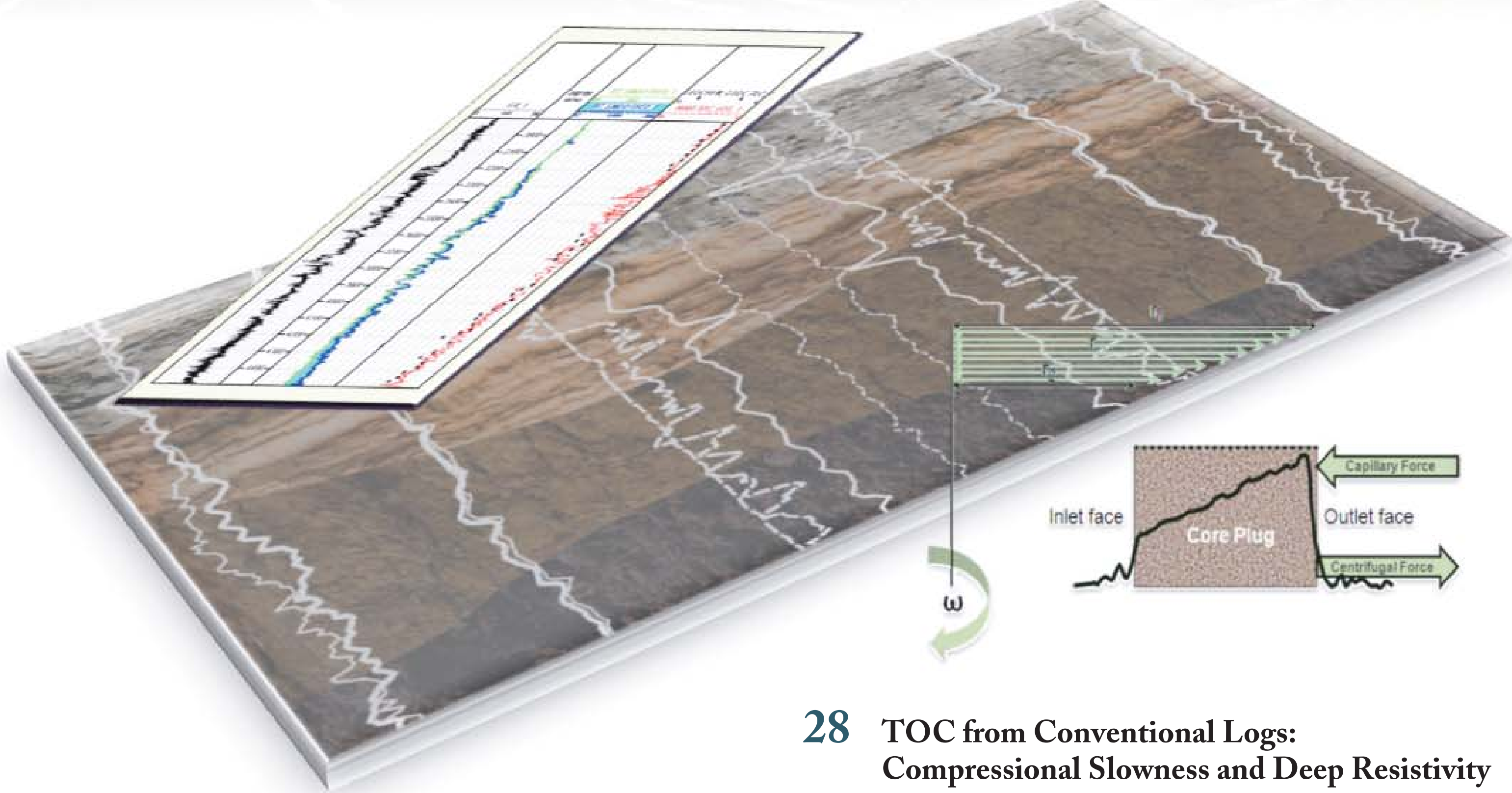
InSite

CWLS Magazine
May 2009 Issue 1 Volume 28



InSite

CWLS Magazine May 2009

Issue 1 Volume 28

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Photos: If you have a photos that the CWLS can use on its next InSite please send a high resolution jpeg format version to kusuma1@slb.com or naladani@petro-canada.ca. Include a short description of the photo with your submission.

The 2009 - 2010 CWLS Executive:

Back row (l - r): Simon Corti, Dave Shorey, David Ypma, Garry Drebit, Agus Kusuma.
Front row (l - r): Maggie Malapad, Roy Benteau, Vern Mathison, Nabil Al-Adani.

President's Message

It seems we are heading into stormy waters once again in the energy industry not only in Canada but world-wide. Some of us have been here before, some more than once and others not at all. For the veterans they know it is time to consolidate, re-evaluate, reduce costs and generally just weather the storm. For the younger generations who have only seen the smaller cycles over the past 10 years this is an entirely new phenomenon from which they will gain some valuable experience. We all know it will get better eventually, history proves this, it's just a matter of when.

The beginning came with the introduction of the federal tax on energy trusts then the provincial government stepped in with its royalty review and the final straw was the collapse of the global economy. Recently however the provincial government has introduced two drilling based royalty incentives to help out the Mid and Small Cap producers for one year. Will this be enough to save some companies and will it stimulate others to increase their budgets? Only time will tell and only after break up is over and we are well into summer will we know for sure. What other industry can withstand so many cycles and still be able to recover only to repeat the entire process again in 5 or 10 years time. The powers that be always say they have learned their lesson and it will never happen again yet here we are once more repeating the same story. Remember the bumper sticker, "Please let there be another boom, ...".

For the Canadian Well Logging Society it will also be a time for us to look within our executive to ensure we give the membership the value they expect and deserve. That being said, we are once again participating in the CSPG, CSEG and CWLS joint convention which starts on May 4th, 2009. With Dave Greenwood as the CWLS Co-Chair and Satyaki Ray as Technical Co-Chair this will be an excellent convention for the CWLS. The CWLS will be offering up 7 short course programs this year for which you can register though a link at www.cwls.org or go directly to www.geoconvention.org. The majority of these courses will be run the week prior to the convention so as not to interfere with any of the papers being presented.

We are also moving forward with plans to complete a display at the Canadian Petroleum Discovery Museum near Devon. A project involving the hiring of a summer student is also underway to enter the Core Database into an excel format to make it more user friendly. We will also be asking oil and gas companies to supply more core data to update the database since the most recent data is from 1986. You will also see a new look and functionality to the CWLS website soon as the final touches are being added to make it more user friendly.

Lastly, the CWLS will be operating booths at both the Frontiers and Innovations Convention in Calgary and the 50th Anniversary SPWLA Convention at The Woodlands Waterway Hotel in Texas. I am looking forward to 2009 being a fulfilling year for the CWLS and I am very pleased to serve you as president for the upcoming term.

Vern Mathison
CWLS President

CWLS 2009 to 2010 Executive

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Past President's Message

Last year in the Oil and Gas Industry after unprecedented commodity price highs, an economic recession drove the price to a low that has stalled exploration and now threatens to put production in the red. Despite the turmoil, the CWLS jointly ran a financially and technically successfully convention, held 9 technical luncheons which were attended by 1,500 members, recorded webcasts of most luncheon presentations and made them available on our website, increased student membership by 28 and overall membership to 740, published 2 InSite magazines and raised and gave more to charity than ever before. 2008 was a good year for the society.

These successes were made possible by the many volunteers who contributed their time, expertise and enthusiasm and to the executive that organized their efforts. In particular, I would like to thank Vern Mathison who fulfilled his role as treasurer and was a valuable and reliable asset at every event and meeting. 2008 was not without challenges as executive and key convention chairs were unable to complete their responsibilities due to relocation or work pressures. Brian Glover, our 2008 Convention General Co-Chair stepped up to fill in any gaps and ensure the convention success. All of our remaining executive had to take an expanded role and I thank Jeff Taylor, Vern Mathison, Gary Drebit, Dave Ypma and Greg Schlachter for their extra efforts. There were also a great number of individuals who helped me personally: John Kovacs, Dave Greenwood, John Nieto, Tyler Maksymchuk, Robert Bercha, Kathy Chernipeski and many others.

Despite the early date of the AGM this year, all the necessary business was concluded smoothly. Congratulations to our new executive, and thanks to all those society members who were in the running but did not get elected, as it takes us all to make the society work. Vern Mathison, our new President accepted the election results on behalf of the new executive and outlined key initiatives for 2009. After the AGM business was completed we had an excellent dinner prepared by the Palliser and Simon Whitfield, Canadian Olympic Gold Medalist gave an interesting, entertaining and sometimes comedic presentation.

In 2008, as "Past President", I will be supporting the incoming President, Vern Mathison, and other executive as well as soliciting CWLS executive candidates for next year's election. Please contact me if you are interested in volunteering your time to keep this organization active. In addition, I will be chairing the Student Awards Committee and helping to mentor the summer hire working on the CWLS special core analysis database. Once again, it was a pleasure working with last year's executive and volunteers and I would like to thank the membership for allowing me to serve you as President this last year! Thank You!

Roy Benteau, P.Geol.
CWLS Past President

Same Website Address! New Look!

