July 24-26, 2012
Cleveland, Ohio

STRAY GAS

Incidence & Response Forum

Agenda and Abstracts:

Acknowledgements: *Event Sponsors and Contributors*

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Agenda

Tuesday – July 24	
8:00-10:00	*Introductions – **Mike Paque**, GWPC Executive Director and **Stan Belieu**, Nebraska O&G and GWPC President* *Welcome - **Rick Simmers**, OH Oil & Gas Director* *Panel: **Federal Agency Perspectives Regarding Stray Gas and Related Research Initiatives*** With the recent Executive Order that led to the establishment of an EPA, DOE, & DOI memorandum of understanding to coordinate research on natural gas development, we will have a panel of agency representatives to discuss individual agency and coordination of initiatives related to stray gas issues. Abstract 1: *Panelists include:* ***David Russ**, Northeast Region U.S. Geological Survey ;* ***George Guthrie**, National Energy Technology Laboratory; and* ***Kevin Teichman**, US Environmental Protection Agency.* *Charge to Participants - **Scott Kell**, OH Oil & Gas and former GWPC President*
20 min.	BREAK: Provided by… ISOTECH www.isotechlabs.com
10:20-11:20	*Introduction to Stray Gas* - What is stray gas? - Properties and potential hazards of methane *Stray Gas Incident Response Short Course* Abstract 2: *Instructor – **Fred Baldassare**, ECHELON Applied Geosciences Consulting* • Interviews, Reconnaissance surveys and Determination of threat level • Establishing a Timeline and Defining the preliminary area of investigation • Stray Gas forensics & secondary effects • Combustible gas field screening-gas and monitoring protocols • Protocol for active soil gas surveys • Mitigation Strategies
11:20-12:20	*Response Framework & Action Levels for Methane Concentrations* Development of State Regulations to Include Emergency Response Procedures Abstract 3: *Presenter – **Joe Lee**, Pennsylvania DEP Bureau of Oil & Gas Management* *Working Toward Rational, Consistent, Science-based, Risk-assessment Protocols* • Gas in confined inhabited spaces • Gas in confined, non-inhabited spaces • Gas emitted from water well head space • Dissolved gas in groundwater • Soil gas Abstract 4: *Presenter – **Scott Kell**, OH Oil & Gas*
60 min.	LUNCH BREAK (on your own)
1:30-2:00	*Measures to Protect Public Health and Safety* Abstract 5: Best Suggested Practices to Reduce and Mitigate Problematic Concentrations of Stray Gases in Water Well Systems – *Kevin McCray, National Ground Water Association*
2:00-2:30	*Tools for Preliminary Communications with the Public* Abstract 6: Communication of Methane Analysis Results and Mitigation Information to Private Well Owners in Ohio – *Rebecca Fugitt, Residential Water and Sewage Program, Ohio Department of Health*
2:30-4:30	*Pre-Drill Sampling and Variability* Abstract 7: Real-Time Monitoring System for Evaluating Long-Term Variability in Methane in Domestic Water Wells in Northeast Pennsylvania – *Charles Whisman, Groundwater & Environmental Services, Inc.* Abstract 8: Short-Term Intra-well Variations in Methane Concentrations in Groundwater from Domestic Water Wells in Northeastern Pennsylvania – *Nancy Coleman, Environmental Consultants* Abstract 9: The Occurrence of Methane in Shallow Groundwater from Extensive Pre-Drill Sampling – *Elizabeth Perry, AECOM* Abstract 10: Evaluation Water Well Analytical Data Associated with EPA's Hydraulic Fracturing Retrospective Case Study - *Deborah Watkins, and Thomas Cornuet, Weston Solutions, Inc.*

Tuesday – July 24	
20 min.	BREAK: Provided by… 
4:50 5:50	*Characterizing Gas Composition: Stray Gas Forensics* Abstract 11: Lines-of-Evidence Approach to the Evaluation of Stray Gas Incidents - ***Lisa J. Molofsky**, GSI Environmental* Abstract 12: A Geochemical Context for Stray Gas Investigations in the Northern Appalachian Basin: Implications of Analyses of Natural Gases from Quaternary-through-Devonian-Age Strata – ***Fred Baldassare**, ECHELON Applied Geosciences Consulting*

6:00- 7:30

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Wednesday – July 25	
8:00-10:00	*Oil and Gas Well Integrity Evaluations When Oilfield Activities are Considered a Possible Source of Stray Gas* Background - Case History Abstract 13: Summary of Water Quality Impacts from Historical Oil and Gas Well and Industrial Development in Northeast Pennsylvania Counties - ***Damian M. Zampogna**, ALL Consulting* ***Well Integrity Evaluation Short Course*** Abstract 14: *Instructor – **Dan Arthur**, ALL Consulting* Oil and gas drilling operations • Shallow System Gas Intrusion • Subsurface blowouts Completed oil and gas wells • Assessing Annular Pressure and Pressure Trends • Assessing Annular Gas Vent Rates • Cement Evaluation Relevant to Stray Gas • Planning and Evaluating Cement Adequacy • Surface Casing Adequacy and Testing • Intermediate and Production Casing Considerations • Testing and evaluating Internal & External mechanical integrity • Designing for Remedial Action • Products Used in Remedial Stray Gas Operations • Considerations for Effectively Sealing Perforations • Holistic Well Evaluation Process
20 min.	BREAK: Provided by… energy API
10:20-11:00	*Physical and Inorganic Water Quality Changes in Groundwater Associated with Stray Gas* Abstract 15: Water Quality Changes Associated with Stray Gas Incidents - ***Anthony Gorody**, Universal Geoscience Consulting*
11:00-11:30	*Stray Gas Information Management* Abstract 16: RBDMS Environmental: Online Reporting and Tracking of Environmental Data Associated with Oil and Gas Operations – ***Paul Jehn**, Ground Water Protection Council*
60 min.	LUNCH BREAK (on your own)
12:30-2:00	*Subsurface Gas Migration: Defining Migration Pathways Short Course* Abstract 17: *Instructor – **Dr. Scott Bair**, Ohio State University* • Importance of understanding the three-dimensional geologic framework • Factors affecting subsurface gas migration (dissolved gas; free gas) • Identifying migration pathways • Identifying driving mechanisms • Distribution of gas in aquifer systems • Down-hole videography • Evaluating potential contributing factors - Drought - Seasonal water table fluctuation - De-watering - Seismic activity - Barometric pressure changes
2:00-3:00	*Long-Term Monitoring and Mitigation* Abstract 18: The Application & Case Studies of Geophysical, Remote Sensing & Earth Fracture Analysis Techniques to Identify Methane Gas Migration Pathways in the Subsurface - ***Tim Eriksen**, Moody & Associates* Abstract 19: Engineering Design of Methane Mitigation Systems - ***John Sepich**, P.E., Brownfield Subslab* Abstract 20: Collection and Analysis of Gas Samples from Probes and Groundwater - ***Keith C. Hackley**, Isotech Laboratories*
20 min.	BREAK: Provided by… energy API

Wednesday – July 25	
3:20-6:20	*Stray Gas Incidence Case Histories:* Lessons Learned Abstract 21: Tools for Assessing Stray Gas Migration: A Case Study in Pennsylvania - ***Seth Pelepko**, Pennsylvania Department of Environmental Protection's Bureau of Oil & Gas Planning and Program Management* Abstract 22: Origin of Combustible Gases in Water-Supply Wells in North-Central Pennsylvania –Isotopic data from 2005 during a time when there was no Marcellus development or hydraulic fracturing activity – ***Kinga Revesz**, USGS* Abstract 23: Geologic and Baseline Groundwater Evidence for Naturally Occurring, Shallow Source, Thermogenic Methane Gas in Northeastern Pennsylvania - ***Brent Wilson**, Chesapeake* Abstract 24: Mamm Creek Field Colorado: A Case Study in Potential Stray Gas Migration in an Unconventional Resource Development Context - Pete Penoyer, National Park Service Abstract 25: The Parker County, Texas Study- ***Peter Pope**, Railroad Commission of Texas*
Thursday – July 26	
8:00-10:00	*Stray Gas Incidence Related Studies* Abstract 26: Isotope Forensic Techniques for Differentiating Fugitive Gases in Complex Geological Settings – ***Thomas Darrah**, and Avner Vengosh, Division of Earth and Ocean Sciences, Duke University* Abstract 27: Geochemical and Isotopic Evidences for Possible Natural Migration of Marcellus Formation Brine to Shallow Aquifers in Pennsylvania - ***Avner Vengosh**, Division of Earth and Ocean Sciences, Duke University* Abstract 28: Isotopic Forensic Techniques for Methane Source Discrimination – ***Julie Sueker**, ARCADIS* Abstract 29: Field Test of an Alternative Hypothesis for Stray Gas Migration from Shale Gas Development - ***Daniel J. Soeder**, National Energy Technology Laboratory*
20 min.	BREAK
10:20-11:20	*Potential Legal Implications of Stray Gas Migration* Regulations and legal interpretation: Abstract 30: Can You Trespass with Gas? The Law as it Pertains to Alleged Gas Migration Incidents - ***David Overstreet**, K&L Gates* Abstract 31: Where Do the Liabilities Lie? - ***Jean Mosites**, Babst Calland*
11:20-12:00	*Industry Stray Gas Incident Prevention Initiatives* Abstract 32:– Overview of API Responsible Practices and Guidance - ***Glen Benge**, ExxonMobil (retired)*
60 min.	LUNCH BREAK
1:00-3:00	Abstract 33: Baseline Water Quality Sampling in Shale Gas Exploration and Production Areas – ***Debby McElreath**, Chesapeake* Abstract 34: The Shell-NEOS neoPROSPECTOR Project in Tioga County, North-Eastern Pennsylvania: Use of Remote Sensing Technologies to Detect Surface and Near-Surface Stray Gas Occurrence and Potential Migration Pathways - Bryce McKee, Shell E&P *Industry Stray Gas Incident Prevention Initiatives (continued)* Abstract 35: Isolating Potential Flow Zones during Wellbore Construction: API Standard 65-2- ***Glen Benge**, ExxonMobil (retired)*

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Abstracts

Abstract 1:

Federal Panel Bios

Dr. David P. Russ is the Regional Executive for the Northeast in the U.S. Geological Survey. He is located at the USGS National Center headquarters in Reston, Virginia. A geologist by training, he leads 15 USGS science centers in the Mid-Atlantic and New England region. These Centers conduct a broad range of geologic, biologic, and hydrologic investigations and studies.
From 1970-1972, Dr. Russ served in the U.S. Army Corps of Engineers, where he was assigned to the Waterways Experiment Station in Vicksburg, Mississippi. Dr. Russ began his career with the USGS in 1975 conducting research and coordinating USGS earthquake projects in the New Madrid Seismic Zone in the Mississippi Valley. Much of his efforts centered on detecting and characterizing patterns of surface and subsurface deformation associated with the devastating 1811-12 earthquakes and determining recurrence rates and hazards of earthquakes in the Central United States. He has also conducted earthquake research in China and Europe. In 1982, Dr. Russ became the Deputy Chief of the USGS Office of Earthquakes, Volcanoes, and Engineering in Reston, Virginia, where he coordinated Earthquake Programs and managed international earthquake projects. In 1987 Dr. Russ was selected as the Assistant Chief Geologist for Program, a position in the Senior Executive Service, where he was responsible for developing the program goals and budget for the Geologic Division of the USGS. Dr. Russ has also served as the Associate Chief Geologist and the Associate Chief Hydrologist of the USGS.

