696 Fax: +45 45932850, E-mail:mann@env.dtu.dk, sttr@env.dtu*

Keywords: Subsurface contamination, Plant uptake, Monitoring, Indicator chemicals, Organic compounds

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The investigation of subsurface pollution by examining tree cores provides a rapid, inexpensive and low-invasive alternative to investigate the extent and temporal development of subsurface contaminations. The uptake of common organic soil and groundwater contaminants into trees was investigated in modeling studies and tree core sampling campaigns.

Results of dynamic uptake modeling showed that chlorinated ethenes generally posses a high potential of being found in tree stems, which corresponds to tree core sampling campaigns, where perchloroethene, trichloroethene and dichloroethene were successfully found. Vinyl chloride, however, could not be detected in many cases, which can be explained by a high biodegradation rate in roots and the rhizosphere.

Aromatic hydrocarbons (BTEX) were also predicted of potentially being found in tree stems. Toluene and Benzene have occasionally been found in field studies, but there also reports of non-successful studies. Reasons for the latter could be a high benzene background in air as well as rapid biodegradation in the root zone and within plants, which is reflected by the modeling results. Even at a site with very high soil and groundwater concentrations (former hydrogenation plant near Zeitz, Germany), benzene and toluene could hardly be found, which can be explained by a deep groundwater level and binding layers in the vadose zone. At another site with shallow groundwater (former air field near Szprotawa, Poland), benzene was measured in willow trees.

The high lipohilicity of polycyclic aromatic hydrocarbons (PAH) hampers effective transport in xylem, and thus most PAH are not suited as indicator chemicals as they will not reach the stem. Naphthalene seems to be an exception: although this compound is very sensitive to biodegradation in the stem it could be detected in trees cores from at a PAH contaminated site in Hunedoara, Romania.

5) Evaluation of a flux-weighing sampling device using a thermo flowmeter and tracer experiments

Gutiérrez Cirlos Maraña, A.[1]; Weiss, H.[2]; Halla, P.[3]; Leven, C.[1]

[1]*University of Tübingen, Center for Applied Geoscience, Hölderlinstraßse, 12, 72074 Tübingen, Germany*

[2]*IMW Innovative Messtechnik Dr. Weiss, Vogtshaldenstraße 47, 72074 Tübingen, Germany*

[3]*Berghof Analytik + Umweltengineering GmbH & Co. KG, Lilli-Zapf-Straße 32, 72072, Tübingen, Germany*

Keywords: Mass fluxes, thermo-flowmeter, sectional sampling system, depth-oriented concentrations

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Risk assessment and management of contaminated sites can greatly be improved if contaminant mass fluxes are considered. Evaluation of contaminant mass fluxes provides a useful insight into the spatial concentration distribution in the aquifer, since it is calculated by combining concentration data with the Darcy velocity of groundwater.
Traditional sampling techniques usually provide a flux-weighted average of the concentrations within a monitoring well. However, zones with different hydraulic conductivity contribute accordingly with different weights to the sampled water. These samples do not reflect a direct measure of aquifer concentrations and may obscure zones with concentrations higher than the permitted limits.
To quantify the relative contribution of zones with different hydraulic conductivity to the sampled water, the knowledge of vertical distribution of concentration and hydraulic conductivity is necessary. In this regard, the Thermo Flowmeter Monitoring (TFM) system, which consists of a thermo flowmeter and a sectional sampling system, allows to determine depth-oriented concentration profiles and simultaneously to estimate vertical hydraulic conductivity profiles in the decimeter range. By combining these results it is possible to calculate mass fluxes and aquifer concentrations at the targeted depths.
The objective of this work is to evaluate the ability of the TFM system to measure depth-oriented mass fluxes. For this purpose a setup using tracer tests and specialized monitoring wells was designed with the goal of assessing the TFM system in comparison to independent measurements of concentration and hydraulic conductivity.
To compare the hydraulic conductivity profiles, multi-level slug tests (MLST) were performed and data from direct push injection logging (DPIL), impeller flowmeter and sieve analysis from previous investigations were analyzed. A forced gradient tracer test was performed to mobilize a tracer plume and to be able to measure vertical concentration profiles in the aquifer. The methods used for this purpose were a 7-port continuous multichannel tubing system (SOLINST®-CMT) and Geoprobe®-SP16 sampling points. The sampling methods were carried out simultaneously during the tracer experiment and compared to the results obtained by the sectional sampling system.