Anyone visiting the CWLS booth at the 2009 GeoConvention noted our new look. Our compass style logo has been incorporated with an outdoor backdrop to showcase the natural beauty of the Canadian Rockies. This new image will represent the CWLS at upcoming events including the SPWLA Annual Meeting in The Woodlands, Tx.

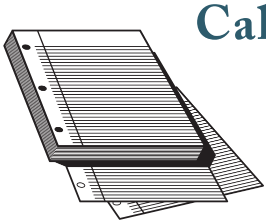
Visit the website to learn about upcoming events including training courses and luncheons, search the Rw Catalogue, find contact information for your executive and to update your contact information.

www.cwls.org

webcast

If you still need to revisit the luncheon that you have recently attended or attend the ones that you missed, visit our web cast section. Watch whole talk with speaker's slides on our website.

Call for Papers



The CWLS is always seeking materials for publication. We are seeking both full papers and short articles for the InSite Magazine. Please share your knowledge and observations with the rest of the membership/petrophysical community. Contact publication Co-chair: Agus Kusuma - kusuma1@slb.com or Nabil Al-Adani - naladani@petro-canada.ca

The CWLS Treasurer's Report for 2008

The accompanying Profit & Loss Statement and Balance Sheet reflect the financial position of the Canadian Well Logging Society (CWLS) for the year ended December 31, 2008. Jeff Taylor (Past-President), Roy Benteau (President), and Doug Hardman (Vice-President), all members of the CWLS in good standing, in accordance with the CWLS by-laws, have reviewed the financial reports.

The net income was a gain of $92,396 for the 2008 year. The society received revenues from membership dues, technical luncheons, publications, joint conference, short courses and sponsorships.

Membership

The membership dues are allocated to pay general office expenses, support the fall social and to subsidize publications and the cost of the AGM. Membership income has risen from $23,864 in 2007 to $31,324 for 2008 as a result of the dues increase in March 2008.

Dues will remain unchanged for members and new members for the March 2009 renewals. The CWLS still offers the lowest dues of any petroleum society in Calgary.

Technical Luncheons

The luncheons are priced to break even only and to generate revenue if attendance is strong. Expenses have increased due to increases from the Palliser venue as well as the addition of the Webcasts and bringing in speakers from across Canada and the U.S. Lunch prices will remained unchanged for 2009 and the society will subsidize the difference. Average attendance for 2008 was 185 people per lunch, an increase of 65 per lunch over 2007.

Fall Charity Social

The Fall Charity Social is a fully subsidized event with revenue from ticket sales contributed to charity. The cost for the 2008 event was $14,218. This is an increase of $10,484 from the previous year of $3,734 as the CWLS did not solicit any sponsors for the event. We did accept donations for a silent auction and cash raffle which generated $3,147 for the Canadian Assoc. of Disabled Skiers. The Fall Charity Social provides an opportunity to network with colleagues and renew acquaintances. Attendance was up from last year's attendance of 44 people to 58 people, an improvement of 14 members.

CWLS.ORG Web site

The web site underwent major changes throughout 2008 making it more user friendly as well as the addition of e-voting. The server has been upgraded to allow more functionality and a new web page design is ready for release. Additional improvements are being made to the luncheon booking for those with dietary restrictions.

Annual General Meeting

The AGM is funded through ticket sales and sponsorship for this event. A major expense is the speaker's fee that has to be covered from general revenue. The 2008 Annual General Meeting operated at a cost of $31,528. This is $12,006 more than last year mostly due to the cost of our speaker and venue.

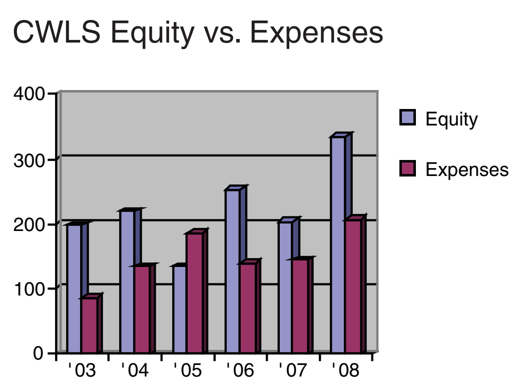
Publications

Revenue from the sale of the RWCD and Publications dropped again from $132 to $71 since this data is now readily available on our web site to members in good standing at no cost.

Only two InSite magazines were published in 2008 at deficit of $14,413. However ad revenue was up from $1,625 in 2007 to $8,421 for 2008. The CWLS executive realizes the time required to put forth these publications and efforts are ongoing to improve this element of our society.

Summary

2008 was a very successful year for the CWLS. We joined the CSPG and CSEG for the 2008 Geo-Conference and will continue to help host this event into the future. Looking back on the year, I can proudly say that our Society is financially strong. Adding value to the membership is the ultimate goal and is always the focus of our discussions. I wish you all success going into 2009 and I hope to serve you again in the future as an executive within this society.



Vern Mathison
CWLS 2008 Treasurer

Profit and Loss Statement 2008

	2007	2008
INCOME		
Interest	10,018	9,377
AGM Revenue	9,810	15,923
Total Meeting Revenue	47,503	58,195
Total Ad Revenue/Web & InSite	1,625	8,802
Total Membership	23,864	31,324
Total Publication Sales (Journals, Rw Catalogs, RWCD's)	132	71
Other Revenue/Gain-Loss on Securities	2,478	1,701
Short Course (2008) / CWLS/CSPG/CSEG joint conference	94	88,357
Joint Conference	0	86,589
Gross Income	**95,524**	**300,339**
EXPENSES		
Joint Conference Expenses	2,780	2,290
Donation/ 2006 Joint Symposium seed money	80	0
Short Course Expenses	0	21,880
Total Meeting Expenses	50,532	82,933
Student Awards	7,343	0
Election Expenses	2,160	2,485
AGM Expense	19,522	31,528
Total Publications (Includes InSite Magazine)	15,927	14,413
Total Office Expense	21,071	26,573
Web Page	25,071	25,842
Bank Charges	14	0
Total Expense	**144,500**	**207,944**
NET INCOME	**(48,976)**	**92,396**
Member's Equity at beginning of year	**252,454**	**203,478**
Member's Equity at end of year	**203,478**	**295,874**

Balance Sheet 2008

	2007	2008
ASSETS		
Current Assets		
Chequing /Savings	33,329	32,017
Cash Box	170	170
Accounts Receivable	1,367	5,732
Inventory Asset	1,550	1550
Prepaid Expenses	0	11,269
Term Deposits	176,579	279,282
Accrued Interest on GIC	4,039	
TOTAL ASSETS	**212,995**	**334,059**
LIABILITIES & EQUITY		
Current Liabilities		
Accounts Payable	10,797	38,155
Accrued Payables	0	0
Unearned Revenue	0	0
GST	(1,280)	0
TOTAL LIABILITIES	**9,517**	**38,155**
Member's Equity	**203,478**	**295,874**
TOTAL LIABILITIES & EQUITY	**212,995**	**334,029**

The Canadian Well Logging Society Estimated Budget 2009

	2006	2007	2008	Est 2009
INCOME				
Interest	7,202	10,018	9,377	10,000
AGM Revenue	5,364	9,810	15,923	16,000
Total Meeting Revenue	52,635	47,503	58,195	60,000
Total Ad Revenue/Web & Insite	5,550	1,625	8,802	12,000
Total Membership (Memb + Sponsors)	17,849	23,864	31,324	25,000
Special Core Database Sponsorship	–	0	0	0
Total Publication Sales (Journals,Rw Catalogs,RWCD's)	1,343	132	71	500
Other Revenue/Gain-Loss on Securities	17	2,478	1,701	2,000
Courses	6,415	94	88,357	65,000
Joint Conference	160,830	0	86,589	80,000
Gross Income	**257,205**	**95,524**	**300,339**	**270,500**
EXPENSES				
Joint Conference Expense	14,233	2,780	2,290	0
Donation (U of C Student Petroleum Club)	80	80	0	1,000
Special Core Database Expenses	0	0	0	0
Total Meeting Expenses	47,934	50,532	82,933	80,000
Student Awards	2,000	7,343	0	9,000
Election Expenses	237	2,160	2,485	6,500
AGM Expense	21,634	19,522	31,528	30,000
Total Publications (Includes Insite Magazine)	23,371	15,927	14,413	22,000
Total Office Expense	23,680	21,071	26,573	28,000
Web Page	6,165	25,071	25,842	36,000
Bank Charges	36	14	0	400
Course Expenses	0	21,880	25,000	
Total Expense	**139,370**	**144,500**	**207,944**	**237,900**
NET INCOME	**117,835**	**(48,976)**	**92,396**	**32,600**
Member's Equity at beginning of year	**134,619**	**252,454**	**203,478**	**295,874**
Member's Equity at end of year	**252,454**	**203,478**	**295,874**	**328,474**

Geosteering Techniques in Thin Coal Reservoirs

By Christine Burinda, Halliburton, Jason Pitcher and Dennis Lee

Introduction

Thinly bedded reservoirs, including coal seams represent the frontier of today's E&P targets. Geometric drilling of these reservoirs is often precluded by a lack of closely spaced offset wells around the horizontal section, as well as the presence of unanticipated faults and structural changes that may require dramatic changes in well bore placement with respect to the reservoir section. The current challenge for geosteering is to stay in the productive interval of these increasingly thinner reservoirs.

