PTTC TECHNOLOGY | CONNECTIONS

Appalachian Region

Timely, Informed Technology Decisions

Newsletter

Spring 2004 Vol. 5 No. 2

FROM THE DIRECTOR'S DESK

For whatever reason, I'm running ahead of schedule this year, although some would say that after five years I've finally gotten on schedule. Either way, here it is, not even mid June, and I'm writing the second edition of Volume 5. Perhaps 2004 will be the year I finally get four editions on line.

During the past three month since the last version went on line, the Appalachian Region Producer Advisory Group (PAG) added a new member: **Michael Wallen** of Daugherty Petroleum in Lexington, KY. Thank you, Michael, for agreeing to serve, and welcome to the PAG. Now those of you in the Lexington area will have another contact person for input into the regional PTTC program.

After taking the winter months off, you may have noticed that with the arrival of the workshop season, we are in full swing. In late May, the Ohio Geological Society hosted a workshop on **Horizontal Drilling: A Technology Update for the Appalachian Basin.** For details, see the article

below. Ten days later, the West Virginia Geological Survey hosted a workshop in Washington, PA on **Understanding the Trenton-Black River Reservoir.** Again, see below for a summary. And, just 8 days later, the Kentucky Geological Survey hosted a sold-out workshop on **Introduction to Petra Geological Interpretation Software.**

Even as these workshops were in their final stages of development, we were moving forward with negotiations and plans for others. Andrew Scott agreed to teach the one-day version of his **Coal Bed Methane Exploration Model** workshop that he taught at the AAPG national convention in Dallas in April – for a much higher registration fee. Andrew will be in Morgantown on July 19. If you are interested in finding sweet spots in coal beds, don't miss it. And, Matt Vavro has agreed to plan, host and team-teach two more editions of his popular **Well Safety for Well Tenders** workshop on September 1 and 2 in Olean, NY and Meadville, PA, respectively.

Ron Riley and Larry Wickstrom, two movers-and-shakers behind the upcoming ES-AAPG meeting in Columbus, approached me with the idea of PTTC and ES-AAPG co-hosting a workshop on Wednesday, October 6, like we did last year in Pittsburgh. I agreed to do this, especially when Larry told me that he already had a commitment from Ron Nelson to teach a one-day version of his **Exploration and Development of Fractured Reservoirs** workshop. Dr. Nelson attracted more than 140 fully-satisfied customers when he taught this workshop in Washington, PA in December 2002.

We also have been approached recently by others who were either interested in having us organize a workshop on a particular theme, or in teaching a workshop that they currently are developing. Sandra Mark, Director of PTTC's Rocky Mountain Region, approached me at the AAPG meeting in Dallas with an offer to bring a workshop being organized by Dick Inden on **The Hydrothermal Dolomite-Mineral Ore System** to the Pittsburgh area in November. The Pittsburgh Association of Petroleum Geologists (PAPG) agreed to co-host this workshop with us, probably in conjunction with their monthly evening meeting.

PAPG also is interested in having us organize a workshop on **Low-Resistivity Upper Devonian Sandstone Plays in Pennsylvania**. When I was approached by Greg Wrightstone at the Salt Fork workshop, I immediately introduced him to PAG member Leo Schrider, who has expressed an interest in developing a workshop on how these sandstones are best completed. A combination geology-engineering workshop may be forthcoming.

PAG chairman Bernie Miller is still interested in developing a workshop on **gas measurement and compression,** perhaps in November, probably in the Lexington area. If you are interested in being a part of this, contact Bernie.

Taury Smith, who is working with us on the Trenton-Black River Play Book study, expressed an interest in teaming with Fred Reid, from VPI, in teaching a one-day **short course on carbonates**. We are considering offering this at the Holiday Inn, Washington, PA to be followed by a reception at the Racetrack, possibly hosted by PAPG and/or the Pittsburgh Chapter of SPE.

If you have a special interest in any of the possible workshops mentioned above, please contact me.

Douglas G. Patchen

RLO Director

Flexible, Composite Drill Pipe Closer to Reality

The domestic oil and gas industry is one step closer to gaining access to a new, lightweight drill pipe made of carbon fiber rather than traditional steel, according to the U.S. Department of Energy. DOE's National Energy Technology Laboratory announced that the composite drill pipe, developed by Advanced Composite Products and Technology of Huntington Beach, California, has been successfully tested in a horizontal well in an Oklahoma gas field. The field test "proved convincingly" that the carbon fiber drill pipe can withstand the stresses encountered in commercial drilling operations.

The flexible pipe is manufactured by winding graphite fibers and epoxy resin around a spindle, producing a composite tube around the supporting spindle. After the composite tube is cured, the spindle is withdrawn and the pipe is machined to a smooth finish and coated to resist abrasion.

This innovative drill pipe "could revolutionize the drilling industry because of its versatility and strength" said Gary Covatch of NETL's Gas Technology Management Division. Covatch went on to say that the enhanced flexibility of the new pipe is an important advantage for operators who wish to re-enter old wells and drill horizontally to reach untapped reservoir rock. "It could provide an important new tool for the industry to recover more gas, keep recovery costs low, and extend the life of many of the nation's gas wells," said Covatch.