6) Fiber optical temperature measuring technique – new opportunities in long-term monitoring of disposals and mine dumps

Schwartz, A.[1]; Großwig, S.[1]; Hurtig, E.[1]

[1]*GESO GmbH Jena, www.geso.eu, info@geso.eu*

Keywords: fiber optics, hydraulic engineering

In the subsurface natural and anthropogenic influenced processes occur. Examples are the ground water flow in consolidated and unconsolidated rocks or the subsurface response to geothermal usage. Furthermore the subsurface contains technical installations like pipelines and other buried buildings posing a threat in case of leakage or disaster. If human beings or the environment may be at risk by technical arrangements a long term monitoring system would be wise. But often there are strict safety regulations concerning the measurement technique nearly preventing the application of conventional measurement techniques containing single sensors or sensors in a row. In that case the fibre optical temperature measurement technique may be the solution for the named problems because of meeting demands to an effective long-term monitoring. Moreover the fibre optical measurement technique has some advantages over the predominantly electrical conventional measurement techniques, especially the electrical passivity.
Using the fibre optical temperature measuring system it is possible to observe the temperature on distances of many kilometres at the same time with a spatial resolution of 12.5 cm and a thermal resolution better than 0.1 K. The possibility of application in a vertical or horizontal way enables many different applications of the fibre optical temperature measurement technique.
Experiences in numerous projects document the successful application of the fibre optical temperature measurement technique in disposals and mine dumps for more than ten years. Especially exothermal processes inside a mine dump are monitored very well. Therefore the success of remedial actions can be proofed. Moreover the flow of contaminated water in disposals can be observed with that technique. One example each for the usage of the fibre optical temperature measurement technique in disposals and mine dumps will demonstrate the success of the measurements. It becomes apparent that the usage of fibre optical sensor systems could contribute to environment protection by detecting contaminated water flows in deposits and controlling the effectiveness of remedial actions.

7) Geoelectrical soil characterization for hydrological modeling

Mannschatz, T.[1,2]; Feger, K.H.[2]; Dietrich, P.[1]

[1]*Helmholtz Centre for Environmental Research – UFZ, Department of Monitoring and Exploration Technologies, Leipzig, Germany*

[2]*Dresden University of Technology, Institute of Soil Science and Site Ecology, Tharandt, Germany*
theresa.mannschatz@ufz.de

Keywords: geoelectrics, hydrological modelling, soil characterization, tropical soils

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Tropical forest plantations established on degraded soils may provide effective measures that help further mitigate soil degradation and erosion, subsequently leading to an improvement in soil fertility. Furthermore, they provide renewable biomass resources, which can be used for energy production or construction materials.
However, land use change (e.g. from grassland to forests) can have a crucial impact upon the water balance and thus on water availability - even in humid tropical climates, where water is not normally a limiting factor. Furthermore, climate change predictions for some humid tropical regions assume decreasing precipitations. This study considers the predicted decrease of mean annual precipitation of ≈ 40 - 60% for low emission (B2) and high emission (A2) scenarios for the years 2071-2100 and compares this predicted decrease to actual results obtained between 1961-1990 (Marengo et. al, 2007).
This study evaluates the influence of a fast-growing bamboo plantation in semi-humid NE Brazil on the soil water balance. This is important, as it allows us to provide recommendations for future soil and forest management strategies. The 1D hydrological Coup model (Jansson and Karlberg, 2004) is used for soil water balance modeling. The model requires information about soil layering and soil hydraulic information. This information is derived from geoelectrical field measurements, which are based on several parallel profiles of different spatial resolution. This information is then used to understand soil homogeneity and soil layering. Furthermore, two infiltration tests were performed to investigate rates of water infiltration into the soil. Beside the infiltration ring, a probe with 10 electrodes was introduced into the soil (to a depth of about 1m) in order to simultaneously measure changes in resistivity. Geoelectrical results were verified by soil sampling up to 1m soil depth. First profile results show small differences in resistivity, therefore indicating relatively homogeneous soil. Even so, soil layers with generally decreasing resistivity with depth are distinguishable. The decrease in resistivity is assumed to be mainly due to increasing water content with depth.