New innovations in logging technology, such as the recently introduced Azimuthal Deep Resistivity (ADR) tool and Gamma-at-Bit Inclination (GABI) motor, are making this possible. These logging tools were used in drilling thin coal beds where the primary drilling requirement was to place the horizontal section as close as possible to the lower coal-seam boundary. These tools made it possible to geosteer close to the top and bottom of the thin coal beds without exiting. Tool measurements such as Azimuthal standoff enable calculation of the distance-to-bed-boundary, which is used to map the lower boundary of the reservoir. A field example demonstrates how this tool combination was also used to identify and map sub-seismic coal-on-coal faults and how this knowledge influenced well bore placement.

Methodology / Theory

Geosteering

The key to successful geosteering is accurate real-time reservoir knowledge. This knowledge is obtained using several different sources of information through out the planning and drilling of the well. During planning, information about the reservoir is obtained from seismic, offset well, reservoir positions, cores, and several other sources. Proposed well paths are planned as accurately as possible, placing the well in the best possible position with regards to the reservoir. Many times this process can be hampered by lack of information. If the well is drilled according to the proposed well path it ends up being placed in poor reservoir or even out of the reservoir section. Geosteering can help prevent this by modifying the well path during drilling using all of the information used in planning the well along with information that is obtained in real-time.

Examples of sources for information during drilling, can be LWD tools (including new generation resistivity and gamma-at-bit tools), cuttings, surface data, 3D placement software, and well personnel. The geosteering specialist collects this information, analyzes it, and makes decisions in real-time to modify the well path so that it is placed in the best possible position with out exiting the reservoir.

Recently Halliburton helped drill a well located in the Swan Hills area in Alberta, Canada. It was very important to place the well as low in the reservoir as possible without exiting, as the reservoir was only 1.8 m thick. No seismic and only one old offset well were available during planning of the well. The client decided to use geosteering for drilling the well due to the importance of placement of the well and lack of knowledge of faults and other unknown geologic structures.

In this well, Halliburton's geosteering team primarily use the Azimuthal Deep Resistivity (ADR) tool, Gamma/At-bit Inclination (GABI) motor, and StrataSteer 3D software. These tools along with other real-time information allowed the team to place the well in the best possible position for the client.

Azmuthal Deep Resistivity (ADR) tool

Halliburton's newest generation resistivity tool is called the InSite ADR tool. This tool measures multiple truly compensated resistivities at different depths of investigations, multiple truly compensated images at different depths of investigations, and multiple possible geosteering signals that are used to calculate distance to be boundary (DTBB). The ADR tool fires three frequencies at each of the six transmitters (three compensated spacings) which are then measured at three tilted antenna receivers. This data can be transmitted in real-time allowing the geosteering specialist to evaluate the reservoir while drilling.

Transmitting an image from one frequency and spacing resistivities allows the geosteering specialist to compare the high side resistivity with the low side resistivity. These two resistivities will differentiate when coming in contact with a boundary. The resistivities also react differently when crossing an upper boundary and a lower boundary of a formation, helping with the placement of the wellbore with respect to the reservoir. Transmitting two resistivities with different depths of investigation also allows a better evaluation of the reservoir.

Transmitting one or more geosteering signals (geosignals) also helps with placement of the well bore. From the geosignal a distance to bed boundary (DTBB) can be calculated. The DTBB will indicate where the nearest boundary is located helping with well placement. Faults will also be mapped easily with DTBB. Sometimes an upper boundary and a lower boundary can be calculated near enough to each other to estimate the thickness of the reservoir. The geosignal can also be used as a qualitative measurement in giving an idea of the location of the well bore. In most instances, if the geosignal is positive, then the well is in the upper part of the reservoir, and if the geosignal is negative, then the well is in the lower part of the reservoir. This also helps with well placement.

Gamma/At-Bit Inclination (GABI) Motor

The GABI sensor provides two important measurements, located just behind the bit, for steering a well. The first measurement is the At-bit inclination, which helps with the direction of the well. Not only does it contribute to longer and flatter well bores, it provides immediate feedback about trajectory changes. The second measurement is an Azimuthal Gamma Ray. This close to the bit gamma ray detects adjacent beds and bed boundaries when being approached. The image also indicates the direction of the well path; if it is going up dip or down dip.

StrataSteer 3D software

With the combination of these two tools and the StrataSteer 3D (SS3D) software an accurate picture of the geology and well placement can be mapped. The SS3D combines the resistivities, gamma rays, images, geology, and well bore placement into one screen making a powerful tool for the geosteering specialist. With all of this information at the touch of the fingers, the geosteering specialist can make real-time decisions to prevent a reservoir exit, and to place the well bore in the best possible position.

Sample Data

The following are examples from a Swan Hills area well that was drilled in Alberta, Canada using the ADR tool, GABI motor and StrataSteer 3D software. The goal of this well was to stay at the bottom of the reservoir to achieve maximum production rates.

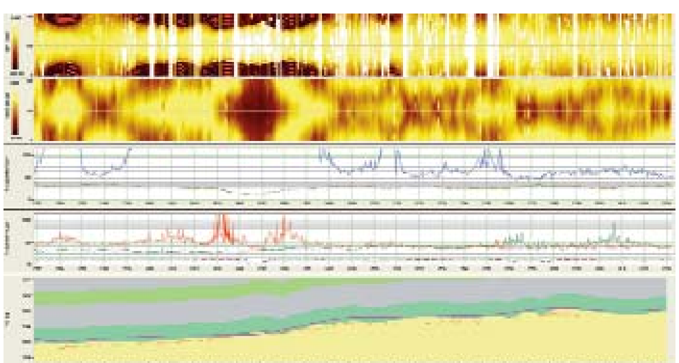


Figure 1

Figure 1 is an example of ADR data with GABI image and DTBB calculations. The GABI image (lower image) shows the direction of bed dip with respect to the well path. DTBB is indicated in read dots on the geology plot (at the bottom) showing that the well is placed near the lower boundary of the coal seam. The upper resistivity and the lower resistivity comparison also indicate that the lower boundary is being approached (polarization horns).

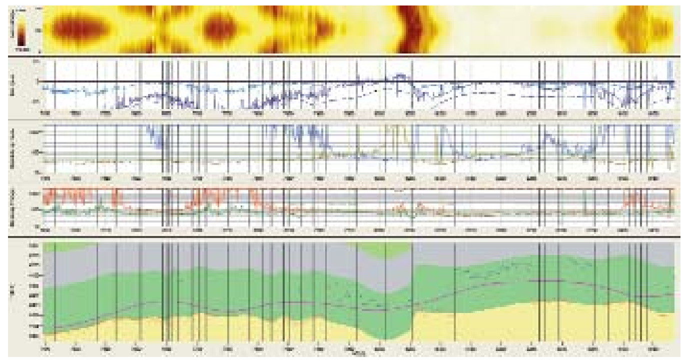


Figure 2

Figure 2 is also an example of ADR data, GABI image and DTBB calculations along with geosignal data. DTBB indicates a lower boundary along with a possible upper boundary of the formation. A fault also occurs at approximately 8050 m. This can be determined by the up and down resistivity track along with the geosignals. As the fault approaches, the lower resistivity is polarizing, indicating that the top of the reservoir is approaching. When the fault occurs, the upper resistivity is polarizing indicating that the bottom of the reservoir is approaching. The geosignals also indicate this. Upon approach, the geosignal is increasing so that it is towards the middle of the track and even above the middle of the track. After the fault, the geosignal is below the middle of the track again.

Conclusion

It is possible to drill thin reservoirs in real-time with today's technology. As fields become more difficult to drill and produce it is important to place the well bore in the best possible reservoir during drilling. Geosteering the well in real-time is the only way to do this. With the new ADR tool, a GABI motor and Stratasteer 3D software along with a geosteering specialist this is possible. The ADR tool can calculate DTBB, and indicate which boundary is being approached. The GABI motor can indicate bed dip and Stratasteer 3D software puts the information together for the geosteering team to make quick and accurate decisions.

Continued on page 13…

Geosteering Techniques

…continued from page 11

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Shale Gas Evaluation
March 18th 2009 CWLS luncheon presentation

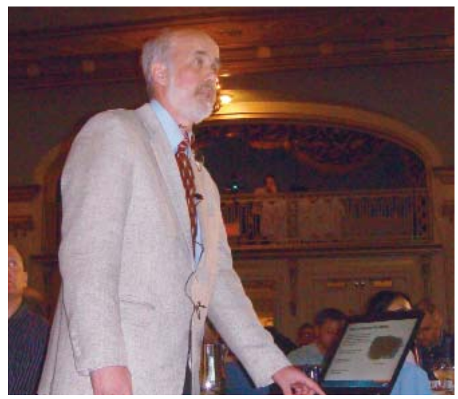
David Jacobi (Baker Hughes/INTEQ) has presented an integrated approach to evaluate shale gas plays in North America. He indicated the necessity of petrophysical and geochemical gas shale facies prediction for successful completion in shale gas. His focus was on the Barnett shale play in USA. The key data used in this method are nuclear magnetic resonance, free and bound porosity, bulk density, compressional and shear slowness, and elemental nuclear interaction yields. Baker Huges has a set of tools to provide the listed measurements. The claimed unique feature of Baker's FLEX tool is the ability to predicting TOC from excessive carbon yield.