In his current position as NE Regional Executive, Dr. Russ serves as the executive leader of the USGS Chesapeake Bay program and he leads USGS participation on the Northeast Regional Ocean Council and the Mid-Atlantic Region Council for the Ocean. He is overseeing the development of an interagency plan to study the effects of Marcellus Shale gas production on the environment and he is the national coordinator in the USGS for hydrofracture-related research and studies.

Dr. Russ received B.S. (1967) and PhD (1975) degrees from Penn State and an M.S. degree (1969) from West Virginia University, with specialties in geomorphology and structural geology. He is the recipient of the Department of the Interior Meritorious Service Award. In 2006, Dr. Russ received the Presidential Rank Award as a meritorious executive in the Senior Executive Service for sustained superior accomplishment in management of programs of the U.S. government and for noteworthy achievement of quality and efficiency in the public service.

Dr. George Guthrie is the focus area leader for geological and environmental sciences at DOE's National Energy Technology Laboratory. As such, he leads NETL's intramural research activities across a range of fossil-energy related challenges, including CO_2 storage and unconventional fossil fuels (including environmental aspects related to shale-gas production).

Dr. Guthrie is a mineralogist/geochemist with a research focus in the interactions between minerals and fluids. He received his AB from Harvard University (1984) and PhD from Johns Hopkins University (1989) and was a postdoctoral fellow and subsequently staff member, deputy group leader, program manager, and program director at Los Alamos National Lab. In 2008 he became a federal employee for the Department of Energy when he joined Office of Research and Development at NETL.

Dr. Kevin Teichman is the Senior Science Advisor in the Office of Research and Development (ORD). In addition to providing advice on all aspects of ORD's research programs, Dr. Teichman coordinates ORD's research efforts with other Federal agencies and organizations. Most recently, he has been working to coordinate interagency research devoted to hydraulic fracturing, net zero environment impact buildings, and applications and sensors for air pollutants.

Dr. Teichman previously served as the Director of the Office of Science Policy (OSP) within ORD. In this capacity, he coordinated ORD's research planning and ORD's participation in EPA's policymaking in all media (air, water, waste, pesticides and toxic substances) to ensure these policies reflected sound science. During the enactment of the Clean Air Act Amendments of 1990, Dr. Teichman served as the Associate Director of Science in OSP, and OSP Staff Director of the Air Staff prior to that, with similar responsibilities to those above but focused on air pollution. In addition, he managed EPA's indoor air quality research program, including research devoted to characterizing indoor pollutants sources, assessing indoor exposures, studying associated health effects, assessing potential risks, and developing prevention / mitigation approaches to indoor air pollution.

Dr. Teichman has B.S. and M.S. degrees from the Massachusetts Institute of Technology and a Ph.D. degree from the University of California at Berkeley, all in Mechanical Engineering. He lives in Derwood, Maryland, where he and his wife Marsha are proud "empty nesters."

Abstract 2:

Stray Gas Incident Response

Fred Baldassare, P.G.

Fred Baldassare is a Sr. Geoscientist and owner of Echelon Applied Geoscience Consulting. He has 19 years of experience investigating approximately 200 incidents of stray gas migration. Fred previously worked for the Pennsylvania Department of Environmental Protection where he developed the agency's stray gas investigation protocol and served as the statewide consultant for characterizing source(s) of stray carbon dioxide and methane. Fred has helped to pioneer the application and advancement of isotope geochemistry to characterize microbial and thermogenic gases. He has authored and co-authored peer reviewed manuscripts and guidance documents on the application of isotope geochemistry and stray gas response.

Incidents of alleged stray gas migration often require the evaluation of multiple potential sources in the area of investigation. The source of stray gas may be the result of a natural condition or due to anthropogenic activity. Incidents can manifest as non-threatening or as a potential risk to public health and safety. Incident response must, therefore, be prioritized to include assessment and monitoring protocols that are prioritized to identify and mitigate potential threats to public health and safety. Following this response, a more deliberate investigation is necessary to identify the potential stray gas source(s) and to identify the mechanism of migration.

Stray gas samples analyzed for molecular composition and isotope geochemistry provide evidence to constrain gas origin and narrow the focus on potential sources early on in the investigation; however, similarities in stable carbon and hydrogen isotope compositions between a receptor and potential source are not, exclusively, sufficient evidence to identify the stray gas source. Forensic evidence determined from additional isotope analyses, time series geochemical data, time series monitoring data, and investigation to identify mechanism of migration are necessary to provide further lines of evidence to identify the stray gas source(s).

Abstract 3:

State Regulation and Response to Stray Gas

Joseph J. Lee, Jr., P.G.

Joe Lee is Manager of the Division of Compliance and Data Management, for the Bureau of Oil and Gas Management, in the Department of Environmental Protection for the Commonwealth of Pennsylvania; and, he is a licensed professional geologist. His present area of work is in the development and implementation of compliance programs and data management for the state's oil and gas management program. Prior to his present position, Mr. Lee managed the state's development and implementation of various source water assessment, protection and treatment programs under the Safe Drinking Water Program. Mr. Lee began his career with the Bureau of Mining and Reclamation evaluating the impacts of coal mining and quarries on surface and ground water systems. Mr. Lee has served on the Board of Directors of the Ground Water Protection Council for over 10 years and is presently the immediate Past President.

Pennsylvania was the historic home of economic development of oil and gas resources, and has had nearly a 2 century history of coal mining. Over that time, stray gas incidents related to exacerbated natural conditions and mineral extraction have occurred. Since 2005, Pennsylvania has experienced a rapid resurgence in oil and gas development with the modern development of the state's extensive deposits of shale gas. This development has expanded the areas of the state where deep gas drilling is being done beyond areas of traditional intensive development. The site specific challenges of gas shale development in these new and rediscovered areas and intensive redevelopment in traditional gas drilling areas has led to an increase in stray gas incidents in the state. Conditions ranging from inadequate casing and cementing of gas wells to unidentified abandoned wells have allowed stray gas migration to shallow aquifers and ground surface.

Over its' regulatory history, Pennsylvania has developed a frame work to prevent and respond to stray gas incidents and to protect public health and safety. Events related to the development of shale gas has prompted Pennsylvania to adopt regulatory and policy changes to define more decisive and open actions by the oil and gas operators in identifying and responding to stray gas. The most recent regulatory changes improved operator notifications of complaints and a defined hierarchy of response based upon monitoring data. Pennsylvania continues to assess standards and methods used in gas well drilling in cementing, casing and identification of deepest fresh ground water to improve best practices of the industry in the state to further prevent stray gas events.

Working toward Rational, Consistent, Science-based Risk-assessment Protocols

Scott R. Kell

Bio

Scott Kell is a consulting geologist focused on national energy and groundwater protection policy. Mr. Kell served thirty years as a geologist and administrator with the Ohio Department of Natural Resources, Oil and Gas Division. Prior to retirement from management in 2010, Mr. Kell served ten years on the Board of Directors of the Ground Water Protection Council, including two years as President. Mr. Kell earned a B.S. in Geology from Mount Union College and a M.S. in Geology from Kent State University.

Abstract

The occurrence or migration of stray gas in groundwater can manifest as a non-threatening condition or a serious threat to public safety if not mitigated. Stray gas incidents can escalate into multi-agency emergency response events that may require coordination between industry representatives, local and state emergency responders, state regulatory officials, as well as federal officials. When multiple parties respond to emergencies, it is critical they use consistent terminology and standards with regard to characterization of methane measurements and the associated level of risk. In 2001, the Office of Surface Mining Reclamation and Enforcement released a report prepared by a team of national experts entitled Technical Measures for the Investigation and Mitigation of Fugitive Methane Hazards in Areas of Coal Mining. Based upon a comprehensive assessment of published standards and literature, the Methane Work Group proposed a set of Recommended Action Levels for Methane concentrations in various media. These recommended action levels provide a sound and defensible foundation that should enable multiple agencies to make consistent determinations regarding 1.) recommended actions, 2.) enforcement determinations, or 3.) communications with the public or media. Such consistency is critical to agency credibility and public confidence.

Abstract 5:

Best Suggested Practices to Reduce and Mitigate Problematic Concentrations of Stray Gases in Water Well Systems

Kevin McCray

As a benefit to members of the National Ground Water Association and others, the Association developed, by means of a consensus process, a document to provide water well system professionals (WWSP) with basic knowledge for gases that may be encountered during well drilling/construction and suggested practices to reduce and mitigate elevated stray (or fugitive) gas levels. Because of varying geologic conditions and other factors, it is not practical to develop a totally prescriptive guideline.

Subsurface gases may occur dissolved in groundwater or as a gas in the head space of a water supply. Sometimes the concentrations of select gases will prove to be unacceptably high even after careful site selection and well construction, or after cleaning an existing well. The WWSP can recommend cost-effective options to mitigate such problems. For instance, it may be less expensive for the consumer to install an appropriate watertight vented well cap to lower concentrations of a gas than to replace or deepen an existing well or to use a more expensive drilling technology to emplace a new well. Such decisions are site-specific and, thus, based on careful analysis by the WWSP.

For the purposes of the best suggested practices document it is not essential for the WWSP to understand groundwater chemistry or how stray gases form, although there are extensive studies and related publications that document these processes. However, the WWSP will benefit from knowing the geologic settings, as well as the human-related activities that may contribute to gas presence in water well systems.

- Section 1 offers background on the health and safety issues related to stray gases commonly encountered by water well system professionals.
- Section 2 is guidance about how geologic conditions and land-use settings may affect the concentrations of gases in groundwater.
- Section 3 provides a description of well location and construction methodologies to minimize the buildup of gases.
- Section 4 examines well function and stray gases.
- Section 5 deals with post-drilling operations.
- Section 6 describes groundwater sampling methods and treatment options.