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8) Soil sampling strategies for VIS-NIR spectroscopy: A case study using conditional Latin Hypercube Sampling

Grau, T.[1]; Werban, U.[1]; Zacharias, S.[1]; Dietrich, P.[1]

[1] *UFZ – Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research, Permoserstraße 15, 04318 Leipzig, Germany*

Keywords: visible-near infrared spectroscopy, proximal soil sensing, sampling methods

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Recently VIS-NIR spectroscopy has become a popular method for the prediction of soil parameters. Key quantities like soil organic carbon (SOC), texture or clay mineralogy are important key parameters for developing soil management practices in regard of efficient water resource development. VIS-NIR spectroscopy provides an inexpensive and efficient measurement method with a good accuracy. However as part of the workflow several soil samples have to be taken and analyzed in the laboratory which can still be expensive and time consuming. Using optimized sampling schemes the amount of taken samples can be reduced, without sacrificing significant accuracy.

The aim of this study is to predict spatial distribution of SOC using a mobile VIS-NIR measurement platform. Results of two fieldsites will be presented where the usability of a conditional Latin Hypercube sampling (cLHS) for the prediction of SOC values is discussed, furthermore guidelines for optimized sampling will be given.

The study areas are agricultural field sites in Münchenbernsdorf and Burkersdorf (Germany) with a size of 7 resp. 4 ha. Geophysical measurements of VIS-NIR Spectroscopy, Electromagnetic Induction (EMI) and Gamma Ray Spectroscopy have been conducted. EMI and Gamma measurements were used as proxy datasets for the cLHS with the intention to cover the variability of soil properties. Sets of 50 and 30 samples were taken on each site as a cLHS result. Furthermore they were analyzed in the laboratory for SOC. Laboratory results are then used for calibration models using the method of Partial Least Square Regression. The results of the SOC prediction are discussed in regard to cLHS sampling and different sampling schemes using VIS-NIR measurements.

9) Calibration of EMI data based on different electrical methods

Nüsch, A.-K.[1]; Werban, U.[1]; Dietrich, P.[1,2]

[1] *Helmholtz Centre for Environmental Research, Department Monitoring and Exploration Technologies, Leipzig*

[2] *University of Tübingen, Center of Applied Geoscience, Tübingen*

Keywords: electromagnetic induction, vertical electrical conductivity logging, electrical resistivity tomography,

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The advantages of the electromagnetic induction (EMI)-method have been known to soil scientists for many years. Thus it is used for many soil investigations, ranging from salinity measurements over water content monitoring to classification of different soil types. There are several companies that provide instruments for each type of investigation. However, a major disadvantage of the method is that measurements obtained under different conditions (e.g. with different instruments, or at different times or field sites) are not easily comparable. Data values yielded when using the instruments are not absolute, which is an important prerequisite for the correct application of EMI, especially at the landscape scale. Furthermore drifts can occur, potentially caused by weather conditions or instrument errors and subsequently give results with variations in conductivities, which are not actually reflective of actual test results. With the help of reference lines and repeated measurements, drifts can be detected and eliminated. Different measurements (spatial and temporal) are more comparable, but the final corrected values are still not absolute.
The best solution that allows for absolute values to be obtained is to calibrate the EMI-Data with the help of a known conductivity from other electrical methods. In a series of test measurements, we studied which electrical method is most feasible for a calibration of EMI-data. The chosen field site is situated at the floodplain of the river Mulde in Saxony (Germany). We chose a profile 100 meters in length which is very heterogeneous and crosses a buried back water channel. Results show a significant variance of conductivities. Several EMI-instruments were tested. Among these are EM38DD and EM31 devices from Geonics. These instruments are capable of investigating the subsurface to a depth of up to six meters. For the calibration process, we chose electrical resistivity tomography (ERT), Vertical Electrical Sounding (VES), and vertical in Situ resistivity measurements.
A model of the subsurface is derived from each of the electrical methods. The models are used with a 1D-EMI-modelling program. Finally, theoretical and real EMI-measurements are compared and adapted (if applicable).
The focus is the comparison of these methods according to their accuracy and applicability to derive true subsurface models.
As a result we could show that all method are suitable for this calibration, however resistivity-logs are slightly advantaged in accuracy, because they offer high resolution models while ERT measurement are easier to accomplish but deliver ambiguous models. A decision which method to use is dependent on demand and technical requirements.