The main highlights of this luncheon were as follows: the traditional bulk density and TOC correlation seems to be the best if bulk density is not affected by the borehole condition. However, existence of minerals like apatite (high density and PEF) and pyrite may severely affect the TOC prediction. Carbonate concretions and phosphatic minerals may have similar effects. It is known that successful prediction of porosity or organic volume from density or neutron porosity will depend strongly on the rock composition.

The thorium and uranium ratio is one of the crucial indicators of depositional environment. It can assist in understanding the maturity and possibility of existence of organic mater.

In addition, targeting open fractures based on borehole images interpretation, increases stimulation success rate. However, this does not exclude the closed fractures filled with siliceous material as they may reopen during stimulation as well.

Acoustic measurements of shear and compressional slowness are key parameters in deriving the stress profile along the borehole. These measurements can help in predicting zone stimulation success, and in understanding the potential existence of natural fractures.



Finally, the nuclear magnetic resonance tool estimates bound porosity, and measures total porosity with elemental nuclear interaction, yielding predicted TOC and thus defining the organic material volume. The comparison between bulk density-derived and nuclear magnetic resonance porosities may help in evaluating free porosity in shale gas reservoirs.

The entire presentation is posted on the CWLS website. You may also see the web cast with presentation slides.

Nabil Al-Adani
Publication Co-Chair

New Members

John Clark, Renegade Oil and Gas Ltd
Parsegh Oksayan, Bnbkennel
Bruce Palmer, Birchcliff Energy Ltd.
Ian Smith, Telluric Petrophysical Consulting Ltd.
Reigh MacPherson, Devon Canada Corp
Norm Hopkins, Fairmount Energy Inc.
Clark Strong, Datalog
Andriano Lalang, Datalog Technology
Patrick McLellan, Weatherford Advanced Geotechnology
Tyler Klatt, EnCana
Omar Sabbah, Natural Resources Authority, Petroleum Directorate
Jason Montpetit, Caltex Energy Inc.
Shaun Rhyno, Sunshine Oilsands
Garett Nykipilo, Athabasca Oil Sands Corp.
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Full Cycle Costs of Natural Gas: April 8th 2009 CWLS luncheon presentation

W. P. Gwozd, P. Eng., Vice President of Ziff Energy Group presented insights on North America remaining gas reserves and a gas supply outlook for Western Canada to 2020. The 40 minute presentation summarised Ziff Energy's Finding and Development cost assessment along with operating costs for Western Canada. Using these data sources, the presentation illustrated the full cycle cost of the Western Canada natural gas 'hamburger'. Consistently rising costs have pushed the full cycle costs to almost $10 in the Alberta Foothills. With the actual gas price at less than half of this, Mr. Gwozd indicated that the industry will face considerable challenges. So by better understanding cost issues and how they may unfold, active solutions can be undertaken now. In additional to Western Canada full cycle costs, the presentation shared recent insight on a 2008 new gas supply cost curve for 30 gas basins across North America covering 85 gas plays (an updated study will be available at the end of 2009). The color PowerPoint slides of his talk will not be available on CWLS web cast or downloads. The following are Mr. Gwozd's responses to the most frequently asked questions:

1. **What is the status of gas reserves in Western Canada compared to North America?**

   North American gas remaining resources (proved reserves and undiscovered resources) exceed 1,400 Tcf and Western Canada has 190 Tcf remaining. Noteworthy, 47% of Western Canada's ultimate gas potential (360 Tcf) was produced by the end of 2008, a key indicator of a maturing gas basin.

2. **Briefly how do you compare gas supply in North America and in Western Canada in the coming decade? Is international supply going to be the alternative?**

   Western Canada gas supply will decline in the coming decade, despite the growth of unconventional gas supply (especially Shale Gas). Other major North American gas basins (Continental SW, East Texas & North Louisiana, U.S. Rockies, and Other Lower 48) are growing in the coming decade, although more international gas supply (LNG) is needed to balance North American gas demand.

3. **Do you predict a drastic drop in the number of wells to be drilled from the current level in the coming decade (even with Tight Gas, Shale Gas and CBM)? This should guide logging companies on where to focus their future technologies.**

   Ziff Energy predicts a 35% drop in the number of wells in the next couple of years (especially in the Southern Shallow conventional gas) and a recovery to the current level after that. The actual gas price received for gas is simply not adequate to offset the high 'full cycle' cost of gas in Western Canada. While some gas producers may be pleased that they are able to achieve lower than average full cycle costs, unfortunately, their best effort may not adequate as they need to have even lower full cycle costs as benchmarked against their peers.

4. **In the short term, what suggestions can you offer for us in Western Canada?**

   Ziff Energy's current assessment (that is underway) of full-cycle break-even costs leads to the conclusion that overall drilling costs are too high. Thus, by critically examining the cost structure of material supplied and services provided, plus incorporating the industry best practises, costs can be corralled and driven lower. While benchmark assessments take time, it is through better understanding of costs that solutions can be crafted and implemented. Industry's current strategy is to simply cut drilling costs by reducing activity with the aim of reducing future gas supply and thereby driving up gas prices. As before, this strategy will be severely tested with unfortunate results, as the full-cost structure underlying imported LNG is actually lower and will create a signal for even more world-wide LNG liquefaction to be developed. In the past, high gas prices masked the growing concern of spiralling costs. Now, managing (and understanding) costs is a key strategy for industry to focus on.

Nabil Al-Adani
Publication Co-Chair Executive

June 21-24, 2009

SPWLA THE WOODLANDS 1959-2009

Welcome to The Woodlands!

The 50th Annual SPWLA Symposium

The Society of Petrophysicists and Well Log Analysts (SPWLA) will be holding its 50th Annual Symposium June 21-24, 2009 at The Woodlands... a scenic master-planned community approximately 30 miles from downtown Houston. This year is special in that we will be celebrating the SPWLA's 50th anniversary. Over the last 50 years, the SPWLA has played a major global role in strengthening petrophysical education and strives to increase the awareness of the role petrophysics plays in the oil and gas industry and the scientific community.

The SPWLA annual symposium is the societies foremost technical conference and exhibition. In recent years, it has alternated between a U.S. venue and an international venue. With 75-100 oral presentations and posters and an attendance of several hundreds of participants, this event offers the industry's largest gathering of petrophysicists and formation evaluation specialists, as well as an excellent advertisement and recruiting venue. In 2008, the SPWLA had an extremely successful annual meeting in Edinburgh, Scotland, and we expect the 2009 Woodlands meeting to be just as successful.

This year's symposium provides plenty of activities for the whole family. We have a great exhibition, an outstanding technical program, and some exciting social events in store for you. The Symposium will be held at The Woodlands Waterway Marriott Hotel & Convention Center located at Lake Robbins Drive in the The Woodlands. We will be taking up the entire hotel, so you can go to technical presentations, short courses and exhibitions under one roof. Many restaurants, plenty of shops, and numerous activities are located a short walking distance from the hotel. With 110 forested parks and 165 miles of hike and bike trails nearby, you can bike, walk, run, or just take a leisurely stroll whenever the mood strikes you.

We are offering five Short Courses for you to choose from. If you'd rather relax and play some golf, we have chosen a wonderful venue for you. Weatherford will be hosting a tournament at the Woodforest Golf Club on Sunday. Carved through majestic pines and towering oaks, its courses are designed for golfers of all skill levels. Schlumberger will host an Icebreaker on Sunday evening at The Marriott Woodlands Waterway where you can chat with old friends, make new ones and sample cuisines from around the world.

On Monday, June 22nd, a special 50th Anniversary Session will kick off the technical program for three days of presentations and poster sessions on the most recent technologies. The Exhibition also starts on Monday in the Exhibit Hall with more than 25 participating companies. The Annual Business Meeting will also be held on Monday over lunch, immediately following the last morning presentation. On Monday night, Baker Hughes will sponsor another evening social event at the Houston Museum of Natural Science.

Tuesday, June 23rd, over lunch and immediately following the last morning presentation, we will honor award recipients for their technical and service achievements. On Tuesday evening, Halliburton will host the third and final social event of the conference at the House of Blues in downtown Houston. We have lots of activities in store for the delegates' families (both spouses and children). Monday's trip will be an organized shopping and sightseeing trip that includes a water taxi ride and a visit to The Woodlands Museum of Natural Science. For Tuesday, we have planned a visit to the Bush Presidential Library and Museum along with a stopover for the classic Blue Bell Ice Cream tour. Wednesday will conclude the family activities with an interactive cooking demo at "Chocolate Passion" and fun contests at an especially reserved hospitality suite.

On behalf of the SPWLA Houston chapter and the organizing committee, we would like to welcome you to The Woodlands!

Regards, Conference Committee


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Capillary Pressure Curves Determined by Direct Measurement of the Saturation using Magnetic Resonance Imaging

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Abstract

Traditional techniques for measuring capillary pressure, such as porous plate, centrifugation, and mercury injection, are inaccurate and/or time-consuming. The centrifuge technique requires the fluid(s) to reach equilibrium at seven to ten different speeds. This is very time-consuming, as each equilibrium step can take up to two days or more. In addition, the inlet saturation must be computed using an approximate solution that is known to cause errors. Porous plate capillary pressure measurements are considered to be the most accurate, but acquiring the complete curve can take several months. Mercury injection is rapid but inaccurate as non-reservoir fluids are used, and the capillary pressure curve is modeled from the measurement pore throat sizes.