The most recent field test in Le Flore County, Oklahoma was in a formation that is hard and extremely abrasive. Unlike previous tests, which used rotary tools, this test was conducted using an air hammer to drive the 2.5-inch diameter pipe. The air hammer severely challenged the pipe's fatigue life, mechanical strength and ability to deal with stress. According to the DOE press release, after a week of drilling, the drill pipe was removed and examined, and showed "little or no sign" of wear.

Although the current price of the composite pipe is about three times the cost of steel drill pipe, researchers are working to reduce the cost. Additional tests are planned in coming months, designed to ensure industry confidence in the new product.

Another potential advantage of the new carbon fiber drill pipe is its ability to become part of a 'smart" drilling system. Future research will embed wire in a larger, 7-inch diameter composite drill pipe so that the wire can carry data from the bottom of the hole to the surface during drilling. This digital communications capability will give operators real-time data to monitor drilling progress, avoid undue stresses on the drill pipe and make virtually instantaneous decisions to better target the drilling operation. Ultimately, these systems should reduce risk and costs of drilling deeper wells.

Visit the following site for further information.
www.fossil.energy.gov/news/techlines/03/tl_compositedrillpipe.html

Technical Program Set for AAPG Eastern Section Meeting

The Ohio Geological Society and the Ohio Geological Survey, co-hosts of the 2004 Eastern Section meeting of the American Association of Petroleum Geologists, have announced that 94 abstracts have been accepted for the technical program. Sixty four papers will be presented in these 9 oral sessions: Reservoir Analysis/Stratigraphy; Environmental Assessment and Remediation/CO2 Sequestration; Rome Trough/Cambrian Exploration; Shallow Producing Horizons/Gas Storage/GIS Mapping; Trenton/Black River Exploration and Development; Trenton/Black River Stratigraphy; Coal Bed Methane; and Geochemical Character and Origin of Appalachian Petroleum.

Thirty abstract were accepted for presentation in one of three poster sessions, including: Cambrian-Ordovician Petroleum Geology/Rome Trough; GIS Mapping/Environmental Issues/CO2 Sequestration; and Stratigraphy/Seismic Applications.

The meeting will be held October 3-6 at the Ramada Plaza Hotel in Columbus, Ohio. For further information, visit the official 2004 Eastern Section meeting website at www.ohiodnr.com/geosurvey/aapg04.htm.

"Exploration and Development of Fractured Reservoirs" Returns to Basin

PTTC and the Eastern Section AAPG have agreed to co-sponsor Ron Nelson's excellent short course on fractured reservoirs as part of the 2004 AAPG Eastern Section meeting. Dr. Nelson will offer the course on Wednesday, October 6 at the Ramada Plaza Hotel in Columbus. Anyone wishing to attend this short course must register through the 2004 AAPG Eastern Section meeting, not through PTTC.

This one-day course will cover the basic elements needed in the evaluation of fractured petroleum reservoirs from both an exploration and development point of view. A general sequence of study will be presented, as well as the data types needed to complete the study. Techniques presented will emphasize outcrop and subsurface rock data, petrophysical data, rock mechanic principles and reservoir performance data. A multidisciplinary approach to the study of fractured reservoirs will be stressed. Participants should leave the course with knowledge of what controls short-term and long-term performance in fractured reservoirs and the types of data necessary to explore for, evaluate and develop them.

A more complete description of the contents of the course should be included in the meeting announcement booklet, or on the meeting website once the announcement book is completed this summer.

Dr. Nelson taught this very popular short course to more than 140 attendees at a PTTC workshop in Washington, Pennsylvania in December 2002. Many who were unable to attend asked if we could bring Dr. Nelson back to the basin, and we are pleased to have the opportunity to do so. Dr. Nelson has worked with fractured reservoirs for nearly 30 years with Amoco, BP Amoco and now Broken N Consulting, Inc. He has offered similar courses on fractured reservoirs to members of AAPG, SEG, SPWLA and NexT, and has authored numerous publications on the subject, including the

1985 and 2001 editions of his textbook entitled "Geologic Analysis of Naturally Fractured Reservoirs." Dr. Nelson has lectured on the subjects of structural geology and fractured reservoirs to geological societies, universities and national oil companies in more than 20 countries, and has been an AAPG Distinguished Lecturer (twice) and an SPE Distinguished Author. He recently served as President of the Houston Geological Society, Vice President of AAPG, and as a proposal review panelist for the Department of Energy and the Petroleum Research Fund.

Coal Bed Methane Exploration Model Short Course Coming Soon

Mr. Andrew Scott, former Regional Director of PTTC's Texas Region, has agreed to bring his highly-successful short course on "An integrated coal bed methane exploration model: defining coal bed methane exploration sweet spots" to Morgantown on July 19, 2004. Mr. Scott taught this short course recently at the national AAPG meeting in Dallas, and at several locations in Australia in late May and early June 2004.