10) Temperature variations in small diameter direct push monitoring wells and their implication on groundwater temperature monitoring

Schelenz, S.[1]; Kreck, M.[1]; Dietrich, P.[1,2]; Vienken, T.[1]

[1]*UFZ - Helmholtz Centre for Environmental Research, Department Monitoring and Exploration Technologies, Permoserstraße 15, 04318 Leipzig, Germany, Tel.: +49 (0)341 235 1008, Fax +49 (0)341 235 451382, sophie.schelenz@ufz.de*

[2]*University of Tübingen, Germany*

Keywords: temperature measurement, monitoring, borehole, casing, screening

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The finite use of fossil fuels drives an elevated demand on renewable energies. In addition to the energy derived by sun, wind, and biomass, the use of the shallow subsurface as a thermal storage gains in importance. In addition, shallow geothermal energy systems are increasingly used for heating or cooling of residential buildings or industrial facilities. In this regard, there exists the pressing need for adapted temperature monitoring strategies to ensure protection of the groundwater quality and ecosystem services and to prevent conflicting uses between adjacent systems using shallow geothermal energy.
An exact measurement and monitoring of groundwater temperature is indispensable to ensure a sustainable thermal use of the shallow subsurface. Potential effects triggered by groundwater temperature changes include the depletion of groundwater quality, e.g. by changing microbial activities or solution-dissolution processes, and the reduction of system efficiency.
Several literature studies investigate the influence of well construction on temperature variations inside of large diameter boreholes or groundwater quality in monitoring wells. In large diameter wells formation of convection cells caused by temperature variations within the water column can affect a reliable and depth resolved measurement of temperature variations. Therefore, small diameter (< 50mm) observation wells with a limited screen length of 1m are recommended for ground water temperature measurements [Bund/Länder-Arbeitsgemeinschaft Wasser. Grundwasser, Richtlinien für Beobachtung und Auswertung, Teil 2: Grundwassertemperatur. 1987].
However, detailed field studies comparing the effects of well diameter and screen length on the vertical distribution of groundwater temperatures in monitoring wells < 50.8mm (2”) do not exist. Therefore, six neighboring permanent PVC direct push groundwater monitoring wells with diameters of 50.8mm (2‘‘), 38.1mm (1,5‘‘), and 31.1mm (1,25‘)‘ were installed, each diameter partly (1m) and fully (9m) screened, to compare depth-dependent temperature measurements under the influence of varying well diameters and screen lengths at the UFZ test site Bitterfeld, Germany.
After six month results show a clear impact of the borehole construction on the measured groundwater temperatures. With increasing well diameter, temperature variations decrease and fully screened wells are characterized by higher temperature fluctuations compared to the partly screened wells. Results clearly stress the impact of well construction on measured temperature variations even in small diameter groundwater monitoring wells.

11) Modelling strategies for the thermal management of shallow rural and urban groundwater bodies

Händel, F.[1,3]; Epting, J.[2]; Huggenberger, P.[2]; Liedl R.[1]; Dietrich, P.[3,4]; Fank, J.[5]

[1]*Institute for Groundwater Management, Technische Universität Dresden, Bergstr. 66, 01069 Dresden, Germany*

[2]*Applied and Environmental Geology, Environmental Sciences, Basel University, Applied and Environmental Geology, Environmental Sciences, Basel, Switzerland (jannis.epting@unibas.ch, +41 (0)61 267 2998)*

[3]*Department Monitoring and Exploration Technologies, UFZ-Helmholtz Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany*

[4] *University of Tübingen, Center of Applied Geoscience, Sigwartstr. 10, D-72076 Tübingen, Germany*

[5] *JOANNEUM RESEARCH, Resources, Elisabethstr. 18/II, A-8010 Graz, Austria*

Keywords: Heat Transport, Regional Modelling, Groundwater Heat Pump, Geothermal Energy

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Thermal management of aquifers requires knowledge on interactions and heat transport processes not only on a local but also on a more regional scale. Therefore, prediction of temperature developments due to thermal use and other anthropogenic impacts necessitate the use of large scale numerical models based on field temperature measurements. This contribution presents different modelling strategies for the thermal management of shallow rural and urban groundwater bodies. Depending on the settings and the relevant management topics different boundary conditions have to be considered. Whereas, thermal regimes within rural groundwater bodies primarily are governed by natural boundaries and the interaction with the atmosphere, in urban areas also the influences of urbanization and heated subsurface constructions have to be considered. Therefore, the setup of modelling tools as basis for the thermal management of groundwater bodies in different settings requires different interaction processes to be focused on.