The new method described here, called GIT-CAP, centrifuges the core plugs, then directly measures the water saturation distribution inside the core plug using MRI. The measured water saturation together with the known centrifugal force, leads directly to a capillary pressure curve. The technique is rapid, requiring as few as a single equilibrium step, and is accurate, directly measuring the water saturation inside the rock. The technique is ideally suited to the study of "tight" or low permeability rocks. Tight rocks can easily take two to four days to reach equilibrium in a centrifuge or many weeks for porous plate, making the time savings achieved with GIT-CAP significant when compared to traditional measurement techniques.

Introduction

Capillary pressure, Pc, is the difference in pressure across the interface between two immiscible fluids and is dependent on the interfacial tension, pore size, and wetting angle. Capillary pressure is the most fundamental rock-fluid property in multiphase flows, just as porosity and permeability are for single phase flow in oil and gas reservoirs (Lake 1989). Capillary pressure curves directly determine the irreducible water saturation, residual oil saturation, rock wettability, and can be used to determine water-oil or water-gas contact points and approximate oil or gas recovery. Water flood performance is also significantly affected by the capillary pressure of the rock (Masalmeh 2003).

Capillary pressure is typically measured in the laboratory by using mercury injection, porous plate, or centrifugation techniques (Dullien 1991). The porous plate method is considered the most direct and accurate method but takes a long time since each capillary pressure point requires an equilibrium time that can take weeks or months. The mercury injection method is fast and can reach very high capillary pressures but the test uses a non-representative fluid, mercury, and it is destructive. In addition, mercury injection is an indirect measurement as it measures pore throat sizes which are then interpreted into capillary pressure. A common compromise between porous plate and mercury injection is centrifugation (Hassler and Brunner 1945). This method uses reservoir fluids and decreases the equilibrium time by using high centrifugal forces.

This paper describes a new method (Green et al 2007, US Patent 7,352,179, Chen and Balcom 2005 and 2006) for measuring capillary pressure employing a centrifuge and a new quantitative magnetic resonance imaging (MRI) method for measuring fluid saturation. The capillary pressure is calculated from the Hassler and Brunner equation at each radial position in the rock. This together with saturation as measured by MRI at each position directly produces a capillary pressure curve with as few as a single centrifuge equilibrium.

Traditional Centrifuge Pc Measurement

Hassler and Brunner (1945) proposed a centrifuge method to determine capillary pressure saturation data from small core plugs. In this method, a fluid saturated core plug, confined in a special core-holder, is rotated at different rotational speeds as shown in Figure 1. In the Figure, the relevant distances, de-

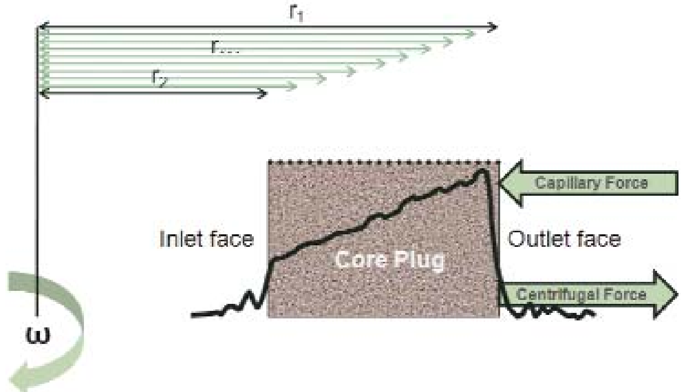

Figure 1 – Schematic of a rock core plug spinning in a centrifuge with a typically saturation profile overlaid

noted as r_1, r_2 and r, are the distances from the rotational axis to the inlet face, the outlet face, and any point along the core length, respectively. The core-holder contains another fluid which replaces the fluid displaced from the core. After reaching hydrostatic equilibrium, the amount of liquid expelled from the core plug is measured. From the expelled water the average water saturation at each centrifuge speed is known, and using an approximate solution, the saturation at the inlet face can be obtained. This saturation is plotted against the capillary pressure at the inlet as calculated from the centrifuge speed. This procedure is repeated 7-10 times to fully define the capillary pressure curve.

When a cylindrical core is placed in a centrifuge, a centrifugal acceleration $a_c = -\omega^2 r$, is generated, where w is the angular rotation speed of the centrifuge and r is the distance from the axis of rotation. Applying Darcy's law at hydrostatic equilibrium and using the Hassler-Brunner boundary condition that the outlet capillary pressure is zero (i.e. 100% saturation), we have

$$P_c(r) = \frac{1}{2}\Delta\rho\omega^2(r_2^2 - r^2)$$

where Δr is the density difference between wetting fluid and non-wetting fluid.

The radial capillary pressure distribution results in a fluid saturation distribution along the length of the core. Neither of these distributions is actually measured with the traditional method. What is measured is the rotational speed, ω, and the average fluid saturation, $\overline{S}$, within the core. The average fluid saturation of the core after centrifugation can be expressed as

$$\overline{S} = \frac{1}{r_2 - r_1}\int_{r_1}^{r_2} S(r)dr$$

Equation (2) may be rewritten and mathematically manipulated to yield the Hassler-Brunner integral equation

$$\overline{S}P_{cL} = \frac{r_1 + r_2}{2r_2}\int_0^{P_{cL}} \frac{S(P_c)}{\sqrt{1 - \frac{P_c}{P_{cL}}(1 - \frac{r_1}{r_2})}} dP_c$$

Equation (3), however, cannot be directly solved for the unknown function S. A number of approximate solutions exist to obtain the required inlet saturation (Ruth and Chen 1995, Forbes 1997, Rajan 1986). Hassler and Brunner assume short cores (i.e. $r_1/r_2 \approx 1$), and in differential form equation (3) is reduced to

$$S_L = \frac{d(\overline{S}P_{cL})}{dP_{cL}}$$

The inlet Pc is calculated at each rotational speed by setting r to r_1 in equation (1) and, saturation at the inlet face, S_L, is obtained according to equation (4). A plot of these two values, inlet Pc and inlet saturation, at different rotation speeds yields the capillary pressure curve.

Magnetic Resonance Imaging

Nuclear Magnetic Resonance (NMR) detects the amount of hydrogen (for proton NMR) in the sample or object under study. The lifetime of the detected NMR signal depends on the environment of the hydrogen. For example, signal detected from the hydrogen in most oils decays away faster than the hydrogen in free water. Magnetic resonance imaging (MRI) spatially resolves the NMR signal. Spatially resolving the MRI signal is achieved by linearly altering the magnetic field creating a magnetic field gradient. Both the field of view and the resolution are limited by the linear region and strength of the magnetic field gradient. A wide variety of different pulse sequences (combinations of gradient, excitation, and detection schemes) are available. The main difficulty with NMR (or MRI) is that because the signals are dependent upon so many things (amount of hydrogen, pore size, fluid diffusion, etc), obtaining quantitative results can be difficult.

The standard SPRITE MRI (Balcom et al. 1996) technique has proven, over the last 10 years, to be a very robust and flexible method for the study of a wide range of systems with short magnetic resonance relaxation times. As a pure phase encoding technique, SPRITE is largely immune to image distortions due to susceptibility variation, chemical shift, and paramagnetic impurities. Repetitive excitation and data acquisition are performed in the presence of ramped phase encoding gradients, which enable systems with short signal lifetimes to be successfully visualized.

A centric scan strategy for SPRITE MRI (Mastikhin 1999) removes the longitudinal steady state from the image intensity equation of standard SPRITE imaging, increases the inherent image intensity, and makes the detected signal only depend on the amount of hydrogen. The image signal intensity no longer depends on the spin-lattice relaxation time (T_1) and the repetition time making centric scan SPRITE an ideal method for quantitative imaging of sedimentary rocks with short relaxation times (Chen, Halse and Balcom 2005). A 1D double half k-space SPRITE (DHK) technique, also called 1D centric scan SPRITE, is illustrated in Figure 2.

Capillary Pressure Curves

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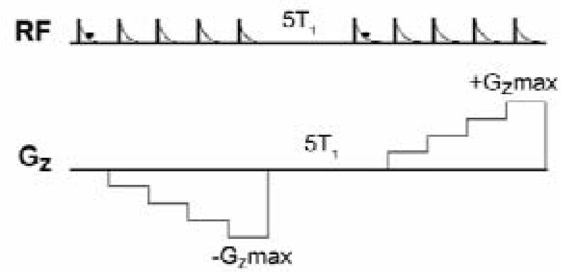

Figure 2 - The double half k-space version of the SPRITE MRI method

Other MRI methods have a T_2 dependence which is known to be multi-exponential and depend heavily on the saturation level. This makes quantitative analysis nearly impossible with these MRI methods (Baldwin and Spinler 1998).