Kevin McCray, CAE, is the executive director of the National Ground Water Association (NGWA). In addition to executive director of NGWA, McCray is the chief executive of the National Ground Water Research and Educational Foundation.

McCray has served on a number of water-related advisory groups, including the U.S. Water Resources Export Council, Water Systems Council, U.S. Department of Commerce mission to Australia and New Zealand, U.S. EPA/AWWA Comprehensive Integrated Resource Cooperative Blue Ribbon Panel, Kellogg Foundation Ground Water Education Consortium, the Great Lakes Commission Ground Water Education Roundtable, The American Ground Water Trust and the Ground Water Remediation Technology Analysis Center Advisory Board.

At the National Ground Water Association he has led initiatives to develop industry standards, best suggested practices, and significant upgrades to the voluntary certification program. He led an award-winning effort to develop computer-based business management tools for water well drilling and pump installation contractors.

Communication of Methane Analysis Results and Mitigation Information to Private Well Owners in Ohio

Rebecca J. Fugitt

Shallow natural gas is present in geologic formations in Ohio that are commonly used as aquifers for drinking water supply in suburban and rural areas. Water wells drilled into geologic formations that also produce natural gas provide a natural migration pathway to enter homes causing conditions that range from a nuisance to a public health hazard. The presence of natural gas has impacted well owners by causing fizzing or bubbling water from the faucet, pump locking and water hammer, or explosive levels of natural gas accumulating in basements or other living areas. Until recently, there were no state standards or guidance for natural gas mitigation for water well owners. An explosive incident at a home and water sampling prior to gas-shale drilling has increased public concern and awareness about natural gas, and specifically methane in aquifers in Ohio. Last year the Ohio Department of Health (ODH) established a dissolved methane standard of 10 mg/l and approved methods of methane mitigation for private water systems. ODH has worked with industry and local health districts to develop methane mitigation guidance to provide information for contractors and local health districts on methane occurrence, the types of detectors used, sampling methods for air and water, reporting levels for results, who can sample and investigate the presence of natural gases, required action levels and required methods for reducing methane and natural gas levels entering the home. ODH is coordinating with the Ohio Water Well Association to schedule water well contractor training in late summer 2012 on approved methods, materials and equipment for removal or reduction of methane levels for well owners. A companion fact sheet for well owners and related public information will be disseminated through local health districts, websites and social media.

Rebecca Fugitt has B.S. and M.S. degrees in Geological Sciences from Ohio University with specialization in hydrogeology, and is a Registered Sanitarian in the state of Ohio. Rebecca is currently Program Manager of the Residential Water and Sewage Program at the Ohio Department of Health which regulates private water systems and sewage treatment systems. For the last 16 years, Rebecca has been working at ODH on program improvements and implementation including legislation and rule revisions, enforcement and training.

Abstract 7:

Real-Time Monitoring System for Evaluating Long-Term Variability in Methane in Domestic Water Wells in Northeast Pennsylvania

Charles B. Whisman, P.E.[1], Debby McElreath[2], Charles Olmsted, P.G., CPG[2], Denise Good, P.E.[1], and Richard Wardrop, P.G.[1]

Charles Whisman is GES' Chief Technical Officer and has over 17 years of industry experience. He leads GES' business strategy, engineering, and technology initiatives. He holds a BS in civil engineering and a certificate in environmental engineering from the University of Pittsburgh.

Debby McElreath is a Senior Corporate Environmental Specialist at Chesapeake Energy Corporation.

Charles Olmsted is the Supervisor of Regulatory Compliance at Chesapeake Energy Corporation.

Denise Good is a Principal Engineer at GES with 14 years of experience in groundwater remediation system design and management.

Richard Wardrop is a Principal Hydrogeologist with over 25 years of experience in subsurface fate and transport of contaminants and in groundwater resource evaluations.

Naturally-occurring methane is present in many domestic water wells in northeast Pennsylvania. A significant amount of data is currently being collected by the oil and gas industry as a result of sampling efforts and investigations, much of which is from pre-drilling ("baseline") sampling conducted prior to any drilling activity. However, gaps remain in understanding and quantifying the natural temporal variation in methane concentrations in these wells. This is of significant importance in assessing claims of gas migration when there is nearby anthropogenic activity. This presentation will discuss a research project developed and implemented to gain an understanding of the long-term variability of methane in domestic water wells.

Real-time remote monitoring and data trend analyses are being utilized to understand natural dissolved methane fluctuations in groundwater and correlations between methane headspace concentration in the well annulus and other physical and chemical parameters which could correlate to changes in headspace concentration. Significant efforts were made to select, evaluate, and prepare the wells for the study including borehole geophysics, well equipment upgrades, and installation of water-treatment systems. Descriptions of the customized real-time remote monitoring equipment, array of well headspace and water-quality sensors utilized, and equipment setup will be presented, as well as the associated challenges and logistics. Barometric pressure, water use, water quality, well recharge, water-level fluctuations, and pump cycling are examples of the variables monitored.

Interim results from the on-going study will be presented, including discussion of well construction, geologic settings, water quality, initial trends and findings, and real-time display of data. The usefulness of the data and the accuracy/precision of sensors will be discussed. The long-term study will provide further information to better understand the occurrence and potential causes of methane fluctuations in groundwater and associated water well quality issues in northeast Pennsylvania.

[1]Groundwater & Environmental Services, Inc.
[2]Chesapeake Energy Corporation

Short-Term Intra-well Variations in Methane Concentrations in Groundwater from Domestic Water Wells in Northeastern Pennsylvania

Nancy Pees Coleman and Debby McElreath

Nancy Pees Coleman is an environmental toxicologist and owner of Environmental Consultants in Oklahoma City, Oklahoma. She has over 30 years experience in evaluation of environmental data and risk assessment. Prior to entering consulting, she was toxicologist/epidemiologist for the Oklahoma Department of Environmental Quality. She has a B.S. degree from Old Dominion University and M.P.H. and Ph.D. degrees from the University of Oklahoma Health Sciences Center (r-n-coleman@sbcglobal.net).

Debby McElreath is a Senior Environmental Specialist in the Environmental Compliance Group for Chesapeake Energy Corporation, Oklahoma City, OK. She was the quality assurance manager for a full-service environmental consulting firm prior to joining the staff of Chesapeake. She has B.S. and M.S. degrees from Oklahoma State University (Debby.McElreath@chk.com).

Domestic water wells in Northeastern Pennsylvania have been found to contain varying concentration of dissolved light gases, such as methane. Baseline sampling by a major natural gas production company in this region has shown that over 24% of samples contain detectible concentrations of dissolved methane. Short-term variation in dissolved methane concentrations within domestic water wells is not well understood. Daily monitoring of seven domestic water wells located near a natural gas wellhead was conducted for a period of 24 days following a well control event. An additional 23 water wells located near the same wellhead were sampled on a weekly basis for two to six weeks. Additional weekly data is available from eleven domestic wells located within the same county. Analytical data from these sampling events were statistically compared and evaluated for short-term temporal intra-well variability.

A comprehensive review of the analytical data indicates that there can be significant differences is water quality in northeastern Pennsylvania domestic water wells that are a result of natural temporal changes in water quality, or changes due to differences in sampling methodologies between sampling events and domestic water use. Proper recognition of these differences is important in evaluating this type of groundwater data in order to accurately determine if groundwater impact has actually occurred. Review of these data show the importance of obtaining representative samples of area water wells during baseline sampling and understanding the nature of potential natural temporal variability in water well groundwater quality when evaluating the results of subsequent samples from the same well. Data from this study can be used to better design baseline sampling programs and used to better understand the natural temporal differences in water quality that occurs in domestic water wells in northeastern Pennsylvania.

Abstract 9:

The Occurrence of Methane in Shallow Groundwater from Extensive Pre-Drill Sampling

A. Elizabeth Perry, PG
Rikka Bothun
Bert Smith, PG
Mark Hollingsworth

Authors' Bios: Ms. Perry is a hydrogeologist at AECOM with over 26 years experience. She is a registered professional geologist in Pennsylvania and Indiana and holds a MS in Engineering Geology from Drexel University and a BA in Mathematics/Geology from Hamilton College. Ms. Bothun is a senior data analysis specialist and geologist with AECOM with over 13 years experience. She holds a BS in Geology from Colorado State University and is a MEng Civil Engineering/GIS candidate at the University of Colorado at Denver. Mr. Smith is a Senior Hydrogeologist with Chesapeake Energy. Mr. Hollingsworth is an Environmental Manager at Chesapeake Energy with over 15 years of environmental experience. He holds a BS in Chemistry from David Lipscomb University in Nashville, TN.

Abstract: On behalf of a major shale-gas operator, sampling of over 14,000 water wells has been conducted from 2009 to the present, from shale-gas development areas across Pennsylvania, Ohio, and West Virginia. Sampling was conducted prior to Marcellus/Utica Shale-related exploration, drilling, and production activities in the vicinity of these water wells. The pre-drill samples have been analyzed for methane, ethane, and propane as well as many inorganic parameters.

This presentation will explore the occurrence and distribution of methane in groundwater prior to unconventional gas development. GIS-based mapping and statistics will be used to evaluate the geographic distribution and relationship to bedrock geology. The relationships between methane and other parameters can also help explain methane occurrence, including parameters such as ethane and propane, alkalinity, TDS and major ions, barium, etc.

Better understanding of methane in shallow groundwater will lead to better decision-making when evaluating potential impacts of shale-gas development on water supplies and stray gas occurrence.

Abstract 10:

Evaluation Water Well Analytical Data Associated with EPA's Hydraulic Fracturing Retrospective Case Study Bradford County, Pennsylvania

Deborah M. Watkins, P.E. and Thomas S. Cornuet, P.G.; Weston Solutions, Inc.

Ms. Deborah M. Watkins, P.E. earned a B.S. in Chemical Engineering from Bucknell University and a M.S. in Environmental Engineering and Water Resources from Villanova University. She holds professional engineering licenses in the Commonwealths of Pennsylvania and Virginia, and in the States of New Jersey, Maryland, and Delaware.
Mr. Thomas S. Cornuet, P.G. earned a B.S. degree in Geology from Indiana University of Pennsylvania and a M.S. in Engineering Geology from Drexel University. He holds a professional geology license in the Commonwealth of Pennsylvania.