The study is illustrated by selected examples of a rural groundwater body located in the "Leibnitzer Feld" (Austria) and an urban groundwater body located in the city of Basel (Switzerland). The two case studies differ in their respective hydrogeological setting, above all in the vertical extents of the saturated and unsaturated zone. Therefore, specific modelling approaches are used to focus on a reliable description of the main governing impacts. The regional models evaluate current and future thermal use of the groundwater bodies and highlight the advantages arising from a regional view of heat transport processes.

12) Demand driven observation of soil moisture – A multi sensor approach

Schröter, I.[1]; Dietrich, P.[2]; Wollschläger, U.[3]

[1] *Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany, E-mail: ingmar.schroeter@ufz.de*

[2]*Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany, E-mail: peter.dietrich@ufz.de*

[3]*Dept. Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research GmbH – UFZ, Permoserstraße 15, 04318 Leipzig, Germany, E-mail: ute.wollschlaeger@ufz.de*

Keywords: soil moisture, monitoring design, multi sensor approach, geophysical measurements, remote sensing, meso-scale catchment

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Soil moisture is a key variable of the hydrological cycle, controlling for instance the partitioning of rainfall into a runoff and an infiltration component and modulating physical, chemical and biological processes in the soil. For a better understanding of these processes, knowledge about the spatio-temporal distribution of soil moisture is indispensable. For the field to the small catchment scale with areas up to a few km^2, there are numerous new and innovative ground-based and remote sensing technologies available which have great potential to provide temporal information about soil moisture patterns. Up to now, there only exist a few studies that combine time series of data from a complete suite of available traditional, geophysical and remote sensing technologies in order to investigate the temporal development of soil moisture patterns at the small catchment scale.

The aim of this work is to design an optimal soil moisture monitoring programme for a meso-scale hydrological catchment in central Germany using a suite of traditional, geophysical and remote sensing techniques. This poster outlines the conceptual framework of the multi-sensor monitoring approach and presents first results from field measurements.

The expected results of the project are expected to improve the understanding of small catchment scale hydrological processes and to contribute to a better representation of soil moisture dynamics in physically based, hydrological models operating at the field to the small catchment scale.

13) Hydraulic characterisation of the Stuttgart formation at the pilot test site CO2 storage, Ketzin, Germany, through analysis of four cross-hole pumping test by inverse modeling.

Otto, C.[1, 2]; Wiese, B. [1]

[1] *GFZ Helmholtz Centre Potsdam GFZ German, Research Centre for Geosciences, Centre for Geological Storage, Telegrafenberg, D-14473 Potsdam, Germany*

[2] *University of Potsdam, Institute of Earth and Environmental Science, Karl-Liebknecht-Str. 24-25 14476 Potsdam-Golm, Germany*

Keywords: pumping test, permeability, inverse modeling, cross-hole, Ketzin,

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The poster presents an approach for the interpretation of cross-hole pumping tests of the reservoir at the pilot site for CO2 storage in Ketzin, Germany. Prior to injection, four hydraulic tests have been carried out in three wells.
The sandstone reservoir is geologically characterised by a wide meandering fluviatile channel structure embedded in a low-permeability matrix. This results in a complex spatial distribution of the permeabilities, embedded structures with one or two aquifers or a combination of this. Different bars of sand- and mudstone facies result in a complex and heterogeneous geology and can therefore not be easily predicted. A unusual case at Ketzin test site is that the measured permeabilities at the cores were much higher than those measured at the hydraulic test at the field. Preliminary investigations show pumping test permeabilities which are mainly between 50-100 mD (millidarcy), while core samples showed a mean aquifer permeability of 500-1100 mD. Based on this it was concluded that some kind of continuous low-permeability structure exists.
Reservoir simulations were carried out with ECLIPSE100 in a 500 m x 500 m x 12 m 2D horizontal model. Inverse modeling is carried out with PEST. A spatially distributed hydraulic permeability field is calibrated constrained by regularization constraints. Further parameters are specific storage, horizontal anisotropy and well skin.
The distribution of permeability and pathways of possible hydraulic connection between the wells were geologically interpreted. First inversions showed no spatial distribution of storage, although a high spatial variability of hydraulic permeability with an unreasonable wide range of values. For a more efficient model calibration a strong regularization was required. It is not possible to obtain one definite aquifer configuration. Depending on scenarios of the geological context, a number of calibrated models are obtained. Therefore the most reasonable results will be discussed with respect to the geologic context.