MRI-based Capillary Pressure

Capillary pressure theory combined with MRI-determined saturation profiles allow us to directly obtain capillary pressure curves. With this technique, the centrifuge is used to create a distribution of fluid in the rock core plug dependent on capillary pressure, which then can be quantified using MRI. The capillary pressure at each position down the rock at hydrodynamic equilibrium is known from equation (1). The saturation at the corresponding positions is measured using MRI. The fully saturated profile gives us the 100% saturation level. We know that the 0% saturation level will yield no MRI signal as there is no hydrogen present. Therefore, dividing the centrifuged measured profile by the 100% saturated profile gives a quantitative saturation level versus position. Figure 3 shows a fully saturated and a series of centrifuged profiles.

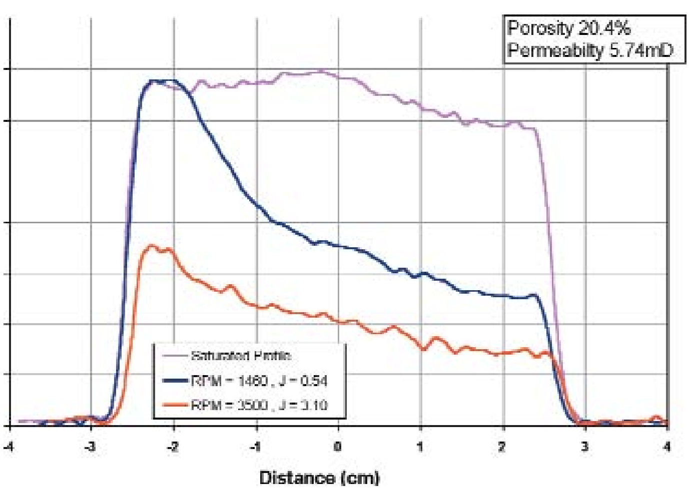

Figure 3 - MRI profiles of 1.5" diameter rock core plug. The fully saturated profile is the relatively uniform profile showing the homogeneity of the rock. The remaining profiles are acquired after successively higher centrifuge speeds. The left edge is the outlet face.

The radial distance is determined at each profile point knowing that one edge is the distance r_2, see Figure 1. The capillary pressure is then computed using equation (1) at each point and plotted with the saturation percent to create a capillary pressure curve.

Saturation profiles acquired after centrifugation at different speeds are plotted on the same curve expanding the range and resolution of the capillary pressure curve. The rotational speed(s) can be estimated by using the Leverett J function (Leverett 1941)

$$P_c(r) = \frac{1}{2}\Delta\rho\,\omega^2\left(r_2^2 - r_1^2\right) \geq \frac{J\left(S_{wi}\right)\sigma\cos\theta}{\sqrt{\frac{k}{\phi}}}$$

where J is the Leverett value, is the normal interfacial tension, is the contact angle, k is the permeability and is the porosity for a given rock. The J value "normalizes" the speed using this function (Brown 1951).

Results and Discussion

The new MRI-based method has proven to correlate very well with existing centrifuge and porous plate measurements (Green et al. 2007, 2008). This MRI-based capillary pressure measurement technique directly measures the water saturation in the rock core plug. Traditional centrifuge techniques measure the

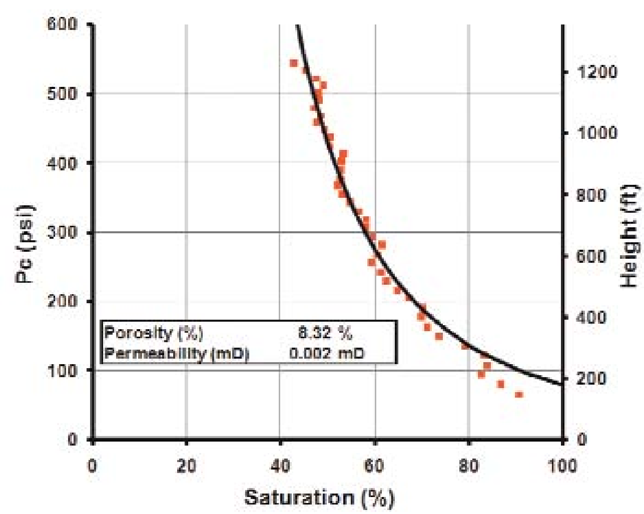

Figure 4 - Air/brine capillary pressure curve of a low permeability rock

expelled water and require simplifications and assumptions. The capillary pressure measurement using MRI requires only that the outlet boundary condition be met (i.e. 100% saturation at the outlet face). The assumption that the core plug length is negligible compared to the radius of rotation is not required in this new technique. In fact, the measurement relies on the capillary pressure gradient and the subsequent saturation gradient along the length of the core plug.

A typical air/brine result for a very low permeability core is shown in Figure 4. In this example, a single centrifuge equilibrium was used to acquire the Pc curve. The total experiment time was two days for core preparation, four days for the one centrifuge step, and less than two hours for the NMR scanning. A traditionally acquired Pc curve with only ten data points would have taken approximately 42 days. An additional benefit of the technique is that the T_2 pore size distribution can be acquired with virtually no increase to the overall experiment duration. The corresponding T_2 measurements; one fully saturated showing the pore size distribution, and the second used to determine connate water saturation, bound volume, and T_2 cut-off are shown in Figure 5.

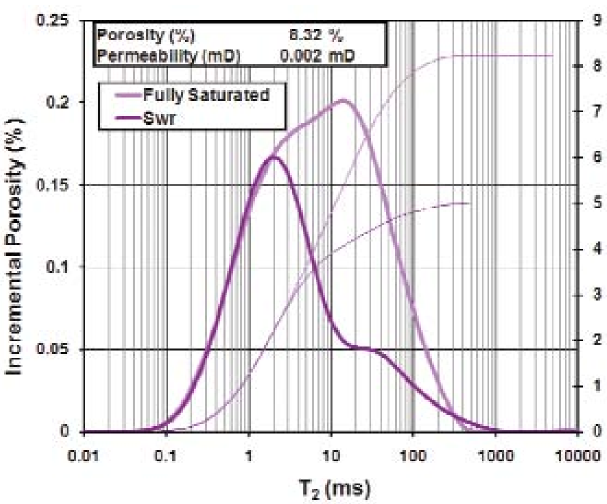

Figure 5 - T_2 cutoff measurements of a low permeability rock

The technique is easily expanded to oil/brine studies by using deuterium oxide for the brine. This makes the brine phase invisible to the NMR and only the oil phase is detected. A simple subtraction from the fully saturated profile yields the water phase. A typical oil/brine result is shown in Figure 7. In this example, the full set of capillary pressure curves was obtained; primary drainage, imbibition, and secondary drainage. The total experiment time for this measurement was 7 days compared to more than 60 days for the traditionally acquired measurements.

The GIT-CAP technique requires the rock core plug to be moved from the centrifuge to the MRI scanner which takes time. Much care and investigation has been given to the question of the redistribution of fluids between these two steps. It was found that there were two mechanisms that can cause changes in the fluid distribution in a rock: 1) spontaneous imbibition of "free" fluid into the rock; and 2) redistribution of fluid within the rock. Spontaneous imbibition of fluid can occur very rapidly (< 1 minute) but as long as free fluid does not come into contact with the rock this process cannot occur. This is easily achieved by using the standard receiving tubes used in traditional centrifuge capillary pressure measurements.

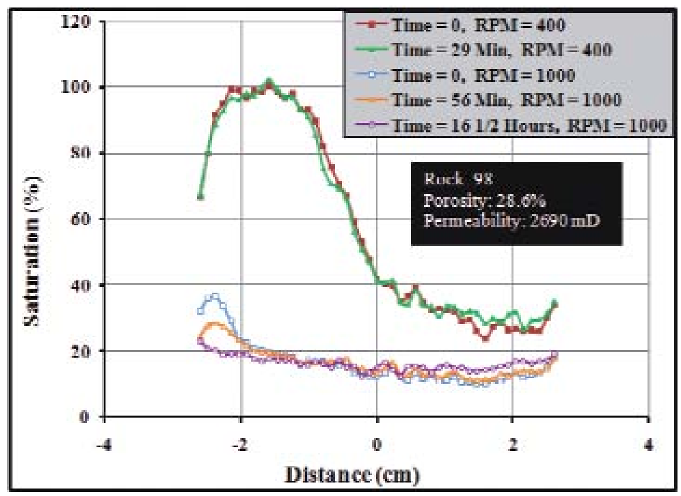

Figure 6 - Redistribution of fluid following centrifugation

Fluid redistribution within the rock is minimized by acquiring the MRI profiles directly after centrifugation. The MRI measurement time is typically between a few minutes and a couple of hours with the longer measurement times required for rocks that are desaturated and therefore have less fluid distributed within the rock after centrifugation. The redistribution of fluids is insignificant in the time required to acquire the MRI profile. Figure 6 shows the MRI saturation distribution down the rock length acquired after centrifugation repeated at different time intervals. In this case, the fluid still has not fully redistributed after two days. Even the high permeability (>2,500mD) rocks take at least 1 hour for any noticeable redistribution to occur within the rock.