The Environmental Protection Agency (EPA) is conducting a retrospective study to evaluate the relationship, if any, between hydraulic fracturing and drinking water resources as described in EPA's "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources" dated November, 2011 (EPA Study). An evaluation of analytical data (split samples), collected by Chesapeake Energy contractors and analyzed by commercial laboratories from 14 water wells and 1 spring (EPA Study Wells) that were included in EPA's October and November 2011 Bradford County, Pennsylvania sampling events, was conducted. The drinking water resources were located within the vicinity of Chesapeake Energy's operating area. The EPA Study Well split-sampling water-quality data provided by Chesapeake Energy were assessed to meet the following objectives:

- To determine whether any of the water-quality parameters had experienced significant changes following Chesapeake Energy baseline sampling;
- To compare the EPA Study Wells water quality with historic water-quality data (USGS NURE and NWIS databases) obtained prior to the commencement of Marcellus Shale activities in Bradford County, PA (pre-2007);
- To identify any EPA Study Well exceedances of various screening criteria derived from EPA MCLs and SMCLs, PADEP Act 2 Medium-Specific Concentrations (MSCs), and EPA Regional Screening Levels (RSLs) and contrast any EPA Study Well exceedances with historic water quality exceedances; and
- To provide general observations regarding the EPA Study Well water-quality data contrasted with historic water quality in Bradford County, and Chesapeake Energy's baseline data for nearby water wells.

Based upon review of the water-quality data for each of the 14 water wells and one spring and subsequent comparison of these results with regional historical and baseline water-quality databases, it was concluded that these fifteen water sources do not appear to be impacted by natural gas drilling or production activities, including hydraulic fracturing.

Abstract 11:

Lines-of-Evidence Approach to the Evaluation of Stray Gas Incidents

Lisa J. Molofsky (lmolofsky@gsi-net.com), John A. Connor, Ann P. Smith, Thomas E. McHugh
(GSI Environmental, Houston, Texas, USA)

Significant recent media attention has been focused on the use of stable isotope analyses and other geochemical methods to determine the origin of methane in stray gas impacts on groundwater wells in regions of active shale-gas extraction. When studying stray gas incidents, the ability to differentiate between multiple potential sources of thermogenic gas (e.g., shallow vs. deep reservoir gas, pipeline vs. storage gas) is important in order to correctly identify the origin of migrating gases and the associated transport mechanism. However, the variable application and interpretation of these well-known industry tools to investigate the sources of methane in groundwater underscores the need for a systematic approach to geochemical fingerprinting and the collection of historical and geological background information in the consideration of stray gas incidents.

Our evaluation of prior investigations of stray gas incidents, including recent highly-publicized investigations in the Marcellus and Barnett shales, indicates the need to properly consider the geochemical signatures of both shallow and deep sources of thermogenic gas, as well as available historical and geologic lines of evidence, to confidently identify the origin of methane in shallow groundwater. Site-specific evidence should include the underlying geologic stratigraphy and existing fracture systems, construction and completion details for gas wells and water wells, and historic information regarding prior stray gas incidents and evidence of naturally-occurring gas seeps. This conceptual model along with recognition of minor yet discernible differences in thermogenic source gases is crucial for evaluating potential methane migration pathways and the identification of appropriate response actions for the protection of water resources.

A Geochemical Context for Stray Gas Investigations in the Northern Appalachian Basin: Implications of Analyses of Natural Gases from Quaternary-through-Devonian-Age Strata

Fred J. Baldassare[1], Mark A. McCaffrey, PhD[2], John A. Harper, PhD[3]

Fred J. Baldassare is a Sr. Geoscientist and the owner of Echelon Applied Geochemistry Consulting. He has 19 years of experience investigating incidents of stray gas migration. Fred previously worked for the Pennsylvania Department of Environmental Protection where he developed the agency's stray gas investigation protocol and served as the statewide consultant for characterizing source(s) of stray gases. Fred has helped to pioneer the application and advancement of isotope geochemistry to identify the origin of natural gases in the Appalachian Basin. He has authored and co-authored numerous technical papers for peer reviewed journals on the application of isotope geochemistry.

Mark A. McCaffrey is a Senior Technical Advisor at Weatherford Laboratories. He has 22 years of petroleum geochemistry experience, including 11 as founder and President of OilTracers LLC, a firm which Weatherford acquired in 2010. Mark has a BA in Geology (1985) from Harvard University and a Ph.D. (1990) in Chemical Oceanography from the Massachusetts Institute of Technology / Woods Hole Oceanographic Institution Join Program. As an Expert Witness in gas fingerprinting, he has testified (i) in Mississippi State Court, (ii) in Ohio Federal Court, (iii) before the Oklahoma Corporation Commission, and (iv) before the Railroad Commission of Texas.

John A. Harper received an M.S. degree in geology from the University of Florida 1n 1972 and a Ph.D. in paleontology from the University of Pittsburgh in 1977. He joined the Pennsylvania Geologic Survey in the Pittsburgh office in 1977 where he has been involved primarily in data collection and dissemination, and studies of the subsurface geology and reservoir characteristics of Pennsylvania's oil and gas fields. He currently serves as Chief of the Geologic Resources Division, overseeing programs responsible for research, data collection, and evaluation of petroleum geology and engineering, industrial minerals, coal, and both organic and inorganic geochemistry.

ABSTRACT

As the pace of drilling activity to the Marcellus Formation in the northern Appalachian Basin has increased, so has the number of alleged incidents of stray natural gas migration to shallow aquifer systems.

Prior to the present study, the occurrence and origin of natural gas in the strata above the Marcellus Formation has not been well defined. More than 1,900 gas and water samples were analyzed in the present study for (1) molecular composition, (2) stable carbon and hydrogen isotope compositions of methane and (3) stable carbon isotope composition of ethane. The samples are from Quaternary to Middle Devonian-age strata in a five-county study area in northeastern Pennsylvania. Gas and water samples were collected from (1) 181 gas wells during Mudgas Logging (MGL) programs for wells being drilled to the Marcellus Shale Formation, and (2) 67 private water supply wells during baseline groundwater water-quality testing programs. Regional and local geologic conditions were evaluated from core analyses and published studies.

Evaluation of this geochemical database reveals that microbial, mixed microbial/thermogenic, and thermogenic gases occur in some shallow aquifer systems, and that the gas occurrences pre-date Marcellus Formation drilling activity. The isotope data reveal that thermogenic gases in the Quaternary and Upper Devonian strata are typically distinct from gases from deeper Middle Devonian strata (including the Marcellus Fm).

Significantly, however, a more detailed review of the geochemistry at the site-specific level also reveals a complex thermal and migration history with gas mixtures indicated by partial isotope reversals ($\delta^{13}C_1 > \delta^{13}C_2$) in deeper formations and throughout the stratigraphic section above the Marcellus Formation in some areas of the basin.

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Abstract 13:

Summary of Water Quality Impacts from Historical Oil and Gas Well and Industrial Development in Northeast Pennsylvania Counties

Damian M. Zampogna, P.G. (ALL Consulting), Dave Cornue, P.G. (ALL Consulting), and Brian Bohm, P.G. (ALL Consulting), J. Daniel Arthur, P.E. (ALL Consulting).

Bio: Mr. Zampogna is a registered Professional Geologist in the State of Pennsylvania, specializing in hydrogeology, water resources management, and environmental issues. He earned a Bachelor's Degree from the University of Pittsburgh in Planetary and Environmental Geology. He has over 15 years experience working in state and federal government, private industry, and a federal interstate compact regulatory commission. Mr. Zampogna is a Senior Water Resources Specialist with ALL Consulting and has supported projects throughout Appalachia, the Gulf Coast and through the Rockies.

Abstract: Tioga, Bradford, and Wyoming Counties in Pennsylvania are experiencing exceptional rates of oil and gas development related to the Marcellus Shale play. For these counties, this is not the first round of oil and gas development activity. Between the time periods of 1890 to 1910 and 1925 to 1935, these counties experienced a boom in oil and gas development concurrent with increased activities in mineral extraction and mining, commercialization of mineral springs, logging, and agriculture. Estimates from the Pennsylvania Department of Environmental Protection's Bureau of Oil and Gas indicate many thousands of wells may have been drilled throughout Pennsylvania during these early boom periods, with little to no documentation of well construction or well locations. In times of war, some of these wells may have even been targets of metal recycling efforts that may have resulted in casing removal with little or no isolation of producing zones from groundwater aquifers. Ever since Northeastern Pennsylvania has experienced environmental and water quality impacts that may have resulted from this early development and the manner in which these old wells were plugged and abandoned. Evidence water quality issues that were documented in newspaper articles, and reports from agencies like the Pennsylvania Topographic and Geologic Survey, the U.S. Geological Survey, and Susquehanna River Basin Commission from the 1930's through the 1980's are identified and discussed. Incidents documented by these entities include reports of poor smelling or foul tasting water, bubbling and turbid groundwater, methane migration impacts to surface water and groundwater, occurrences of exploding water wells, and hydrogen sulfide in groundwater.

Oil and Gas Well Integrity Evaluations Related to Stray Gas

J. Daniel Arthur, P.E. (ALL Consulting), Dave Cornue, P.G. (ALL Consulting), Brian Bohm, P.G. (ALL Consulting), Jeff Kennedy (ALL Consulting), and Preston Wilson (ALL Consulting)

Lead Author Bio: Mr. Arthur is a Registered Professional Petroleum Engineer and SPEC. He is the president of ALL Consulting and has been involved in well integrity issues since the mid-1980s. He is a former member of the EPA's National Mechanical Integrity Test Workgroup, he has written various documents and papers on the subject of well integrity analysis methods, he has conducted MIT training with GWPC, and is currently engaged in numerous well integrity evaluations. Mr. Arthur and his team at ALL Consulting have designed and conducted more than 500 noise and temperature logs, many hundreds of internal pressure tests, along with radioactive tracer surveys, various cement evaluation logs, and designed and implemented well remediation on wells to address methane intrusion.

Abstract: The presentation will cover a range of issues including shallow system gas intrusion, assessing annular pressure and pressure trends, analyzing annular gas vent rates (including measurements methods), review and analysis of cement evaluation logs, internal and external well integrity testing methods with a focus on noise, temperature, and cement logging, applicability of well histories, remedial methods and challenges, and the use of a holistic well evaluation process.

Abstract 15:

Water Quality Changes Associated with Stray Gas Incidents

Anthony W. Gorody, Ph. D., P. G.

BIO

Dr. Anthony W. Gorody is a geoscientist with more than 30 years of diverse international and domestic oil and gas industry experience. His technical specialty relates to state-of-the-art forensic geochemical fingerprinting and hydrogeologic characterization techniques. These are applied to evaluate natural gas resources, groundwater and surface water resources, produced water, and pollution in the near-surface hydrogeologic environment. An industry leader in baseline environmental measurement and monitoring programs, Dr. Gorody provides both consulting and training services. He is licensed to practice geology in Pennsylvania, Texas, and Wyoming.