14) Surface monitoring for coastal protection based on UAV imagery

Schima, R.[1]; Niemeyer, F.[1]; Grenzdörffer, G.[1]; Bill, R.[1]

[1]*University of Rostock, Germany, Institute for Geodesy and Geoinformatics, Justus-von-Liebig-Weg 6, 18059 Rostock*

Keywords: remote sensing, UAV imagery, aerial surface monitoring, aerial photogrammetry

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The use of Unmanned aerial vehicles (UAV) has become an important tool as data acquisition platform or measurement instrument for a wide range of aerial applications. In addition UAVs close the gap between ground based observation and aircraft or satellite based methods. Particularly with regard to aerial photogrammetry UAVs are increasingly being used with the effect that UAV imagery has become a focus of research. Compared to common airborne imaging systems UAVs offer much more flexible and weather-independent working condition with less effort required and significantly less costs. This especially is true for Micro-UAVs with a total take-off weight below 5 kg providing a quickly deployable and easy to handle technique for imagery acquisition at low altitudes. Within a post-process the captured data can be used to generate high resolution spatial data such as orthophotos, 3D point clouds or digital terrain models (DTM).
The objective consists of the surface monitoring for coastal protection based on UAV imagery including planning, flight or rather image acquiring and the semiautomated editing and postprocessing of the data. Therefore a stone revetment at Lühesand, a small island in the Elbe river near the City of Hamburg and a pilot dike near Rostock have been chosen and repeatedly flown over using a quadrocopter in combination with a digital camera. The ambition was to detect and measure both the change of the revetment and the settlement of the dike during concrete periods as accurately as possible.
In general, the field investigations showed that the surface monitoring of coastal protection structures and constructions based on UAV imagery provides a promising alternative to common aircraft based surveys. The achieved ground sampling distance of the captured data ranges from 2 cm/pixel to less than 1 cm/pixel for the ground resolution. Furthermore, the survey flight at Lühesand allows the detection of single stone movements. With special emphasis on the monitoring of the pilot dike UAV imagery was found to be very useful in generating highly detailed DTMs of complex structures and constructions in a simple and cost-efficient way.

15) Two-dimensional characterization of near-surface features in a filled oxbow channel using geophysical methods and soil sampling

Hausmann, J.[1]; Steinel, H.[1]; Kreck, M.[1]; Werban, U.[1]; Vienken, T.[1]; Dietrich, P.[1,2]

[1]*Dept. Monitoring and Exploration Technologies, Helmholtz-Centre for Environmental Research - UFZ, Permoserstrasse 15, D-04318, Leipzig, Germany*

[2]*Center for Applied Geosciences, Tuebingen University, Hölderlinstrasse 12, D-72074 Tübingen*

Keywords: geomorphological characterization, combination of geophysical methods, joint interpretation, ERT, refraction seismic, MASW, GPR

The use of geophysical methods for the characterization of near-surface features has become state-of-the-art in recent years. Geophysical techniques provide a vast number of advantages due to their non-invasive and cost-efficient data gathering. In dependence on the investigation target, suitable techniques can be utilized for a multidimensional characterization and distinction of landforms of various geomorphological origins. We applied electrical resistivity tomography (ERT), refraction seismic (RS), and ground penetrating radar (GPR) to a filled oxbow channel. In addition, we performed Multichannel Analysis of Surface Waves (MASW) as a seismic surface wave. This tool can be easily integrated into refraction seismic surveys without any considerable additional expenditure of time and personal. In addition to this, soil samples were taken to evaluate the results and in order to understand the capability of imaging the assumed fluvial-morphological features like slip-off slope, channel, and cut bank, within a depth up to 8 m. The study was conducted close to Löbnitz/Germany in the recent Mulde meadow in fluvial sediments.

