InSite

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December 2006 Issue 4 Volume 25

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The InSite is an informal magazine with technical content. The material is not subject to peer review. The opinions expressed are those of the individual authors.

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Agip Refinery in Italy, Villa D'agri. Photo courtesy of Andy Hill

If you have a photo that the CWLS can use on its next InSite cover please send a high resolution jpeg format version to Tyler.A.Maksymchuk@conocophillips.com or burlwin@talisman-energy.com. Include a short description of the photo with your submission.

The 2006 - 2007 CWLS Executive:

Front row (l - r): Jeff Taylor, John Nieto, Peter Kubica, Michael Stadnyk
Back row (l - r): Gordon Uswak, Gary Drebit, Dave Ypma, Benjamin Urlwin, Tyler Maksymchuk

President's Message

Those of you who attended the lunch meeting in November took notice of the large cheque CWLS received from the revenues of the last CSPG-CSEG-CWLS convention (over $160000). While some of this revenue is needed to run the business of our society we are finding ourselves in a significant surplus situation. It is the intention of the executive to use some of this surplus to establish a Student Awards Foundation with an initial amount of $100000. The investment income from this initial infusion of capital, along with any other future contributions will be used to fund student awards. A formal motion to establish the Student Awards fund will be made at the AGM in February. The CWLS executive welcomes any feedback on this issue from the society members.

In past years we had some difficulties attracting qualified applicants for our student awards. We are looking for applications from students who intend to work towards a thesis related to Formation Evaluation, Well logging technology or Petrophysics. In my opinion we will need to increase student awareness of the CWLS Award opportunities as well as of careers in our profession. This may take some significant effort on the part of our society. Therefore , I would like to invite members of our society to volunteer to serve on the Student Awards committee to promote our profession to students in engineering and earth sciences.

The joint SPWLA-CWLS topical conference titled " Petrophysics Under Stress" took place at the Kananaskis Lodge Oct 30-Nov 2/06. The attendance exceeded our expectations with over 70 participants from around the world. Many experts in this field made presentations on the significance of stress measurements and interpretations in relation to formation evaluation, drilling, exploration and production. While there are no written records of presentations, the Petrophysics journal will publish a summary of the main conclusions and learnings from this conference.

The end of the term for the present executive is fast approaching. We are about to close the nominations for the new executive to be elected in January 2007. Two more regular technical lunch meetings will take place in December and January. The AGM meeting will follow as usual in February 2007.

A committee of the past 3 presidents under the leadership of Dave Greenwood examined our present society bylaws and made some suggestions for improvements. We are planning to present the proposed changes to the membership at our AGM for a vote approval.

We are already scheduling technical presentations for March 07 and beyond. However, we are always looking for interesting presentations from our members or from suggested visitors. If you would like to present or if you have a suggestion for a speaker, do not hesitate to contact our VP Jeff Taylor.

With the best wishes for the Holiday Season

Peter Kubica
CWLS President
Tel: 296-4241
kubica@petro-canada.ca

Editor's Note

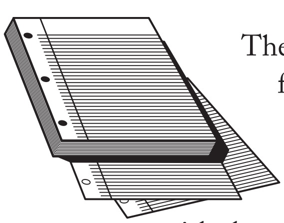
Welcome to the last InSite issue of 2006. Another year down, and another year of busy times in the Calgary/Canadian oil and gas industry.

It has been an interesting year all round, and Calgary has taken on an almost manic disposition. The housing market went crazy early on in the year, right on the heels of an incredibly busy oil and gas market. Then, with a resounding screech, things flipped around and a slowdown occurred (albeit only back to manageable activity levels). Fall saw some of the majors cutting their winter drilling budgets by hundreds of millions of dollars, and a house for sale would actually stay on the market long enough for it to be seen on the MLS website! Coming off the $12/mcf high of last winter, seeing a summertime price of roughly $4 for natural gas was almost enough to spill your Starbucks. The outlook during these times was not helped by the Federal Government blindsiding pretty much everyone in the business world with it's shakeup of Royalty Trusts, which in one fell swoop, shaved between 20 and 30% off of nearly every oil and gas Trusts stock price. Thankfully, the dust from that has settled, and we have even seen Mother Nature throw her hat into the ring. With a vicious winter cold snap here, and the early and abundant snow across the west coast, natural gas prices are now starting to look a little healthier and are on their way back up. With approximately 450 rigs out digging up the earth in November (as compared to well over 600 for this same time last year) things are still going well, just not crazy.

Keep you calendars open for the CWLS AGM coming in Feb 2007, we have a great speaker lined up, and as always, it's a good show!