ABSTRACT

Invasion of stray gas into shallow groundwater aquifers can affect water quality in domestic water wells. The degree to which such impacts will be observed depends on well bore construction and pump design parameters, the vertical distribution and relative confinement of aquifers tapped by a water well, and the dominant transport mode of stray gas in the dissolved and/or free gas phase. Interpreting how environmental variables interact to change baseline conditions at a water well is conditional on having good quality baseline groundwater data from wells in and around the impacted area and on data from multiple samples collected after a complaint is registered.

Commonly observed water quality changes associated with free gas invasion are increased turbidity, changing fluid color, and the sudden onset of hydrogen sulfide odors and associated elevated dissolved sulfide concentrations. Such changes can also be accompanied by significant increases in dissolved iron and manganese concentrations and the detection of other redox sensitive elements such as arsenic and selenium. These effects result from changing oxidation-reduction conditions in a well that are associated with stray gases and not necessarily to invasion of drilling and completion fluids. The most reliable water quality data useful for addressing impacts from oil and gas operation and the subsequent effects of natural attenuation are those that provide indices which adequately reflect the following: hydrochemical facies (charge-balanced major ion analyses), baseline redox conditions (calibrated field parameters, selected nutrients, dissolved iron and manganese and RCRA metals), salt origins (bromide), and bacterially-mediated reactions (BART^{TM}).

RBDMS Environmental: Online Reporting and Tracking of Environmental Data Associated with Oil and Gas Operations

Paul Jehn, Marc Fine, Tom Gillespie and Deb Gillespie

Abstract: The potential for environmental impacts from oil and gas operations has been documented in many news articles and scientific papers. Many of these studies rely on sampling for analytes after environmental contamination has been discovered and subsequently trying to trace chemicals back to the source. The importance of scientifically accurate data interpretation in general is manifest alone by the ubiquitous nature of chemical usage today. The need is further underscored in particular by the often emotional blame-gaming that is playing out in the press and in courtrooms over questions of tragic environmental impact.

Because accurate reporting of temporal, quantitative, and qualitative environmental data is the vital first step in forestalling the potential for misinterpretation of causality, the Ground Water Protection Council, the Colorado Oil and Gas Conservation Commission (COGCC), and Virtual Engineering Solutions have developed Web-based software for tracking and evaluating environmental data from both pre- and post-oil and gas operations. Called RBDMS Environmental because of its capability to store field and analytical results collected from all environmental matrices, the software tracks field observations and analytical data that certified laboratories can submit in several formats directly to the regulatory agency via a Web portal. User- defined automated notifications are incorporated into the system to notify the agency's environmental scientists of a variety of alert conditions, such as violation of maximum contaminant levels (MCLs), increases in trending of specified analytes, and other anomalous data ranges and conditions. RBDMS Environmental can combine data and GIS interfaces and includes statistical and trend reporting for long-term monitoring and analysis.

RBDMS Environmental is now becoming an integral part of the data management strategy in Colorado. As part of a project that will demonstrate the efficacy of this software, the COGCC will conduct sampling at two down-gradient groundwater features within a ½-mile radius of the surface location of a proposed oil and gas well pad. Post-drilling sampling will be conducted within a 1- to 3-year period. The COGCC will then make this groundwater sampling data available to the public and industry operators through the RBDMS Environmental database link on their Web site. The data will be posted within two weeks of the COGCC's receipt of the electronic data deliverables.
The public-facing Web site is under development and is scheduled to come online in the late summer of 2012. This Web site will incorporate a GIS interface and allow users to search and download data associated with oil and gas operations.

Abstract 17:

Geologic and Hydrogeologic Factors Controlling How Stray Gas from the English #1 Well Invaded Residential Homes, Geauga County, Ohio, Causing One In-Home Explosion

E. Scott Bair[1] and Tom Tomastik[2]

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Early in the morning on December 17, 2007, stray gas from construction of the English #1 gas well in Bainbridge Township, Ohio, causing an explosion in the basement of a residential house and a nearby water well to spout 15 feet above the land surface. Beginning that afternoon and continuing for two years, the Ohio Department of Natural Resources (DNR) routinely measured methane concentrations (i.e., lower explosive limits) in basements of homes and in the headspace of residential wells. In an effort to settle a subsequent lawsuit, Ohio DNR, which was not a party in the lawsuit, set-up a panel of experts to review existing data and to identify additional types of data it needed to determine how the stray gas migrated to the other properties. The expert panel consisted of professors from three different universities in Ohio: a petroleum engineer, an aqueous geochemist, and a hydrogeologist.

Acquisition of site-specific geologic data enabled the panel to construct a structure-contour map of the top of the Berea Sandstone, the major aquifer tapped by local water wells, and the base of the overlying Cuyahoga Shale, a fractured caprock. These maps indicated that stray gas from the English #1 well would migrate northward, up the structure-contour surface, into a closed, dome-like structure in the Berea Sandstone that contained a spillover point along its eastern edge. The methane measurements made in residential wells confirmed this migration pattern. Borehole videos taken in several residential wells directly after the home explosion were repeated in 2009. Comparison of videos made in the same wells showed the bottom of the (stray) gas cap was migrating vertically out of the Berea Sandstone, up into the Cuyahoga Shale. Information from the borehole videos was combined with geologic information from well logs to construct two cross sections of the impacted area showing mapped bedding plane openings, vertical joints, formation tops and bottoms, zones of gas emission, and changes in the depth of the (stray) gas cap. The deliberate overpumping of 16 residential wells for up to 7 months caused the stray gas in the Berea Sandstone to migrate to specific locations while protecting other locations. By combining the geologic, hydrogeologic, and methane gas measurements made in residential wells, it was possible to construct a series of maps and an animation showing how the stray gas migrated away from the English #1 well, through time, and into specific sub-areas of the site.

The Application & Case Studies of Geophysical, Remote Sensing & Earth Fracture Analysis Techniques to Identify Methane Gas Migration Pathways in the Subsurface

Timothy M. Eriksen, P.G.

Timothy M. Eriksen, P.G. is a Senior Geologist for Moody and Associates, Inc. and regional manager of the Waverly, NY office location for Moody. Tim directs a staff of nearly 30 people and has provided the oversight and direction of several large scale predrill sampling projects, stray gas migration investigations, groundwater source development projects, groundwater monitoring projects and other support services for the natural gas industry. Tim has received a B.S. in geology from Edinboro University and an M.A. in geology from Binghamton University. Tim is licensed to practice geology in the Commonwealth of Pennsylvania.

Perhaps the most challenging component of a stray gas incident response is the definitive identification of the migration pathway for gas in the subsurface during the incident. Identifying the migration pathway is essential in the identification of the source of the gas. Depending on local geology and site and situation specifics, a number of techniques can be used to identify potential migration pathways. Fracture trace analyses, gas well integrity logs, downwell videography, soil gas surveys and geophysical techniques such as VLF surveys and temperature logs of water wells have been used with varying degrees of success with regard to indentifying migration pathways.

Abstract 19:

Engineering Design of Methane Mitigation Systems

John Sepich, P.E.

Bio: John Sepich is a professional engineer with nearly 40 years of experience in design and installation of methane control systems. His experience began in the early 1970's with landfill gas control systems, and he became involved in gas control above oilfields in the 1980's in California. Mr. Sepich holds several U.S. patents related to gas control, and has helped numerous agencies write methane codes. He is president of a consulting firm, Brownfield Subslab, specializing in soil gas control. And is currently chair of an ASTM E-50 committee to develop a methane soil gas standard.

Abstract: The art of methane gas mitigation became a necessity in the post World War II decades, when burning dumps were outlawed and landfill gas became a problem. At about the same time, extensive urban sprawl in areas such as Los Angeles occurred extensively over old oilfields. Today, continued oilfield development including fracking is a concern. The art of mitigation is becoming a science. The paper will discuss:

Briefly:
-- at-risk areas, by testing or by chance observation
-- site evaluation methodology using probes, surface sweeps, building sweeps
-- determining methane hazard – using concentrations, volumes, pressures, and

In Detail:
-- design options: active (fans, detectors), passive (barriers, venting)
-- oil wells, vent hoods, setbacks vs. modern platforms
-- intrinsically safe construction, including raised floors and podium structures
-- new construction, engineering drawings and details
-- selection of venting methods, trenches, flat pipes, geodomes, design guidelines
-- selection of membrane materials / membrane placement
  - pvc, cpe, ldpe, visquene, hdpe, spray-on (cma), composite
  - mat and post-tensioned slabs
-- gas detectors, types, use with ventilation
-- electrical classifications, electrical conduits and service
-- pathway plugging, trench dams
-- use of subslab monitoring probes
-- elevator pits and pistons
-- hydrostatic design
-- construction methods -- what can go wrong, seams, cuts, tiebacks, bathtub design, waterproofing, foundation wraps
-- construction inspections, testing, certifications
-- monitoring and reporting
-- future modifications to systems (tenant improvements)
-- existing construction retrofit, venting, barriers, detectors

Methane Politics:
Pro-active mitigation vs. Agency mandates/action levels
ASTM proposed standard

Collection and Analysis of Gas Samples from Probes and Groundwater

Keith C. Hackley, Todd M. Coleman, Steven R. Pelphrey

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Naturally occurring methane in the shallow environment and freshwater aquifers is fairly common in much of the Midwest and northeastern US and Canada. Distinguishing naturally occurring gas from anthropogenic sources requires reliable collection of gas samples for accurate analyses and characterization of the gas. With the increase in terrestrial oil and gas exploration in many states accurate methods of monitoring dissolved gas concentrations in domestic groundwater wells is crucial. Merely identifying the presence of a hydrocarbon gas is not always adequate. Often it is important to monitor for changes in the gas concentration, and to be able to collect sufficient gas for more detailed characterization, such as isotopic analyses. Having good analytical data on which to base decisions requires reliable sampling techniques. Even after collection, some containers can leak or microbial alteration may occur and cause erroneous results in concentrations and/or isotopic compositions of the constituents measured.

It is important to minimize atmospheric contamination while sampling gas from probes or groundwater in order to accurately characterize the samples. For dissolved gas analysis there are at least three typical methods used. The common “headspace equilibration” method is sufficient only for gas concentrations below the saturation level. This method involves filling an appropriate bottle completely with water (no air) and creating a headspace in the laboratory with helium which, after equilibration, is sampled and analyzed. When dissolved gases exceed saturation at atmospheric pressure there are typically two different gas collection methods used: the “water displacement” method and a “two phase” method. Water displacement is simple but rather imprecise. The “two phase” method is more precise because both the water and gas phase that forms are simultaneously collected. These techniques will be discussed including a new sampling container for the two-phase method along with information of how the analytical data can be used.