The applied methods contrast certain physical properties, i.e. resistivity, density, and dielectric characteristics of the subsurface. However, each particular method is somehow restricted in its application. Drawbacks and limitations depend on the contrast of and between the physical properties which each technique is sensitive to. Therefore, a combination of the listed geophysical tools can overcome these restrictions. The lacks of each method can be compensated by another. Main aim is the joint interpretation of the multi-method approach. Add to this we evaluated MASW technique towards its capability as possible a complement in the methodical spectrum of geomorphological site investigation.

We were able to characterize and delineate the addressed subsurface features by combination of ERT, GPR, RS, MASW data and the soil samples. Stand-alone data interpretation cannot provide certain structural information. The soil samples ground truth the interpretation of the multi-method approach.

To sum up, it can be stated that the combination of different geophysical methods improve the certainty of the structural information. The main fluvial features were imaged well. The limitations of each single method could be overcome by combined data interpretation, e.g. GPR supports ERT - MASW and RS support ERT, and vice versa. Indeed the MASW results provide a laterally as well as vertically more detailed insight in the structural setup of the near-surface features then RS or ERT. However, soil sampling is indispensable for validation and classification of the results. We can also show in this study that the MASW method is able to complement the spectrum of geophysical techniques for near surface investigations.

16) Combined mobile P-, S-wave tomography and direct push techniques for geotechnical site characterization

Hausmann, J.[1]; Rumpf, M.[2]; Paasche, H.[1]; Werban, U.[1]; Dietrich, P.[1,3]; Tronicke, J.[2]

[1]*Dept. Monitoring and Exploration Technologies, Helmholtz-Centre for Environmental Research - UFZ, Permoserstrasse 15, D-04318, Leipzig, Germany*

[2]*Institute of Earth and Environmental Sciences, University of Potsdam, Karl-Liebknecht-Strasse 24, D-14476 Potsdam-Golm*

[3]*Center for Applied Geosciences, Tuebingen University, Hölderlinstrasse 12, D-72074 Tübingen*

Keywords: site characterization, direct push, mobile P- and S-wave tomography, particle swarm optimization

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Assessing the spatial distribution of geotechnical parameters is increasingly important for the exploration of development sites and corresponding risk analysis. Such information is essential for the sustainable use of the near-surface underground, the reliable foundation of large buildings as well as for site-specific geotechnical risk assessment. According to the specific geotechnical issue to be addressed, different traditional geotechnical surveying and analysis tools are typically used at selected locations. However, the high spatial heterogeneity of near-surface unconsolidated sediments is usually not reliably captured by sparse geotechnical measurements. Hence, additional geophysical explorations are carried out, such as seismic tomography.

Within the MuSaWa project we present first results from a combined P- and S-wave tomography survey at an abandoned meander of the Mulde River, in order to develop a routinely applicable tool for local-scale development site exploration. The experiment was solely performed at multiple temporarily installed boreholes. It is based on mobile direct-push devices that provide the flexibility to easily access different locations and investigations depths. In addition to this mobile cross-hole survey, we also added surface mounted three-component geophones for vertical seismic profiling (VSP). Furthermore, we performed a set of direct push driven soundings providing high-resolution vertical information. In particular, we applied electrical resistivity logging (EC), cone penetration testing (CPT), and SONIC core sampling. These data were essential for a detailed and reliable interpretation of the seismic results.

We show that the spatial interpolation of sparse geotechnical information on the basis of tomographic surveys is improved by joint interpretation using additional direct-push acquired geotechnical parameters. These are required for ground truthing. Both show the stratigraphic pattern of the subsoil and are comparable to each other. Moreover, the validation of tomographically reconstructed velocity models becomes more reliable. The results demonstrate the potential of mobile P- and S-wave tomography to be a routine application for local-scale development site exploration.