The course has been designed to review the basic fundamentals of coal bed methane and to provide additional details about the various aspects of coal bed methane exploration and development for those who may already be familiar with this resource. The course will concentrate on a geologic/hydrologic-centered approach to coal bed methane exploration, and development of an integrated, basin-scale, coal bed methane exploration model. Participants are expected to complete multiple exercises that have been included to provide them with "hands-on" experience in evaluating coal bed methane prospects and defining coal bed methane exploration fairways.

Mr. Scott plans to begin the workshop with a series of presentations that will provide an overview of the fundamentals of coal bed methane, including how coal reservoirs and coal bed methane production differ from conventional gas plays. A coal bed methane exploration model emphasizing key geologic and hydrologic controls on coal-gas production will be reviewed during the course. The key factors affecting coal bed methane producibility include basin tectonic and structural setting, natural fracture patterns, coal depositional environments, coal rank and thermogenic and biogenic gas generation, sorption characteristics, gas content distribution, gas composition, hydrodynamics and permeability. These topics will be covered in the short course.

Andrew Scott has nearly 15 years of experience working with coal bed methane and has published more than 70 senior-authored papers and abstracts on various aspects of coal bed methane exploration and development. He has taught or participated in numerous coal bed methane workshops and short courses in the United States and internationally, and has received more than a dozen awards for his research efforts. Prior to starting his current company, Altuda Energy Corporation, Mr. Scott held a position as a Research Associate with the Bureau of Economic Geology, the University of Texas at Austin, where he also served as Program Director of Domestic Energy Research and as Director of the Texas Region of PTTC. He is a past President of the Energy Minerals Division of the American Association of Petroleum Geologists and serves on AAPG's Research Committee.

Coal Bed Methane Parametric Study Determine Key Parameters

Mr. Randahl D. Roadifer, a Staff Reservoir Engineer with ConcocoPhillips, recently presented a talk on "Coal Bed Methane Parametric Study – What's Really Important to Production and Why?" at the May meeting of the Pittsburgh Chapter of the Society of Petroleum Engineers and the Pittsburgh Association of Petroleum Geologists. Mr. Roadifer began with this premise: that coal reservoir performance is controlled by a complex set of reservoir, geologic, completion and operation parameters and the interrelationships among those parameters. Therefore, in order to identify, analyze and mitigate risk associated with a CBM prospect, one must first understand the relative importance of each of these parameters, and how they interact to affect CBM production.

Mr. Roadifer stated that to date, no comprehensive parametric study on coal bed methane is known to have been conducted by industry. The parametric studies that have been conducted and reported in the literature have considered only a limited set of parameters, and a limited range of values for those parameters, while holding all other parameters fixed. This method has potentially skewed the results of those studies.

The more comprehensive parametric study presented by Mr. Roadifer in Pittsburgh was designed to enhance our understanding of how a coal bed reservoir performs. The method presented essentially analyses the results obtained from an extensive Monte Carl simulation of more than 100,000 reservoir simulations in which the reservoir, geologic, completion and operational variables that impact CBM production performance were varied. In addition, the study considered the contribution of sandstones associated with coal beds to enhance CBM production. Because CBM reservoirs commonly occur in close conjunction with sandstones of varying reservoir quality, only one half of the reservoir simulations in this study modeled the production from CBM reservoirs alone. The other half modeled the production from CBM reservoirs associated with sandstones of varying quality and degree of wetness (fully water charged to various degrees of gas-charged sandstones were considered). The wetness of the sandstones was a critical factor in production performance.

The goal of the study was to establish the relative importance of the identified parameters and their interrelationships, and to develop ranked correlations between these parameters and various production end states. Research on this technique is continuing, and ultimately, this study could lead to the development of more accurate and efficient CBM screening models.

PAG member Royal Watts attended a second presentation by Mr. Roadifer the following day in Bridgeport at a luncheon meeting of the Northern West Virginia Section of SPE. Watts was impressed with the quality of the presentation, and noted that the meeting was attended by over twenty Petroleum Engineering personnel from northern West Virginia, including students and professors from West Virginia University.

Northern Appalachian Coal Bed Methane Consortium Formed

Appalachian basin coal bed methane stakeholders met at the Holiday Inn, Washington, Pennsylvania on April 15, 2004 to discuss a proposed Constitution and Bylaws that would create a

"Northern Appalachian Coal Bed Methane Consortium," complete with a newly-elected Board of Directors. More than 60 invited guests attended and participated in open discussions involving the proposed consortium. The meeting was supported by a grant from the Research Partnership to Secure Energy for America (RPSEA) as part of a research program at West Virginia University.

During the afternoon business meeting, the group, all of whom were designated as "consortium members for the day," voted to approve the proposed Constitution and Bylaws, accepted the suggested membership fee and elected members to the Board of Directors. Samuel Ameri, Patrick Esposito, Clint Hurt and Melanie Kinderdine were elected to two-year terms; Douglas Patchen, Richard Kyle and Pramod Thakur were elected to one-year terms; and Charles Byrer was elected to an unspecified term as an Ex-Officio member.

The stated vision of the new Northern Appalachian Coal Bed Methane Consortium (NACBMC) is based on the recognition that resident enterprises in the Northern Appalachian region would enhance and increase coal bed methane activities in the region if appropriate communication mechanisms were established. These communication mechanisms would allow representatives of industry and other organizations to experience the benefits of sharing data and lessons learned, while respecting reasonable confidentiality that goes with sharing data.