Abstract 21:

Tools for Assessing Stray Gas Migration: A Case Study in Pennsylvania

Seth Pelepko and Stewart Beattie

Mr. Pelepko works as a geologist for the Pennsylvania Department of Environmental Protection's Bureau of Oil & Gas Planning and Program Management. His areas of interest include stray gas migration case work and gas well integrity. Prior to accepting his most recent position, he was employed as a petrographer by the Pennsylvania Department of Transportation. He has also worked as a consulting hydrogeologist. He received a B.S. in Earth Sciences in 1998 from the Pennsylvania State University and is currently pursuing his M.S. in Geological Sciences at the University of Delaware. He earned his Professional Geologist's license in 2004.

Mr. Beattie is the GIS/Information Specialist for the Pennsylvania Department of Environmental Protection's Bureau of Oil & Gas Planning and Program Management. He has worked for the Department for almost a year and recently finished his M.S. in Geo-Environmental Studies at Shippensburg University. He also holds a B.S. in Secondary Education with a concentration in Historical Geography from Millersville University. Prior to accepting his current position, he was employed by various agencies and organizations including the Pennsylvania Department of Transportation, the National Museum of Bermuda and the Army Heritage Education Foundation where he helped implement GIS and mapping related projects.

A case study in Pennsylvania is presented in order to acquaint state regulators with tools that are readily accessible and may be useful in certain stray gas investigations. The tools may also be valuable for oil and gas operators and consultants unaccustomed to conducting such investigations. Multivariate statistical analyses, including multiple regression and R-mode factor analysis, are discussed in the context of defining background methane concentrations when no pre-drill data are available and correlating gas-well workover activities to water-well response data, respectively. Simple geochemical modeling is introduced to explore the utility of testing for geochemical indicator parameters that may potentially serve as metrics for assessing the return of an impacted aquifer to baseline conditions. The process of transitioning from a simple, one-dimensional time-series analysis of methane in water supplies to a 3D geologic conceptual model that considers stray gas migration pathways is also discussed. Finally, a brief tutorial showing applications within ESRI's ArcGIS environment utilized to complete the investigation is reviewed.

Abstract 22:

Origin of Combustible Gases in Water-Supply Wells in North-Central Pennsylvania –Isotopic data from 2005 during a time when there was no Marcellus development or hydraulic fracturing activity

Kinga M. Révész,[1] Kevin J. Breen,[1] Alfred J. Baldassare,[2] and Robert C. Burruss[1]
1. U.S. Geological Survey, krevesz@usgs.gov 2. E C H E L O N Applied Geosciences Consulting

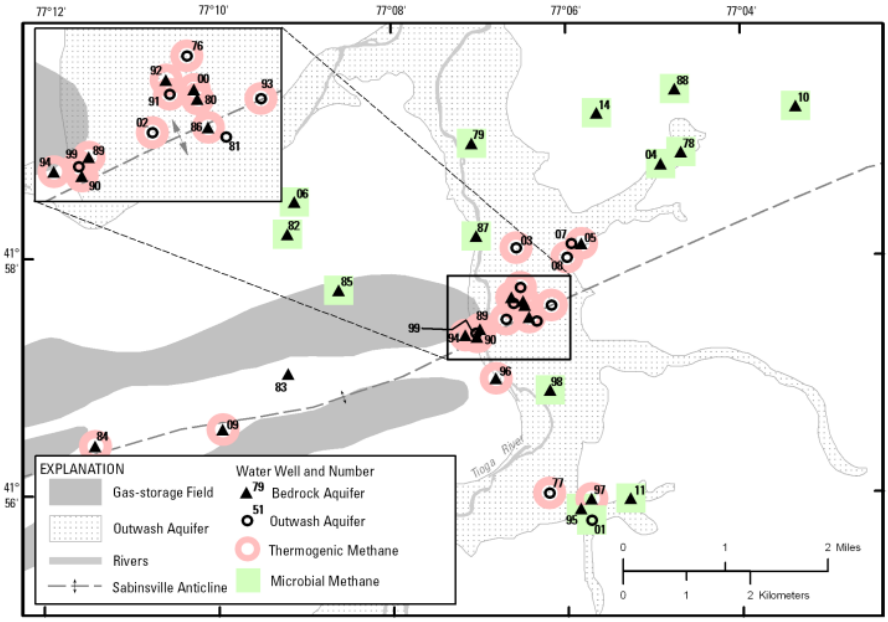
BIO: Kinga Revesz earned her PhD in colloid chemistry and Diploma of Chemistry in Hungary. Kinga's research is concerned broadly with the use of stable isotopes, primarily hydrogen, carbon and oxygen, to examine the dynamics of hydrological systems and associated geochemical problems. She performs studies in the identification and quantification of ground-water recharge, discharge, surface-water/ground-water interaction, redox processes in contaminated aquifers, as well as source identification of stray methane gas in drinking water wells. Kinga develops new sample- preparation techniques in the laboratory including inlet systems for continuous- flow isotope- ratio analytical techniques , such as EA, TC/EA, GPI, Gasbench, GCC, TC/GCC, and TIC/TOC and publishes Standard Operating Procedures in the U.S. Geological Survey Techniques and Methods.

The origin of natural gas in water-supply wells at Tioga Junction, Tioga County, Pennsylvania was investigated using compositional and isotopic characteristics of methane and ethane in gas and water wells. The wells are situated in two aquifer systems in and adjacent to the Tioga River valley. An unconsolidated aquifer of outwash sand and gravel of Quaternary age underlies the main river valley and extends into the valleys of tributaries. Outwash-aquifer wells are seldom deeper than 30 m. The river-valley sediments and uplands adjacent to the valley are underlain by a fractured-bedrock aquifer in sandstones and shales of Devonian age, primarily the Lock Haven Formation. Most bedrock-aquifer wells produce water from the Lock Haven Formation at depths of 76 m or less.

There are four plausible origins for natural gas in the water wells at Tioga Junction: (1) deep native gas in the Oriskany Sandstone (thermogenic), (2) shallow native gas in Devonian shale bedrock (thermogenic), (3) microbial gas from organic debris (drift gas) in unconsolidated sediments and (4) non-native gas from a gas-storage field (thermogenic). Gases from the Oriskany Sandstone and the gas-storage field were similar in chemical composition, with methane (CH_4) and ethane (C_2H_6) being predominant; stable isotope composition however was sufficiently different to distinguish between all these sources with a good degree of certainty.

The $\delta^{13}C$ values of methane in groundwater were measurable in 35 out of 91 sampled waters. The isotopic composition of methane in water samples from 14 wells reflected a microbial origin, while the composition of the other 21 wells was representative of a thermogenic origin.

The $\delta^{13}C$ values of methane and ethane in thermogenic gases from water wells either matched or were intermediate between the values measured from the samples of non-native storage-field gas from injection wells and the samples of gas from storage-field observation wells.



Abstract 23:

Geologic and Baseline Groundwater Evidence for Naturally Occurring, Shallow Source, Thermogenic Methane Gas in Northeastern Pennsylvania

Brent Wilson[1]

[1]Chesapeake Energy; Oklahoma City, Oklahoma, brent.wilson@chk.com

AUTHOR BIO

Recently promoted to manage Chesapeake's Hydrogeology department, which is focused on aquifer characterization and groundwater protection. Spent the last year researching Upper Devonian fractured bedrock aquifers and thin-bedded coal seems found throughout the Catskill and Lock Haven formations in northeastern Pennsylvania. Previous experience includes exploration geology (Chesapeake), environmental geology (consulting firm) and hydrogeology (Oklahoma Water Resources Board).

ABSTRACT

The study documents the presence and the sources of naturally occurring thermogenic methane that predates natural gas drilling activity in Bradford, Sullivan, Susquehanna, Tioga and Wyoming counties of northeastern Pennsylvania. Pre-drill baseline groundwater and surface water samples collected from nearly 17,000 locations in the study area, with more than 13,400 representing water wells. Methane was detected in 26.4% (1 in 4) of the water wells tested, 6.4% (1 in 15) exhibited methane concentrations greater than 3 mg/L, 2.6% (1 in 40) above 10 mg/L, and 0.5% (1 in 200) above 28 mg/L – the average saturation limit of methane in groundwater at atmospheric pressure. A comprehensive geologic investigation was undertaken by Chesapeake Energy to better characterize natural, shallow subsurface conditions in northeastern Pennsylvania in order to establish a coherent baseline to distinguish alleged incidents and impacts from natural regional conditions.

The origin of thermogenic natural gas in the shallow subsurface is associated with numerous organic-rich beds composed of carbonaceous, woody plant material, deposited during the Late Devonian. Widespread, thinly-bedded coal seams were observed throughout the stratigraphic section of the Catskill and Lock Haven formations at nearly 50 surface locations across a 2,600 square mile study area, which included bedrock outcrops, road cuts, quarries and excavation sites. Samples collected exhibit considerable gas source potential with total organic carbon as high as 44.4% by weight and thermally mature with calculated vitrinite reflectance ranging from 1.8% to 3.3%. Methane source potential is further supported by mud gas shows observed while drilling through shallow organic beds. Results of Chesapeake's comprehensive geologic investigation confirm thermogenic methane occurrence in water wells and other groundwater sources to be naturally occurring and common in the region.

Mamm Creek Field Colorado: A Case Study in Potential Stray Gas Migration in an Unconventional Resource Development Context

(Isolated Event or More Pervasive Gas Migration Issue of Broader Concern)

Pete Penoyer, National Park Service

Speaker Bio: Pete Penoyer is a hydrogeologist based in Fort Collins, CO. with the National Park Service, Natural Resource Stewardship and Science Directorate. He joined the Water Resources Division of the Park Service in late 2000 to serve in a technical assistance capacity to parks on surface water and groundwater contamination related issues servicewide. Prior to that he worked 7 years for the Corps of Engineers conducting groundwater investigations and overseeing contractor site investigations and remediation activities at military installations and formerly used defense sites (FUDs). The first 15 years of his working career was spent as an exploration geologist for Shell Oil, Champlin Petroleum Co., a subsidiary of Union Pacific Corporation and Mitchell Energy and Development Corp.. He holds degrees in Hazardous Materials Technology (Assoc. of Sci.) from Front Range Community College; Geology (BS & MS) from Western Kentucky University and Oregon State University, respectively and Hydrogeology (Professional Degree), from the Colorado School of Mines. He is also a registered professional geologist (PG-1089) with the State of Wyoming.