Although it would be ideal to acquire the complete capillary pressure curve at one centrifuge speed, operational and MRI resolution restrictions may prevent this. In order to acquire a complete capillary pressure curve, the centrifuge speed must be selected such that the connate water saturation is achieved at the inlet face of the rock. This can be estimated but cannot be

Capillary Pressure Curves

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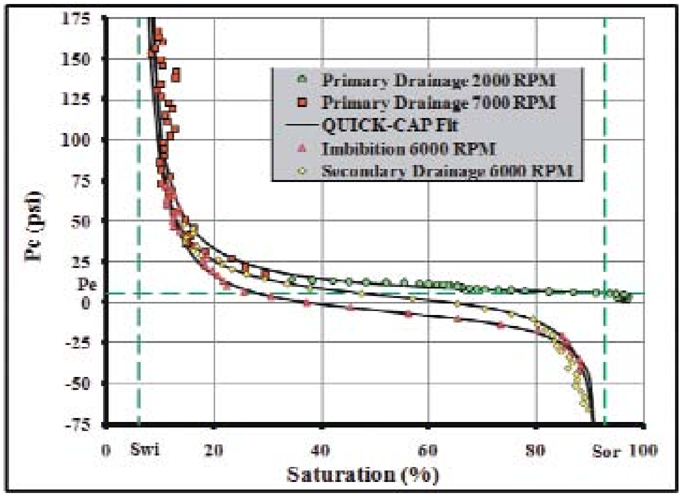

Figure 7 - Oil/brine capillary pressure curves

assured for all rocks. Study has also shown that it is difficult, at the lower capillary pressures, to fully define the curve. It also appears that the 100% saturation at the outlet face may be a very thin layer which cannot be resolved at the MRI resolutions currently used. In the end, it seems apparent that at least two centrifuge speeds will be required. The best two centrifuge speeds appear to be achieved when J=0.5 and J=4. The J=0.5 centrifuge speed allows the capillary entry pressure to be accurately determined. These values can be changed if different portions of the Pc curve are desired (i.e. higher pressures).

A number of additional benefits can be exploited using this technique. The fully saturated profiles can indicate inhomogeneities in the rocks and can be used to determine the pore volume. If the homogeneities are only in a portion of the rock, capillary pressure curves can still be obtained by only using the homogeneous section or alternatively an optimistic and pessimistic Pc curve can be generated from the same data. Another benefit is the ability to use longer rock core plugs to increase the maximum capillary pressure (i.e. decrease r in equation (1)). Longer core plugs will not only increase the maximum capillary pressures, but it will also increases the absolute water volume which will increase the NMR signal to noise ratio decreasing the scanning times. Another benefit is a simpler centrifuge setup. The centrifuge used in this type of measurement need not measure the expelled fluid as we directly measure the water in the rock. This greatly simplifies the centrifuge design and, in turn, significantly reduces the cost both in terms of capital costs, and ongoing maintenance requirements.

Conclusions

The new MRI-based capillary pressure measurement technique (GIT-CAP) is an excellent method to measure capillary pressure. In particular, it is beneficial for low permeability rocks as these rocks require high centrifuge speeds and long equilibrium times. The technique requires far fewer centrifuge equilibrium steps (typically two) and thus decreases the measurement time for a capillary pressure curve by a factor of three to five times. In addition, this measurement is inherently more accurate because the water saturation is directly measured in the rock. Also, GIT-CAP does not necessitate expensive centrifuge modifications and T_2 NMR data can be acquired during the test protocol with little or no time penalty.

Acknowledgments

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Canadian Well Logging Society

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Agus Kusuma

Joint Annual Convention Committee (JACC)

In order to improve future conventions, the three geoscience societies (CSPG CSEG CWLS) have created a permanent Joint Annual Convention Committee, responsible for all aspects of the annual joint conventions. The initial committee will consist of three representatives from the CSEG, three from the CSPG and one from the CWLS. As such, this will be the first joint business committee of the three societies, who will all collaborate together on future conventions under the mandate of improving both the technical and operational aspects of our convention programs.

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TOC from Conventional Logs: Compressional Slowness and Deep Resistivity

By P.Kubica, Petro-Canada

Concentration of organic matter in sedimentary rocks has been a subject of investigation for quite some time. In the past organic rich shales were studied to estimate hydrocarbon generating capability for surrounding reservoirs. With the recent focus on the shale gas potential, organic matter concentrations are important for estimating production potential and gas reserves of this unconventional resource. Many papers were published demonstrating the relationship of wireline logs to organic richness of shales and silts. The organic richness of the rock is usually quantified by the total organic carbon (TOC) expressed in weight percent of the total sample. Geochemical laboratory methods can accurately estimate TOC of rock samples. While this is the most accurate method of characterizing the organic richness, it is also quite a labour intensive and costly method.

Usually only selected samples and intervals are analysed. Therefore, it is highly desirable to employ methods based on wireline data that produce continuous estimates of TOC values along the wellbore.

Numerous data and correlations were used in the past for TOC estimates: Natural GR, spectral GR, Uranium concentration, sonic, resistivity, density, neutron and more recently sophisticated nuclear activation and interaction methods. It is not the intent of this note to review or critique all different methods, but rather to demonstrate a working example of the methodology to estimate TOC from wireline data.

It is well known that organic matter of rocks demonstrates itself by higher GR readings, usually beyond the range of typical shales. Particularly, in marine source rocks, the Uranium component of the GR contributes significantly to the total radiation. Also, along with the high GR we frequently observe increased resistivity and increased porosity in organic rich rocks. This is because organic matter is normally found in kerogen which is a complicated organic compound consisting of C, O and H. Kerogen is electrically non-conductive and of relatively low specific density (~1.2 g/cc). Significant concentrations of kerogen then lead to apparent porosity and high resistivity on wireline logs – similar to the response of hydrocarbons.

One of the most reliable methods of estimating TOC from wireline logs is the deltaT-logR method described by Passey et al. The method is quite simple, requiring only sonic, resistivity and GR logs. This technique consists of adjusting the sonic log to overlay the resistivity in a non-source shale interval. Source rock intervals are then demonstrated by the separation of the resistivity (to higher values) relative to the sonic log. The amount of this separation on a logarithmic scale is then converted to a TOC value by an exponential formula. The GR log is used only as a discriminator between the potential reservoir zones and the source rocks at higher GR.

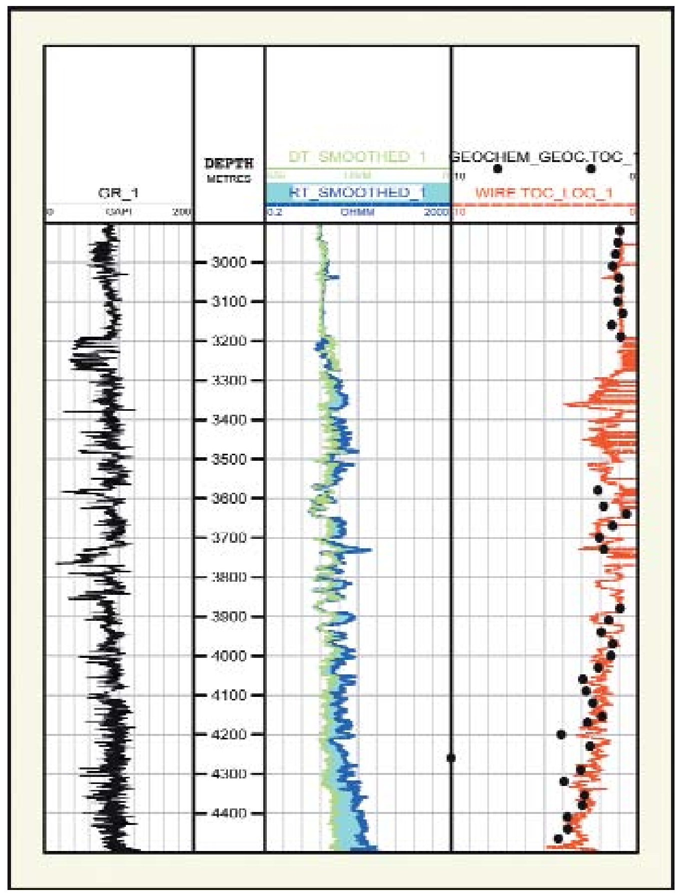

Figure 1: Sonic Resistivity estimated TOC and core TOC.

Figure 1: Sonic Resistivity estimated TOC and core TOC.Figure 1 is an example of this method and the correlation with the geochemical data. At the top of the interval we observe low resistivity indicating organic lean shale. The sonic log is shifted in this interval to overlay the resistivity data. The increase of resistivity above the sonic log below is indicative of the increase of the organic content of shales. This separation was used to estimate the TOC. Good agreement of the log calculated TOC with the geochemical data corroborates the validity of the method.

The only adjustable parameter in the calculation from the wireline data is the estimate of the maturity of the organic matter. The parameter LOM (level of organic maturity) can be estimated from the geochemical data (it is related to Ro – vitrinite reflectance). Another way to estimate the LOM parameter is by varying its value to fit the TOCs from geochemical lab methods. Following is the equation for TOC (in wt. %)

$$TOC = (\Delta)\times 10^{(\alpha-\beta LOM)}$$
$$\Delta = Log_{10}(Rt/Rt_r)+\gamma\left|dTc - dTc_r\right|$$

TOC is the total organic carbon (wt. %), dTc is the compressional slowness (us/m), Rt is a deep resistivity (ohm.m), LOM is the level of organic maturity (higher level indicates higher maturity, dTc_r and Rt_r are the compressional slowness (us/m) and deep resistivity (ohm.m) in selected non organic zones respectively. α, β and γ are calibration coefficients. These coefficients vary from field to field depending on mineral composition, maturity and depositional environment. The above correlation can be applied on density and neutron porosity logs as well. However, acoustic compressional slowness shows less dependency on rock mineral composition.