The NACBMC was created as a group of stakeholders from industry, state and federal agencies, academia and others who desire to share outreach and research, development and demonstration activities in the CBM arena. Annual membership fees will be assessed on individuals, not companies. Individuals can choose to become either a Full member, or an Associate Member.

The mission of the NACBMC is to provide a framework within which coal bed methane developers can collaborate and pool information to advance and accelerate the development of CBM in the Northern Appalachian basin (NAB). This mission will be accomplished through sharing information, conducting research and technology transfer. Specifically, the consortium will formulate research, development and technology assessment goals, and share CBM-related information on NAB coal seams and successes and failures. In addition, the consortium will create a Research and Development infrastructure that will expanding the CBM knowledge base of its members, and promote the dissemination of research results and technology transfer for the benefit of consortium members and the nation as a whole.

The new consortium will be governed and managed by a Board of Directors consisting of seven voting members and ex-officio members, and will be led by a Chairperson appointed by the West Virginia University Research Corporation from among the Petroleum and Natural Gas Engineering faculty at WVU. The chairperson and ex-officio members will not be voting members. Voting members will be elected to staggered two-year terms, with the exception of three of the initial members who were elected to one-year terms to achieve staggered terms in the future.

IOGANY-OPI to Meet in Niagara Falls, Ontario

The Independent Oil & Gas Association of New York and the Ontario Petroleum Institute will host a joint meeting at the Fallsview Hotel in Niagara Falls, Ontario from November 8-10, 2004. A Call for Papers was issued this Spring, with a due date of April 30 for 250-word abstracts.

Organizers hope to organize sessions dealing with area potential, case studies, drilling and completion,

energy future, energy marketing, environment, finance and markets, geology, geophysics and logging, horizontal drilling, information technology and GIS, government policy, leasing and land, new technologies, petroleum engineering, safety and storage. How many of these sessions will be organized depends on the abstracts submitted. The final program will be announced after August 1, 2004.

Trenton-Black River Workshop Again Draws a Good Crowd

Offer it and they will come – as long as you keep it new, informative and useful. Organizers of the recent PTTC workshop on **"Understanding the Trenton-Black River Reservoir"** had this in mind as they assembled a group of speakers for another workshop, this one in Washington, PA on June 7. Speakers were recruited by Lee Avary and PAG member Rick Goings who could address the two main workshops goals: to learn more about the Trenton-Black River reservoirs from those who are active in the play; and to learn more about other plays in rocks of the same age in different parts of the eastern U.S. and Canada.

The morning session was dedicated to three talks that brought participants up to date on Ordovician carbonate plays in western Newfoundland, eastern Tennessee and the Michigan basin. During the afternoon, five speakers took a closer look at the Trenton and Black River reservoirs in the Appalachian basin play, and at some new tools that are gaining wider acceptance to characterize and visualize the reservoir.

Christopher Pike and Paul Patey from Ptarmigan Resources in Nova Scotia, discussed an emerging play in a Cambro-Ordovican carbonate platform offshore from western Newfoundland. They stated that they were eager to attend the workshop to learn more about the Trenton-Black River play in our area, and to tell workshop registrants about a potential carbonate platform play in their part of the world. Ptarmigan is attempting to develop this play in fractured and faulted Middle and Lower Ordovician carbonates in a foreland basin west of a regional fault line associated with a paleomargin. All previous drilling has been east of the fault line, but the new play area is west of the paleomargin, updip from good source beds and is capped by a good seal. Pike pointed out that the prospect area is in a structural position that is similar to a Beekmantown play in the St. Lawrence valley north of Vermont, and to the Knox play in Ohio. The initial discovery well flowed 1500 barrels per day from a thin (2-3 meter) pay zone, but this flow could not be sustained.

Ptarmigan has identified four prospects in what they call the North Platform play, and two prospects in their North Allochthon play. Using a standard industry risk analysis technique, Ptarmigan estimated oil resources in these areas to be in excess of 500 million barrels and gas resources in excess of 975 Bcf. Ptarmigan, a company described by Patey as having "the same talent as a major, but just a little short on cash," is seeking partners for these expensive wells -- $15-20 MM for an offshore well, verses up to $80 MM for deep offshore wells elsewhere.

Dr. Gary Bible from Miller Petroleum in Huntsville, TN, reviewed the Trenton- Stones River play in eastern Tennessee that is in the early stage of development. Dr. Bible stated that the status of this strongly oil-prone play at this time is approximately equivalent to the Trenton-Black River play in New York five years ago. Using a structural map of eastern Tennessee, he defined and discussed three different structural plays and several of the better wells that have been drilled in them. Wells in Morgan County typically produce a waxy crude, yielding an operational problem that has been solved by allowing produced drip gas or naptha purchased from a refinery to drip down the annulus to prevent paraffin buildup. Another typical

technique developed by his company is to run an acoustic noise log to determine gas entry into the well bore, and then hit that zone with acid. This completion technique has resulted in flows of 5000 barrels per day.