Abstract: Mamm Creek Field is an approximately 100 square mile natural gas producing area in the Piceance Basin of western Colorado undergoing development by EnCana Oil and Gas (USA) and other operators since 2003. It is an early example where "stray" or nuisance gas migration has become an issue in an unconventional resource play for tight gas sands. The target gas formation is the Upper Cretaceous Williams Fork that requires hydraulic fracturing to be exploited economically. Some areas have site-specific geological and engineering conditions (e.g. East Mamm Creek Producing Area) that pose particular stray gas migration management challenges to industry and the regulatory community. The East Mamm Creek Production Area (EMPCA NTO) was established after well stimulation of the Schwartz 2-15B (02) was immediately followed by over pressuring of the annulus and seepage of methane gas and small amounts of condensate to West Divide Creek approximately 3000 feet away. Cementing of the well included a unique "event" or several thousand foot "fall back" from surface of production casing cement so that insufficient separation resulted between the top of gas and top of cement prior to well stimulation. In response to this event and other "nuisance" gas migration management issues associated with Wasatch gas bearing zones above the Williams Fork and concerns by local residents and Garfield County Board of Commissioners that oil and gas development activities could lead to more geographically extensive methane and other impacts to groundwater supplies, several studies have been completed and COGCC has made several area-specific policy changes for operators to follow through Notices to Operators (NTOs) and Conditions of Acceptance (CTAs) added to drilling permits (APDs). This presentation briefly outlines the case history and the geological and engineering elements most pertinent to this particular gas migration incident and broader efforts to minimize nuisance gas migration.

Abstract 25:

The Parker County, Texas, Study

Peter G. Pope, P.G.

Mr. Pope has been the Assistant Director of Site Remediation at the Railroad Commission of Texas since December 2011. A graduate of Purdue and Rice Universities, he worked in private consulting as a hydrogeologist for ten years prior to accepting a position with the commission's Site Remediation Section in 2001.

In August 2010, the Railroad Commission of Texas (RRC) responded to a domestic water well owner's complaint of natural gas occurring in his water well located in Parker County, Texas. RRC staff sampled the water well and directed a nearby oil and gas operator, Range Resources, to collect samples and test the integrity of their gas production wells. The EPA became involved at the request of the water well owner, and issued an Imminent and Substantial Endangerment Order on Dec. 7, 2010. The EPA eventually evacuated their order in March 2012. Mr. Pope will discuss a timeline of the activities and events associated with the RRC's investigation of the complaint as well as the outcome of the RRC called hearing to determine if Range Resources gas wells contributed, or were contributing, to the occurrence of natural gas in the water well.

Isotope Forensic Techniques for Differentiating Fugitive Gases in Complex Geological Settings

THOMAS H. DARRAH[1,*], NATHANIEL WARNER[1], AVNER VENGOSH[1], ROBERT B. JACKSON[1] AND ROBERT POREDA[2]

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Osborn et al (2011) recently reported 17-times higher concentrations of thermally mature methane (CH_4), consistent with production gases from the Marcellus shale, in drinking water wells within 1km of hydraulically fractured horizontal drilling sites producing from the Marcellus Shale in northeastern Pennsylvania. We employ a combination of hydrologic groundwater age dating [^3H-^3He and fluid flow modeling]), noble gas geochemistry, and carbon isotopic composition to distinguish the potential sources of gases present in drinking water aquifers within the region. These techniques simultaneously distinguish Marcellus/Devonian gas from deeper Trenton Group/Ordovician gases and other potential sources (e.g. shallow biogenic methane, stray landfill gases, other organic-rich lithologies, and natural gas that has migrated naturally over geologic time) providing a powerful technique for delineating the source and potential for fugitive gas migration in areas active or targeted for drilling. We will present preliminary results of noble gas and isotope geochemistry for Pennsylvania and New York areas of the Marcellus fairway.

Abstract 27:

Geochemical and Isotopic Evidences for Possible Natural Migration of Marcellus Formation Brine to Shallow Aquifers in Pennsylvania

Nathaniel R. Warner, Robert B. Jackson, Thomas H. Darrah, Stephen G. Osborn, Adrian Down, Kaiguang Zhao, Alissa White, and Avner Vengosh*

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The debate surrounding the safety of shale gas development in the Appalachian Basin has generated increased awareness of drinking water quality in rural environments. Concerns include the possible migration of stray gas and the leakage of hydraulic fracturing fluid and/or flowback brine to drinking water sources. The critical question common to these environmental risks is the hydraulic connectivity between the shale gas formations and the shallow drinking water aquifers. Recent publication in the Proceedings of the National Academy of Sciences in the US shows geochemical and isotopic evidences for natural pathways, unrelated to recent drilling activities that exist in some locations between deep underlying formations and shallow drinking water aquifers in northeastern Pennsylvania. The occurrences of saline water do not correlate with the location of shale-gas wells and are consistent with reported data before rapid shale-gas development in the region; however, the presence of these fluids suggests conductive pathways and specific geostructural and/or hydrodynamic regimes in northeastern Pennsylvania that are at increased risk for contamination of shallow drinking water resources, particularly by fugitive gases.

Isotopic Forensic Techniques for Methane Source Discrimination

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Boyce L. Clark, Ph.D., P.Hg., ARCADIS, Baton Rouge, LA
George H. Cramer, P.G., ARCADIS, Baton Rouge, LA

Author Bio: Dr. Sueker is a hydrologist with 21 years of professional experience in geochemistry, environmental forensics, physical hydrology, isotope hydrology, isotope geochemistry, and hydrogeology. She has considerable experience in designing, managing, and conducting environmental forensic investigations and is skilled in applying physical, chemical, isotopic, and statistical approaches to evaluate sources and fate of constituents of interest in soil, surface water, and groundwater. Dr. Sueker leads the Applied Isotope Geochemistry technical team for ARCADIS and is authoring a book on isotope applications in environmental investigations.

Abstract Combustible gases, such as methane, in soil and shallow groundwater present a safety concern due to potential offgassing and accumulation in water well and plumbing systems that could lead to an explosion. Elevated concentrations of methane in enclosed spaces also pose an asphyxiation hazard. Methane observed in shallow subsurface environments can be derived from many potential sources including swamps, landfills, coal beds, and natural gas production and storage operations. Understanding methane provenance may be important for sites where methane hazards are present and multiple unrelated methane sources exist. Generation of methane and other light hydrocarbon gas occurs via three principal mechanisms; 1) biogenesis – microbial decomposition of organic matter (e.g., carbon dioxide reduction and acetate fermentation); 2) thermogenesis – thermal decomposition of deeply buried organic matter (associated with coal, oil, and gas formation); and 3) abiogenesis – formation of methane within Earth's mantle. These different methane generation mechanisms result in differing compositions of light hydrocarbon gases as well as in differing stable carbon and hydrogen isotope ratios which can be used to assess methane provenance. Carbon-14 (^{14}C) age dating can further discriminate methane sources, as thermogenic gases are "fossil" carbon sources and do not contain measureable quantities of ^{14}C, whereas biogenic gases are typically "modern" and contain measurable quantities of ^{14}C. Methane forensic techniques were utilized to distinguish a single source of natural gas released from a Gulf Coast region salt dome cavern storage facility from other sources of methane known to occur naturally in the region. The natural gas release was caused by a breach of a storage well casing at an elevation above the storage cavern. Natural gas escaped through the well casing breach into overlying formations and migrated to the surface. Application of methane forensic techniques resulted in delineation of a significantly smaller affected footprint than originally interpreted.

Abstract 29:

Field Test of an Alternative Hypothesis for Stray Gas Migration from Shale Gas Development

Daniel J. Soeder

USDOE National Energy Technology Laboratory, Morgantown, WV 26507

Speaker Bio: Dan Soeder is a geologist with the U.S. Department of Energy at the National Energy Technology Laboratory in Morgantown, West Virginia investigating energy and environmental issues related to unconventional fossil energy resources. Prior to joining DOE in 2009, Mr. Soeder was a hydrologist with the U.S. Geological Survey in the mid-Atlantic region, after spending eight years on the Yucca Mountain Project in Nevada. His career before joining the USGS in 1991 included a decade of research at the Institute of Gas Technology in Chicago on unconventional natural gas resources, including shale, and several years characterizing drill cores on the DOE Eastern Gas Shales Project. Mr. Soeder received a BS degree in geology from Cleveland State University in 1976, and an MS in geology from Bowling Green State University (Ohio) in 1978.

Abstract: Much ado has been made in the media concerning the presence of methane gas in groundwater, and the possible link between this gas and drilling activities. The news stories often draw the conclusion that the presence of flammable methane gas in a water supply must be related to nearby Marcellus Shale gas drilling activities. The small Pennsylvania town of Dimock became a poster child for stray gas when a domestic water well vault exploded in 2010. A study by Duke University reported a seventeen-fold increase in methane in groundwater near active gas wells in the Dimock area, and isotope analyses identified the gas as thermogenic methane of geological origin. The Duke study found no evidence of drilling fluids, frac fluids or formation brines in any of the groundwater samples analyzed that could positively link the gas to the Marcellus Shale, and industry background data indicate that methane is ubiquitous in the shallow groundwater of northeastern Pennsylvania. If the shale gas wells are not the source of the groundwater methane, perhaps they are affecting the transport. Standard practice is to use high-pressure air while drilling the vertical portion of Marcellus Shale gas wells, including operations that penetrate the freshwater aquifers. Some of this drilling air, which can be at pressures of up to 350 psi, might enter the aquifer and cause the groundwater to surge radially in all directions away from the well bore at a much higher than normal velocity. The fast-moving water may transport pre-existing methane gas to nearby domestic wells, along with sediment and minerals, which have also been reported near shale gas drilling operations. The National Energy Technology Laboratory intends to test this hypothesis by monitoring groundwater heads and methane levels in observation wells located near drill sites. Results should help define effects on aquifers during the drilling of gas wells.

Can You Trespass with Gas?
The Law as it Pertains to Alleged Gas Migration Incidents

By David R. Overstreet and Anthony R. Holtzman

Biographies

David Overstreet has been with K&L Gates since 1993 and has an administrative law and litigation practice spanning several substantive disciplines with an emphasis on energy and environmental matters. He is actively involved on behalf of a number of different clients in permitting, enforcement and litigation matters associated with the development of shale gas facilities in the Marcellus and Utica shale regions.

In the fall, Mr. Overstreet will serve as an Adjunct Professor at the University of Pittsburgh, School of Law teaching a class in water law and shale gas development.

Anthony Holtzman, with K&L Gates since 2005, has a practice focused on appellate, constitutional, and governmental litigation and environmental and energy law. Mr. Holtzman has extensive experience in litigating cases before Pennsylvania's Supreme Court and Commonwealth Court and the Pennsylvania Environmental Hearing Board. On the federal side, he often litigates cases before the Third Circuit Court of Appeals and the U.S. District Court for the Middle District of Pennsylvania.

Currently, Mr. Holtzman is serving as counsel to industry members in a number of cases premised on allegations that their gas well operations caused contamination of residential water supplies.