17) Direct push based characterization of the near surface using in situ gained soil colours

Hausmann, J.[1]; Dietrich, P.[1,2]; Vienken, T.[1]; Werban, U.[1]

[1]*Dept. Monitoring and Exploration Technologies, Helmholtz-Centre for Environmental Research - UFZ, Permoserstrasse 15, D-04318, Leipzig, Germany*

[2]*Center for Applied Geosciences, Tuebingen University, Hölderlinstrasse 12, D-72074 Tübingen*

Keywords: direct push, in situ soil colours, processing, colour surrogates, site characterization

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Nowadays, there has been increasing interest in high-resolved parameterization of the near-subsurface. Latest developments in direct push driven data acquisition systems provide a large set of techniques for in situ data recording. One of these techniques is the measurement of soil colours in unconsolidated sediments throughout depth. This provides proxy information about the layer structure related to dependence on mineral composition and chemical state as well in the saturated as in the unsaturated zone. In addition, site specific pre-knowledge can be enhanced by understanding the soil heterogeneities for various purposes, e.g. distribution of hydraulic properties, location of oxidative-reductive boundary, and micro-stratification.
We show that soil colour yields information about the vertical stratigraphic pattern. The study presents improvements of data acquisition, numerical transformation, filtering, and interpretation of soil colours gathered in situ. We applied a colour spectrometer probe recording data in a vertical resolution of mm. The tool detects soil colours within the visible spectrum and in real-time. So far, there are no routines how to handle high-resolved soil colour data from soil colorimeter probes. We calculate a set of colour surrogates from the repeated soil colour measurements. Then, we applied wavelet filtering to the data set in order decrease variability caused by small scale heterogeneities. This provides clear depth-related information. In comparison to drill logs, the stratigraphic interpretation becomes more solid, because parameters are recorded without changing the sediment texture.
We found that filtered colour surrogates show an increase of the information and correspond with the geological set-up. The findings of this study provide a new understanding of soil colours as a technically reliable parameter. The results suggest that the approach is applicable in soil science and geotechnical engineering. This information can be used to encourage development of direct push driven data acquisition systems for in situ data recording.

18) Optimal sampling and sample preparation for NIR-based prediction of field scale soil properties

Knadel, M.[1]; Peng, Y.[1]; Schelde, K.[1]; Thomsen, A.[1]; Deng, F.[1]; Humlekrog Greve, M.[1]

[1]*Dept. of Agroecology , Faculty of Science and Technology, Aarhus University, Blichers Allé 20, PO box 50, DK-8830 Tjele,*
[*]*Corresponding author: maria.knadel@agrsci.dk, tel.:+45 8715 7615*

Key words: NIRS, PLS, optimal sampling, TOC, texture

The representation of local soil variability with acceptable accuracy and precision is dependent on the spatial sampling strategy and can vary with a soil property. Therefore, soil mapping can be expensive when conventional soil analyses are involved. Visible near infrared spectroscopy (vis-NIR) is considered a cost-effective method due to labour savings and relative accuracy. However, savings may be offset by the costs associated with number of samples and sample preparation. The objective of this study was to find the most optimal way to predict field scale total organic carbon (TOC) and texture. To optimize the vis-NIR calibrations the effects of sample preparation and number of samples on the predictive ability of models with regard to the spatial distribution of TOC and texture were investigated. Conditioned Latin hypercube sampling (cLHs) method was used to select 125 sampling locations from an agricultural field in Denmark, using electromagnetic induction (EMI) and digital elevation model (DEM) data. The soil samples were scanned in three states (field moist, air dried and sieved to 2 mm) with a vis-NIR spectrophotometer (LabSpec 5100, ASD Inc., USA). The Kennard-Stone algorithm was applied to select 50 representative soil spectra for the laboratory analysis of TOC and texture. In order to investigate how to minimize the costs of reference analysis, additional smaller subsets (15, 30 and 40) of samples were selected for calibration. The performance of field calibrations using spectra of soils at the three states as well as using different numbers of calibration samples was compared. Final models were then used to predict the remaining 75 samples. Maps of predicted soil properties where generated with Empirical Bayesian Kriging. The results demonstrated that regardless the state of the scanned soil, the regression models and the final prediction maps were similar for most of the soil properties. Nevertheless, as expected, models based on spectra from field moist soils showed the lowest predictive ability, resulting also in less detailed maps. The best calibration models for TOC, clay and silt were obtained from air dried soils. Sieving improved the results of sand calibration only. In general, no substantial effect of sampling intensity on the predictive ability of calibration models was found. The only significant differences were recorded for sand calibrations between models based on 50 and 15 moist soil samples and for silt between models based on 50 and 15 sieved soil samples. The results from this study show that one can produce acceptable vis-NIR predictions without the necessity of sieving or even drying the soils and using as few as 15 samples for field calibrations. Nevertheless, the selection of sample preparation and number of samples is dependent on soil properties and should be adjusted to the precision needed.