Dr. Bible also discussed Miller Petroleum's interest in the Eastern Overthrust area and in the Swan Creek field. The Swan Creek field was discovered by Amoco in the early 1980s, but Amoco chose not to develop the field. Instead, smaller independents have become involved, and Miller took a 9-well farmout in the field. Dr. Bible stated that they have not seen massive dolomite bodies in their wells, but they have seen fine vugular porosity lined with dolomite crystals. Usually the section drilled by the second drill rod below the first occurrence of fine, vugular pososity yields oil. Operators still have not determined the full extent of the field.

In his summary, Dr. Bible again stated that this oil-prone play in eastern Tennessee is the early stages of development, but there are large structures to be drilled, especially in the Eastern Overthrust area.

Dr. William Harrison, who directs PTTC activities in the Michigan Basin presented a comprehensive overview of Trenton-Black River oil and gas reservoirs in his area. To illustrate what he was saying, Dr. Harrison laid out 160 feet of Black River core in the meeting room, and brought posters that summarized the research of two graduate students who had worked on the core.

Although these fields are developed in dolomite reservoirs encased in otherwise tight limestones, fractures at various scales are the key to field locations and production from the fields. Most of the nearly 20 named fields are small, relative to the Albion-Scipio trend, but collectively they have produced 140MM barrels of oil and 260 Bcf og gas. The Albion-Scipio field has been densely drilled and is characterized by low porosity (< 5%) but a wide range in permeability that averages 84.5 md.

Dr. Harrison went on to discuss structural models for several key fields and showed production histories from those fields, before describing the reservoir rock by showing a series of core photos. The core intervals chosen illustrated the types and diversity of fractures observed, the type of fracture filling, the extent of dolomitization and the original fabrics and depositional environments.

In conclusion, the shelf carbonates in the Michigan basin are very productive of oil and gas, but only because fracturing and dolomitization have created reservoirs in otherwise non-porous and impermeable limestone. These fracture systems are related to basement faults that were reactivated by shear tectonic movement during times of plate collisions along the eastern continental margin. Although matrix porosity is low, fractures, vugs and caverns provide adequate storage, and fractures enhance permeability significantly. Variations in original depositional fabric may have exerted some degree of control over later fracturing and dolomitization that began in the bottom of the formation and proceeded toward the top.

Elliott Wiltse and John Hubbard from Schlumberger Oilfield Services in Charleston, WV were the first two speakers in the reservoir characterization portion of the workshop. Wiltsie discussed the advantages of running a Formation MicroImager (FMI) tool in Trenton-Black River wells, whereas Hubbard discussed an alternative tool, the DSI Dipole Shear Sonic Imager.

Originally, the FMI tool was developed for structural, fault and fracture analyses. Now the tool, and interpretation of the resulting images, has evolved to a point where it also can be used for stress and stratigraphic analyses. Workshop participants were shown a series of slides illustrating bedding in limestones and dolomite sections of the Trenton and Black River; fractures in these units; and vugular intervals that comprise target zones. Other slides illustrated induced fractures, borehole breakout and porosity from formation damage.

A more recent use of the FMI tool is to analyze bedding and interpret depositional environments. One local example, not in the Trenton or Black River, showed two intervals in close vertical proximity, one with beds dipping northeast, the other with beds dipping west-northwest. Both were

interpreted as channel sandstones, but the challenge was to locate two offset wells that would be in the thickest portion of each channel trend. In this case, which was in West Virginia, the interpreter successfully located the two offset wells.

The FMI tool is superior to the DSI Dipole tool for Trenton-Black River exploration, but it can be linked to the FMI. It can obtain compressional and shear measurements in either open or cased holes, but the degree of cement bonding is a factor in cased holes. Its primary uses are to determine porosity and lithology, but it can be used to determine mechanical properties necessary to design a frac job, and to determine stress direction, location of gas zones, open natural fractures and a permeability index.

In general, the FMI tool is more expensive to run than the DSI Dipole tool, and for both tools, approximately 60% of the cost is to run the tool and 40% is for interpretation.

John Repetski presented the results of a Trenton-Black River thermal maturation mapping and modeling study conducted by four geologists at the U.S. Geological Survey. The study involved a stratigraphic analysis, including conodont zonation, and the determination of the maturation of samples (conodont alteration index) collected from these formations throughout the study area. The thermal maturation values were then compared to the locations of major structural features and provinces and oil and gas fields that produce from Ordovician and Silurian rocks, and to maps of vitrinite reflectance values.

At the conclusion of the presentation, burial history plots of several deep wells located on a cross section from northwestern Ohio to the Rome Trough area in western West Virginia were shown. At the eastern end of the cross section, in the Rome Trough, the Utica Shale, a potential source bed, "jumped" rapidly through the oil window at the end of the Devonian, whereas to the west, on the margin of the Rome Trough, it remained in the oil generation window much longer. Still farther west, near the Findlay arch, the Utica may still be near the top of the oil window. Thus, at the eastern end, over the Rome Trough, the Trenton-Black River section is over mature but still above the limit of gas production, and as one moves west, the Trenton-Black River section is mature.