Abstract

This presentation will focus on certain legal implications of alleged gas migration incidents. The speakers will discuss civil lawsuits in which landowners, advancing primarily common law theories of recovery, contend that they have sustained property damage and personal injuries due to the migration of gas and that, as a result, gas well operators are liable. The speakers, in this regard, will provide an overview of the common law theories of recovery that are commonly advanced in the suits. They will likewise discuss key evidentiary issues and the remedies that the landowners seek.

The speakers, additionally, will touch upon statutory and regulatory schemes that relate to gas migration incidents. They will describe, generally, how the statutes and regulations function and explain how they bear upon the gas migration lawsuits.

Finally, the speakers will discuss potential future developments in the legal landscape that surrounds gas migration incidents.

Abstract 31:

Where Do The Liabilities Lie?

Jean M. Mosites

Bio:
Jean Mosites is an attorney in the Natural Resources, Energy and Environmental Services Groups of Babst Calland in Pittsburgh, PA. Her practice focuses primarily on environmental compliance in the energy sector, as well as resolving liabilities under federal and state remediation programs. She advises clients on regulatory matters encountered in the development of unconventional shale, including gas migration investigations. She also practices before the Pennsylvania Environmental Hearing Board on a variety of matters, including appeals from permits and compliance orders. Ms. Mosites is an Adjunct Professor at Duquesne University School of Law, teaching environmental law.

Abstract:
As this country struggles to establish a national energy policy, environmental laws governing the exploration and development of oil and gas have been a primary means by which the development of these resources is directed and restrained.

In response to improved drilling techniques and expansion into new development areas, state environmental laws in this part of the county have evolved in recent years, changing the rules of the game for the oil and gas industry in what had been a quiet area of law for many decades. All of this change is occurring in the context of heightened scrutiny from the public and the press, which makes the need to understand the current state of the law all that much more urgent.

State legislators and regulators have drafted, proposed and adopted numerous revisions to prior law, with many more proposals and programs to come. This presentation will review the framework of state laws and regulations that outline the liabilities and obligations related to stray gas incidents and water supply restoration. The primary emphasis will be on Pennsylvania law, as it continues to evolve, with some discussion of West Virginia and Ohio law as well.

Overview of API Best Practices and Standards

Glen Benge

Glen Benge recently retired from ExxonMobil where he spent over 24 years working as a technical advisor in drilling. While at ExxonMobil he oversaw the cementing and wellbore isolation technologies for their global drilling operations. He has 35 years of experience associated with all aspects of oil field cementing and has authored numerous papers and texts on all aspects of cementing design and application. He is past Chairman of API Subcommittee 10 on Cementing, and has been an active member of API SC10 for over 30 years.

Most recently, Mr. Benge has authored technical papers on zonal isolation in Carbon Capture and Sequestration projects. He is a technical editor for SPE Drilling and Completion Journal and has served as Technical Session Chairman for the National AADE Conference, and on the steering committee for the SPE Forum on Advanced Drilling Techniques. He serves on industry advisory groups for the US Department of Energy and the U.S. National Energy Testing Laboratory. He is past president of the New Orleans Chapter of the American Association of Drilling Engineers, and has been a member of the Society of Petroleum Engineers for 35 years.

In the past few years, the American Petroleum Institute (API) has been developing a set of industry best practices and standards that serve as a template for exploration and production programs, in particular those dealing with hydraulic fracturing. Proper wellbore construction is a cornerstone of these standards coupled with proper facility operation and management.

The presentation will briefly cover the API efforts to publish Industry standards and best practices that cover all aspects of wellbore operations including community involvement, minimizing surface disturbances, proper wellbore construction, water management and proper abandonment. An update on the roll out of these standards to legislative, community and industry groups will be presented.

Abstract 33:

Baseline Water Quality Sampling Programs in Shale Gas Exploration and Production Areas

Debby McElreath and Mark Hollingsworth

Debby McElreath is a Senior Environmental Specialist in the Environmental Compliance Group for Chesapeake Energy Corporation, Oklahoma City, OK. She was the quality assurance manager for a full-service environmental consulting firm prior to joining the staff of Chesapeake. She has B.S. and M.S. degrees from Oklahoma State University. Debby.McElreath@chk.com; 405-935-4179

Mark Hollingsworth is the Environmental Manager of the Baseline Sampling Program for Chesapeake Energy Corporation, Oklahoma City, OK. Prior to joining Chesapeake, he was a Program Manager for Test America, Inc. in Nashville, Tennessee. Mr. Hollingsworth has a B.S. degree in Chemistry from David Lipscomb University. Mark.Hollingsworth@chk.com; 405-935-2417.

Over 20,000 baseline or “pre-drill” samples of groundwater from privately-owned domestic water wells and surface water resources have been collected in seven shale plays within the United States where active exploration for natural gas and natural gas liquids is being conducted. There are a number of challenges associated with the volume of sampling and analyses involved in baseline sampling programs. The experience gained from a large baseline sampling program will be presented. The major challenge is that the future need for any specific piece of baseline data is rarely known at time that the baseline sample is collected and analyzed. Recognition of the purpose and limitations of single-sample baseline sampling regimens is critical to operation of a baseline sampling program. This is particularly challenging when using the baseline sampling data to interpret findings in “post-completion”, that is samples taken after drilling has been conducted. Issues related to analytical parameter selection and criteria for isotopic analysis of light gases as well as electronic data delivery and management will be discussed. Challenges related to light gas sampling methods and sampling personnel training issues will also be presented. Baseline sampling programs must have in place a procedure for rapid notification of the client regarding exceedances of standards or benchmark values for analytical parameters, especially for dissolved light gases.

The Shell-NEOS neoPROSPECTOR Project in Tioga County, North-Eastern Pennsylvania: Use of Remote Sensing Technologies to Detect Surface and Near-Surface Stray Gas Occurrence and Potential Migration Pathways

Bryce McKee (Shell E&P) and Craig Beasley (NEOS GeoSolutions)

Bryce McKee is the Senior Staff Geologist for Shell Exploration and Production Company, at Shell Appalachia's Sewickley, Pennsylvania office He is responsible for oversight and technical assurance of well planning and operations and field development planning within Shell Appalachia's development team. He is also the subsurface technical focal point for Shell's multidisciplinary groundwater protection and stray gas mitigation team.

Craig Beasley is the Vice President of Exploration for NEOS GeoSolutions. He and his team are responsible for acquiring, processing, and interpreting all of the seismic and non-seismic datasets that NEOS analyzes to deliver basement-to-surface insights to its oil & gas company clients.

Shell has an active program of Marcellus gas well development drilling in northeastern Pennsylvania. The gas industry's license to operate in Pennsylvania depends on our ability to drill and complete gas wells in a safe and environmentally responsible manner. The key to this is protection of fresh groundwater resources through avoidance of pre-existing natural and anthropogenic conduits of methane coupled with proper drilling and well construction techniques to ensure zonal isolation.

In Tioga County, Pennsylvania, the surface and near-surface geology is characterized by Paleozoic rocks exposed at the surface overlain in some areas by Pleistocene glacial outwash sediments. Between 20 - 40 percent (depending on area) of pre-drill baseline groundwater samples in northeastern Pennsylvania are found to contain pre-existing methane. Pre-existing methane occurring in freshwater aquifers of northeastern Pennsylvania can be attributed to both geologic and anthropogenic factors. Upper Devonian gas-bearing sandstones of the Bradford Group (Lock Haven and Catskills formations) occur at or near the surface across most of Tioga County. In many cases old oil and gas wells (drilled in this region since the late 1800s) were not constructed to modern well design and zonal isolation standards. Decades-old derelict oil, gas, and water wells have deteriorated in place or were pulled out of the ground for reuse. These historical practices have in some cases resulted in vertical conduits for movement of methane from gas-bearing organic-rich shales and sandstones into freshwater aquifers. Methane, that in past decades was re-injected into the Oriskany Sandstone for storage by pipeline companies, has also been detected by USGS researchers in freshwater aquifers. Finally, in the case of recently drilled gas wells, imperfect zonal isolation by the surface and intermediate casing and cement intervals can result in a potential conduit for methane getting into groundwater.

In August 2011, Shell contracted with NEOS to conduct a remote sensing survey of our Tioga County operating area in Pennsylvania. A fixed-wing aircraft was used to collect band-specific hyperspectral, magnetic, gravity, electromagnetic and radiometric data over all of Tioga County. In addition, a helicopter system was used to collect high-resolution band-specific hyperspectral, magnetic, electromagnetic and radiometric data over a project specific area. Key project objectives were:

- Detection of surface hydrocarbon seeps and potential indirect hydrocarbon indicators.
- Detection of abandoned / derelict oil and gas wells not found in state agency or commercial databases.
- Mapping of resistivity anomalies in the near-surface to provide an indication of potential aquifer salinity variations and locations of shallow gas sands in the Upper Devonian Bradford Group.
- Definition of surface lineaments and fracture corridors, and identification of fault networks that can be extended from the surface into the subsurface when integrated with 3D and 2D seismic.
- Developing a hyperspectral-derived image of surface geo-hazards and geo-botanical variations.

Abstract 35:

Isolating Potential Flow Zones during Wellbore Construction

API Standard 65-2

Glen Benge

Glen Benge recently retired from ExxonMobil where he spent over 24 years working as a technical advisor in drilling. While at ExxonMobil he oversaw the cementing and wellbore isolation technologies for their global drilling operations. He has 35 years of experience associated with all aspects of oil field cementing and has authored numerous papers and texts on all aspects of cementing design and application. He is past Chairman of API Subcommittee 10 on Cementing, and has been an active member of API SC10 for over 30 years.

Most recently, Mr. Benge has authored technical papers on zonal isolation in Carbon Capture and Sequestration projects. He is a technical editor for SPE Drilling and Completion Journal and has served as Technical Session Chairman for the National AADE Conference, and on the steering committee for the SPE Forum on Advanced Drilling Techniques. He serves on industry advisory groups for the US Department of Energy and the U.S. National Energy Testing Laboratory. He is past president of the New Orleans Chapter of the American Association of Drilling Engineers, and has been a member of the Society of Petroleum Engineers for 35 years.

Proper wellbore construction and assurance potential flow zones are properly sealed are critical aspects of any successful operation. In December 2010, the API issued an updated industry best practice that addresses the isolation of potential flow zones for all wells. API Standard 65-2 contains industry recognized best practices for wellbore construction, installation of barriers within the well, and presents evaluation criteria to assure the various aspects of well construction are addressed. The Standard serves as a template for discussion between industry and regulatory agencies.

This presentation will look at the highlights of API Standard 65-2 and how it relates to proper well construction. Good cementing practices from well design through operational procedures and final evaluation of the well are covered.