A qualitative estimate of the source rock maturity can be also made from the observation of the responses of sonic and resistivity logs. It has been observed that mature source rocks have high resistivities and moderate transit times. Lower maturity source rocks have long transit times and relatively low resistivities. A schematic of log signatures for different situations are demonstrated on Figure 2 (from the original publication of Passey et al).

In summary, the deltaT-logR method is a robust technique to estimate TOC quantitatively with a minimal calibration from lab data. TOC of source rocks is an important parameter in estimates of shale gas potential.

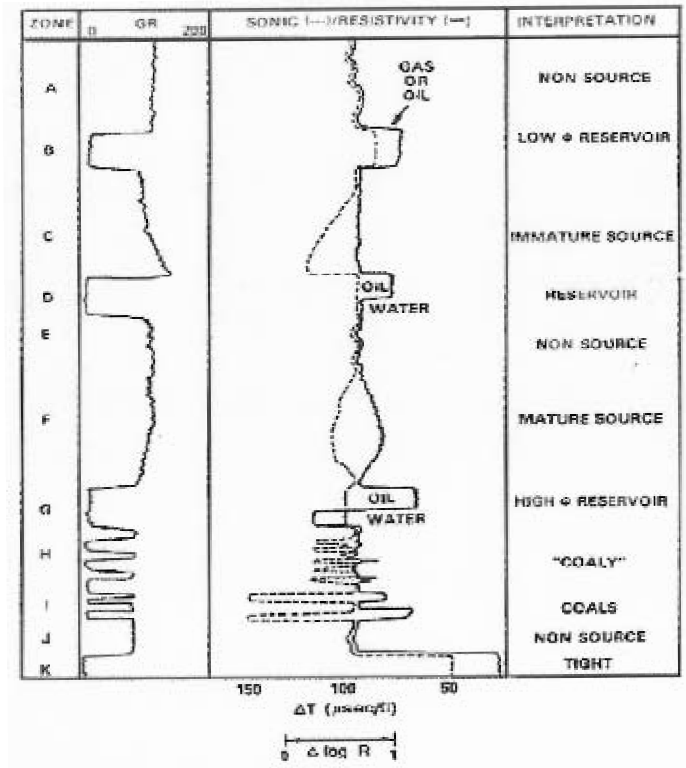

Figure 2: Sonic Resistivity Overlay Interpretation Guide (after Passey et al. 1989).

Reference

Q.R.Passey et al, AAPG Bulletin (1990), v.74, No 12, pp 1777-1794.

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TOPIC: **Development of a Predictive Tool for Estimating Well Performance in Horizontal Shale Gas Wells in the Barnett Shale, North Texas, USA**

SPEAKER: **Russell W. Spears, Petrophysicist, ExxonMobil**

ABSTRACT:

Production from “unconventional” shale gas reservoirs has seen increased attention and economic viability in recent years through the use of horizontal development wells. Maximizing horizontal permeability in such wells has been found to be one of the largest keys to unlocking shale gas reservoirs and producing them at economic rates. Currently, a world-class shale gas accumulation is being developed in and around the Dallas-Fort Worth, Texas area using horizontal well applications.

A multi-component approach to derive reliable and accurate predictions of horizontal shale gas well performance is presented here, using open hole well log data from several vertical pilot boreholes that have been drilled targeting the Barnett Shale. Fundamentally, this approach is founded upon four key elements: a thorough probabilistic volume estimation of lithology, calculation of total porosity, estimation of free gas present using a modified dual water saturation model and prediction of kerogen and total-organic-carbon (TOC) of the interval.

From the primary evaluation from open hole logs, net kerogen-feet, TOC-ft and adsorbed gas-feet have all been identified as meaningful measures of shale “quality” that are useful as a vehicle to obtain accurate predictions of horizontal well ultimate recovery gas volumes (EUR). These factors have been weighted as a function of drilled lateral length for the horizontal production hole that has been subsequently drilled from each pilot. Varying the values calculated at the pilot well according to horizontal length is a key aspect of this evaluation technique and the weighting of these parameters found to correlate to decline-curve based EUR volumes for the study wells. The net product has been a reliable indicator for visualizing and quantifying well performance in five existing Barnett Shale horizontal wells, using standard open hole well log data acquired in the vertical pilot holes.

BIOGRAPHY

Russell W. Spears is currently a Petrophysicist working in ExxonMobil Production Company’s North American Production Division and part-time in ExxonMobil Upstream Research Company. Russell’s direct responsibility involves primarily production and open-hole log evaluation and research in tight and unconventional gas projects in the Piceance Basin, Colorado and the Barnett Shale, east Texas. Russell holds a BS in Geology from the University of Georgia, attended Oxford University, and holds a MS in Geology from Louisiana State University. Russell has worked in a few affiliates both domestic (New Orleans, Houston) and internationally (Nigeria), with experience in deep- and shallow water clastics, tight clastics, shale gas and carbonates. Russell currently serves as the 2008-2010 VP of Education for the SPWLA, has served twice as a Regional Director for the SPWLA, serves on the SPWLA Long-Range Steering Committee and the SPWLA Foundation Scholarships committee. He is also a co-chairman of the SPWLA Depth Control SIG and a former secretary of the New Orleans chapter of the SPWLA.

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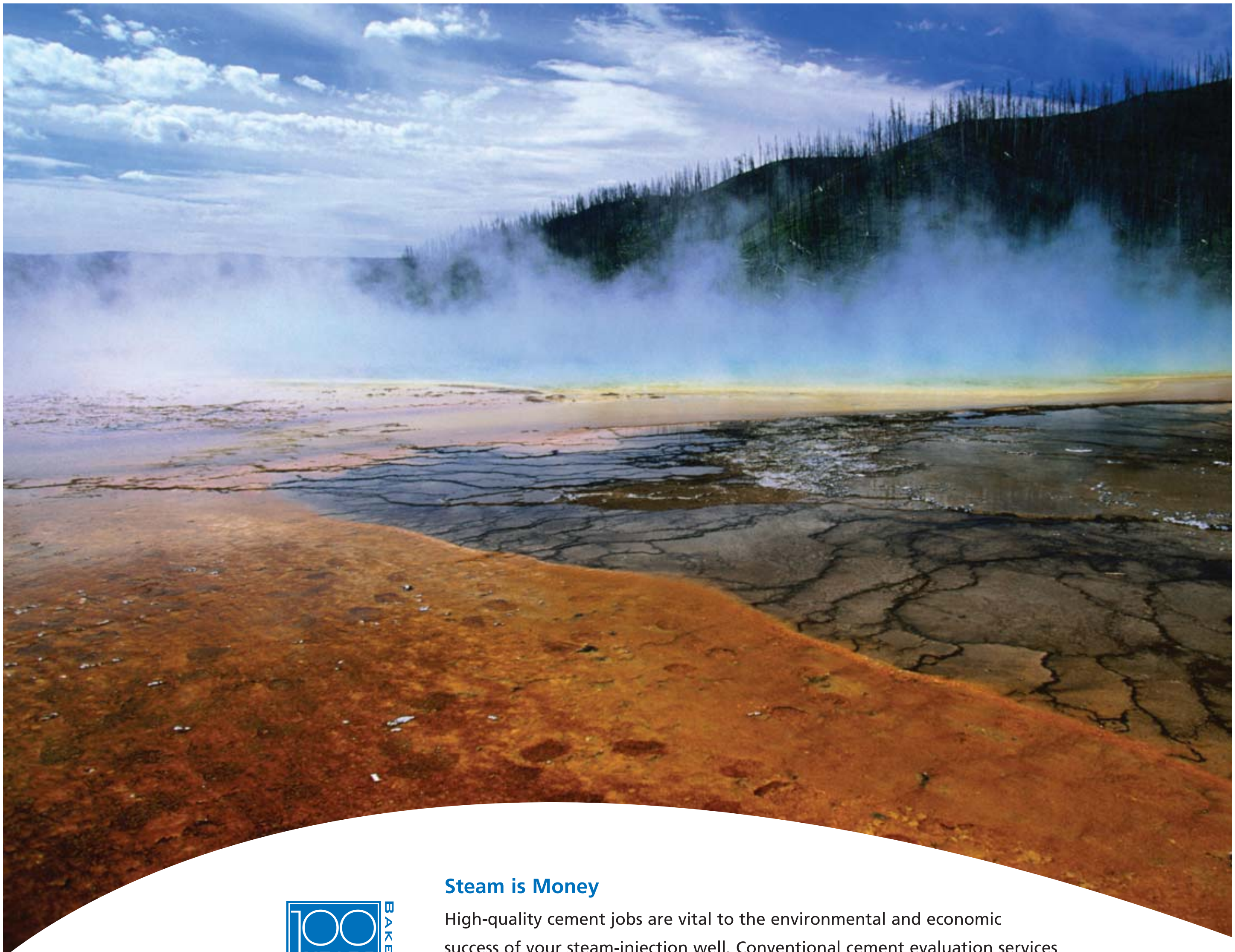

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