Dave Harris, a geologist at the Kentucky Geological Survey who is involved in the current Trenton-Black River play book project, discussed the results of petrographic and geochemical studies of outcrop samples in Kentucky, and plans to take cores and shoot seismic to determine the subsurface extent of these tectonic dolomites. The final results of this study, funded by the U.S. Department of Energy, NYSERDA and Triana, will be available in October 2004.

Taury Smith, a geologist with the New York State Museum Institute who also is part of the Trenton-Black River play book research team, presented a paper on hydrothermal alteration of carbonate reservoirs that posed the question: How common is this? His answer seemed to be, quite common and very important.

Dolomitization and leaching of carbonates occurs in many diagenetic environments, one of which that has historically been under-appreciated is the fault-controlled hydrothermal regime. In this regime, hydrothermal fluids that result in dolomitization follow the same migration pathways and are trapped by the same seals as other fluids that result in leaching or diagenesis, or emplace hydrocarbons. Furthermore, these hydrothermal fluids move up the faults and fractures at times when the faults are active until they reach an overlying seal. At that point, the fluids are forced laterally into permeable zones. Thus, facies and fabrics matter – fluids are preferentially displaced into these more porous and permeable rocks.

Not all of this is positive. These migrating fluids also can bring with them dissolved evaporate minerals that are deposited in the voids created by dolomitization, thus reducing the new porosity and permeability. Other later-stage, porosity-reducing minerals found associated with hydrothermal dolomites are sulfides, calcite, chert, chalcedony, kaolinite and other clays. Many of these have been observed in the Trenton-Black River reservoirs,

along with breccias, vugs, cemented fractures, celestite, saddle dolomite and matrix dolomite. Porosity in these reservoirs is mainly vuggy, breccia and fracture porosity.

How big is the impact of hydrothermal alteration on these two limestone formations? "Without fault-controlled hydrothermal alteration, there would be no Trenton-Black River play in New York," Smith stated emphatically. He also cautioned that whereas this mechanism can enhance a reservoir, in other cases fault-derived mineral cements are precipitated in what otherwise would have been a good reservoir rock.

Seismic data show that the controlling faults commonly die out just above the altered rock, indicating that this mechanism was active early in the burial history of the rocks and occurred at shallow depths. These faults could be reactivated at later times, resulting in subsequent dolomitization. Smith suggested an exploration model where one would look for carbonates with appropriate faults that die out within or just above them, with evidence of movement in the first kilometer of burial.

The geochemical evidence found in the Trenton-Black River section indicates that these units were dolomitized by high temperature saline brines that rose from underlying basement rocks and/or siliciclastics prior to precipitating dolomite. Much of the dolomitization occurred in rocks that were never very hot, so the dolomite in them must be hydrothermal in origin.

Hydrothermal dolomites can form in various structural settings, but the key, regardless of the type of fault, is to have had minimal vertical offset to protect the overlying seal. They commonly are expressed on seismic as subtle sags or anticlines, but can be sub-seismic. A second exploration model offered by Smith is to look for subtle sags and anticlines associated with basement-rooted faults on seismic in a limestone host. Structural closure is not necessary.

Smith stated that many, perhaps most, carbonate platform margins are set up by basement-rooted normal, strike-slip or wrench faults. The same fault systems that create the platform margins can act as conduits for mineralizing and leaching fluids, and as later migration pathways for hydrocarbons. This also is true for many reefs and carbonate mud mounds. Therefore, another exploration model is to look for fault-controlled carbonate margins similar to the western Newfoundland example in the first talk of the day. Smith then showed an example of this in northwestern Ohio, and showed a series of maps developed to aid in the search for evidence of a similar margin in the subsurface of New York State.

Breccias were discussed near the end, with an emphasis on their origin – karst or hydraulic? In Smith's view, most brecciated *reservoir* rock in the Beekmantown/Knox/Ellenburger is hydraulic, not karst. Much of it formed under shallow burial conditions, but in rock that had never been exposed to erosion at the surface of the earth.

In summary, Smith offered this exploration model. First, look for appropriate tectonic settings: basement-rooted intra-platform wrench faults and fault intersections, fault-controlled margins, and the first carbonates deposited on newly rifted/heavily faulted continental basement. Second, look for evidence of fault movement soon after deposition: much of the alteration takes place in the first kilometer of burial, so faults with minor vertical offset at the time of alteration may be in the best locations. Third, breccias may be either karst or hydraulic, so look for saddle dolomite-cemented breccias. These are probably hydraulic in origin. And finally, look for petrographic evidence of hydrothermal alteration in cores and cuttings. With this final statement, Smith supported what Bill Harrison had stated earlier in the workshop: there is no substitute for looking at the rocks.

Horizontal Drilling Workshop Well Received by Ohio Operators

PTTC and the Ohio Geological Society hosted a very successful horizontal drilling workshop in a serene, relaxed setting afforded by Salt Fork State Park near Cambridge, Ohio on May 27th. Greg Mason and Jason Henthorne recruited eight speakers who addressed various drilling methods, steering systems, coiled tubing applications, completion methods and how to identify reservoir candidates for underbalanced drilling. Several case studies were included in the presentations.

Doug Wight, senior exploration geologist with CDX Gas, Dallas, Texas, led off with an excellent presentation on unconventional drilling methods for unconventional reservoirs. His company developed a unique horizontal drilling technique in southern West Virginia coal beds that they later introduced in western basins. This "pinnate" drilling technique is best applied in thick, low permeable coals that have good lateral continuity.

CDX had multiple objectives when they set out to develop coal bed gas resources ahead of mining in southern West Virginia. First, they wanted a means to produce gas from unconventional reservoirs that was economic, and would result in higher and quicker gas recovery. Also, they wanted to develop an underbalanced drilling technology that would maximize efficiency while creating a uniform drainage pattern. And finally, they wanted to optimize dewatering of the coals and minimize the environmental impact of water and gas production operations.

CDX achieved these goals by developing their dual well, horizontal drilling system that results in a pinnate drilling and drainage pattern. So-named because the final drilling pattern resembles the veins of a leaf, the system begins with two closely-spaced (within 20 ft) vertical wells: one well will serve as an air injection well early in the project and then as a producing well; the second well will serve as the horizontal and service well bore. In Wyoming County, WV, a horizontal well drilled from the service well intersected the first vertical well in the lower of two coal seam targets (Pocahontas 3, less than 100 ft below the Pocahontas 4), creating a cavity in the lower coal. Air injected into the cavity through the first well forces fluid and sediment up the second well to the surface. Once this is done, the first well becomes a producing well. The horizontal leg continues to be drilled from the second well, usually reaching a length of 4800 feet before drilling stops and the drill bit begins to be retracted. As the drill bit is retracted along this main lateral, side laterals are drilled at 45 degree angles to the main and 90 degrees to each other. This drilling of side laterals continues as the drill bit is retracted all the way to the vertical producing well. Each successive side lateral is longer than the previous hole, resulting in an essentially square drainage area.

After the first quad is drilled, second, third and fourth mains can be drilled from the horizontal service well, and side laterals can be drilled along each as the drill bit is retracted toward the dual well system. Early in the development stage of this technique, three additional vertical production wells were drilled, with each being intersected by a horizontal main. Now a 360 degree pattern can be drilled using only three vertical wells, not five or even eight as before. The final 360 degree pattern drains 1280 acres and replaces 16 vertical wells, while providing uniform drainage and pressure depletion. The environmental impact is significantly reduced as well. These patterns can be expanded to drain more than 2000 acres, and can be developed in more than one coal seam in the same area, using the same producing and service wells.

CDX developed this technique to drain coal beds of their natural gas prior to mining. Because the mining company's master plan includes a schedule for mine development, CDX knows how long they have to drain the coals completely, i.e., the date that

the mine will begin to come through their operation. Knowing the length of time that they have to drain the coals, the gas content and thickness of the coal, and the volume of coal that has to be drained, CDX uses a computer program to determine the optimum spacing of the side laterals that will drain the coals in the amount of time available. By doing so, the drilling of unnecessary side laterals is avoided, and no gas is left in the coals that could have been drained prior to mining.

PAG member Leo Schrider attended the workshop, and offered these comments on Wight's paper. "The Pinnate drainage pattern in coal beds has improved recovery to over 80% of the gas in place. Unique pattern design and under balanced drilling also prevent well bore damage and improved permeability performance. While this type of drilling and completion is costly (generally in the $million+ range) it has shown to be cost effective in locals that have conditions which warrant these types of drilling and completion techniques."

Jeff "Duff" Smith, Sales Manager & Owner of Directional Drilling Contractors in Traverse City, Michigan, presented a history of the development of horizontal drilling in the basin, beginning with a chain at the end of a drill bit that whipped around to carve out a cavity in the rock, a "weed eater" approach, to the modern methods, like the pinnate operation that had just been presented. He also summarized the various applications for horizontal drilling and developments in other related technology. He stated that when measurement while drilling (MWD) systems replaced the wire-line system, the technology was able to develop more rapidly. He concluded that improved bit technology and steering systems are "coming on strong in the Appalachian basin."

The following speaker, Lars Halvorsen from Schlumberger Drilling and Measurements in Charleston, WV, provided more detail on advanced rotary steerable systems, particularly the PowerDrive series. The PowerV vertical control system was designed to drill a true vertical well while reducing drilling cost per foot by staying vertical. He mentioned that two wells had been drilled in Pennsylvania last month with this system, with both wells in the 6000 ft range. He noted that while Appalachian drilling companies are open to new technology, these tools are in high demand due to their dependability, and although 65 of them are in existence, we are lucky to have even one in this area. Unfortunately, new technology often goes where the money is, and right now that is in the international arena.

Kirby Walker, also with Schlumberger in Charleston, discussed coiled tubing applications, like drilling deeper to a new pay or to produce a rat hole, adding a horizontal leg, removing well bore obstructions, etc. He emphasized two other technologies, SlimPulse and Viper, but mentioned that although Viper may be "a perfect fit for the Appalachian basin," when you are in competition with the rest of the world for technology, "the northeast U.S. does not always win." The reality is, that the rest of the world drives the cost too high for this area. He concluded by saying that "coiled tubing drilling was not meant to take over the drilling market, but it has demonstrated the ability to fill certain niches in the Appalachian basin over the past few years."

At the beginning of the afternoon session, new Moderator Jerry Olds told participants to "forget about old dogs and new tricks; it is time to embrace lots of this new, exciting technology because there is still a lot of oil and gas to be found." Following that challenge to operators, John Rogers, a petroleum engineer/project manager with DOE's National Energy Technology Lab in Morgantown, WV, discussed DOE's programs to develop drilling technologies for tomorrow's exploration and production paradigms. He began with a few givens: we need more gas, much of it will come from the same old places, but it will be harder to get. Therefore, we need new technology to develop deeper on-shore and off-shore gas resources, and to produce oil from old fields. New technology can reduce drilling costs by reducing drilling time from 190 to 60 days in one example, and by improved drilling fluids, hydraulics, motors and rigs.

According to Rogers, as the amount of money being spent by industry for upstream R&D began to decline, DOE stepped in, forming partnerships with

industry and universities to conduct research and technology transfer, including PTTC. He went on to present a comprehensive overview of DOE's efforts to develop drilling fluids, microhole technology, coiled tubing technology – even ice roads and ice pads in Alaska – while presenting specific examples of each.

Dan Mullins discussed a new method to fracture horizontal wells called SurgiFrac Service, which is being marketed as a quick and cost-effective method to boost production from horizontal wells. Jets in the horizontal section cut the rock at any desired angle, thereby creating a preferred direction for induced fractures. Breakdown pressures are lower in SurgiFrac completions versus vertical well fractures, with the inverse relationship between pressure and velocity during injection being the key. However, he cautioned that this technique should not be used in interbedded intervals where the two lithologies have different breakdown pressures. He concluded by saying that they are currently involved in a Trenton-Black River project in New York.

Mark Moody presented a very honest summary of an attempt to re-enter an old vertical Rose Run well in Ohio and drill a horizontal leg to enhance production. The original well at one time was capable of producing a million cubic feet a day with 2-3 barrels of condensate, but over time it began making salt. Fresh water was used to correct the salt damage problem, but because this well was on acreage that was included in a 3D seismic survey, it was decided to drill a horizontal well "with a science project attitude."

The remainder of the presentation was devoted to a summation of a series of disasters with drill bits and motors, one of which was created when a reaction between condensate and foam produced an explosion that killed the motor. The well had to be sidetracked around the problem but after drilling only another 73 feet, the bit quit, the hole began taking the drilling fluid, Baroid came out, and so it continued. He concluded that they put too much fluid in the well while trying to make footage, and the well drank it as quickly as they could pump it in.

Leo Schrider felt that this talk, like the talk by Wight, was particularly will done and presented very useful and practical information, especially because it dealt with a failed project that used horizontal drilling. He felt that the author, Mark Moody, was "very forthright in his discussion of why this project failed," and as a result, "operators should benefit since mistakes were made that may be prevented in future applications of horizontal drilling. While the project failed, it provides a framework of what one needs to consider in preplanning and design."

"Professional Development Hour" Certificates Now Being Offered

The Appalachian Region of PTTC has joined with the other 9 regions to offer certificates for professional development achieved through participation in our workshops. In fact, the certificates that will be used nationally were designed locally by Mark Hoffman, working with Lance Cole, PTTC Project Manager. Although geologists typically do not have an annual requirement to complete a given number of professional development hours through workshops, short courses and seminars, petroleum engineers usually do in order to retain their certification. PTTC is pleased to provide the new certificates as a means of assisting engineers to meet their annual quota.

Under this system, it will be the responsibility of those who receive the certificates to take them to the appropriate group or person to receive credit for hours earned. It will be PTTC's responsibility not

to award certificates to anyone who does not attend an entire workshop. Therefore, the certificates will be given out only at the end of each workshop.

The front of the certificate will include the title, date and location of the workshop, and the number of professional development hour (PDH) credits earned. The number of hours can be verified by turning the certificate over and reading the workshop program on the back, complete with times of each presentation, the title of each talk and the speaker.

PTC will make every effort to print certificates in advance for all those who pre-register, and will bring a few certificates on which a person's name can be printed, by hand, at the workshop. However, if you need to acquire PDH each year and desire to accumulate our certificates, I encourage you to pre-register for all workshops you attend in the future.

AAPG Announces 2004 Election Results, Candidates for 2005

AAPG President Steven Sonnenberg has announced the results of the 2004 AAPG election: Peter Rose, of Austin, TX, President-elect; Neil Hurley, Golden, CO, Vice President; Dwight "Clint" Moore, Houston, TX, Treasurer; and Ernie Mancini, University of Alabama, Editor. Dr. Mancini also serves as Director of the Eastern Gulf Region for PTTC.

Candidates for the 2005 elections, which will conclude next May, are: for President-elect, Thomas Ahlbrandt, USGS, Denver, CO and Lee Billingsley, Abraxas Petroleum, San Antonio, TX; for Vice President, Douglas Patchen, WVGS, Morgantown, WV and Steven L. Veal, DCX Resources, Denver, CO; and for Secretary, John R. Hogg, EnCana, Calgary, Alberta and J. Michael Party, Wagner & Brown Ltd., Midland, TX.