Tyler Maksymchuk & Ben Urlwin
Co-Chairs of Publications

Call for Papers



The CWLS is always seeking materials for publication. We are seeking both full papers and short articles for the InSite Newsletter. Please share your knowledge and observations with the rest of the membership/petrophysical community. Contact publications co-chairs Ben Urlwin (burlwin@talisman-energy.com) at (403) 237-4673 or Tyler Maksymchuk (Tyler.A.Maksymchuk@conocophillips.com) at (403) 260-6248.

As the Winch Turns

One of the bonuses of my chosen profession is the amount of time I spend away from home traveling, of course that is one of the curses as well. But I have been able to see things that I never expected to ever see and done things I can't believe. I will never forget seeing my foot prints in the sands of the Sahara, the first glimpse of Petra, driving in Cairo, or the mountains in Yemen. But there are other memories that are as vivid and will remain as long for slightly different reasons.

One recollection that often comes to mind, unbidden, concerns an experience from a couple of years ago in Egypt. I was sitting some heavy oil wells for a smaller Canadian company near the Suez Canal in the Eastern Desert. We were only a few kilometers off the Gulf along the coastal highway. The Eastern Desert was very dry, with scattered showers that happen about once every ten years. All of the human habitation occurs near the sea shore, so at night all of the lights are along the coast line. But one night as old Earl and I were driving back from supper we noticed a group of lights North West from the rig. I was a bit confused and asked Earl if the coast went that far west. After vague comments on the navigation intelligence of geologists he pointed out that you could see cars on the coast road and this was a long ways inland from that.

A few days later when things were slow we went exploring. Of course he was driving because as he put it:

"It is dangerous riding with geologists because they drive down the road looking at the rocks and sometimes they drive down the rocks looking at the road."

After a few false starts, a couple of illegal turns and a lot of confusion we found a Copt monastery called Saint Paul's at the foot of a mountain and the source of our lights. It was over 1700 years old and built over a spring that put out 4 cubic meters of water a day. One of the chapels had graffiti on the wall left by the crusaders. They even had a garden and flower beds. It was fabulous. Although I am not by nature a religious man it became a habit to go there whenever a break from work and the desert was needed.

I got to know one of the monks a bit as his job was to show the tourists around. He was a small brown man with a large bushy beard that was wild and untrimmed. His clothing was a rough brown robe with a hood that fit over a tight cowl that hid his hair. On his feet was a pair of cheap flip-flops that slapped as he walked. He was very shy, seldom looked up and only very rarely made eye contact. In short, he was the ideal Hollywood monk. We often talked about his belief system, the required fasting days, the quiet life of a monk and of course the history of his home.

On one visit we were comparing notes about the full moon the night before. Both of us had been out walking in the desert until late. It had been beautiful, peaceful and stirring. We compared notes, during which he of course, given his chosen profession, had interjected frequent "Praised be God's". While I was thinking "that must have been a piece of granite that I tripped over." When the topic was played out and silence threatened he turned, looked right at me and said, "I have been having troubles with my email lately, have you noticed any problems?" I am not sure what tripped me that time.

Dave

CWLS 2006 to 2007 Executive

President
Peter Kubica
Petro-Canada
150 - 6th Avenue SW
Calgary, AB T2P 3E3

403-296-4241 (Office)
403-296-5176 (Fax)
kubica@petro-canada.ca

Past President
John Nieto
Pengrowth Corp
2900, 240 - 4th Avenue SW
Calgary, AB T2P 4H4
403-213-3680 (Office)
403-619-7781 (Cellular)
John.Nieto@pengrowth.com

Vice-President
Jeff Taylor
Nexen Inc.
801 - 7th Avenue SW
Calgary, AB T2P 3P7

403-699-4311 (Office)
403-612-8474 (Cellular)
jeff_taylor@nexeninc.com

Secretary
Dave Ypma
Tucker Wireline Services
900, 444 - 5th Avenue SW
Calgary, AB T2P 2T8

403-232-1720 (Office)
403-990-0876 (Cellular)
403-264-2118 (Fax)
dypma@tuckerenergy.com

Treasurer
Gary Drebit
Schlumberger of Canada
525 - 3rd Avenue SW
Calgary, AB T2P 0G4

403-509-4267 (Office)
403-509-4220 (Fax)
gdrebit@calgary.oilfield.slb.com

Publications Co-Chair
Ben Urlwin
Talisman Energy
Suite 3400
888 - 3rd Street SW
Calgary, AB T2P 5C5

403-237-4673 (Office)
403-813-0592 (Cellular)
403-693-2430 (Fax)
burlwin@talisman-energy.com

Publications Co-Chair
Tyler Maksymchuk
ConocoPhillips Canada
2100, Bow Valley Square 4
250 - 6th Avenue SW
Calgary, AB T2P 3H7

403-451-0172 (Office)
403-880-7386 (Cellular)
403-451-0166 (Fax)
Tyler.A.Maksymchuk@conocophillips.com

Chair of Committees
Gordon Uswak
EnCana Corporation
150 - 9th Avenue SW
PO Box 2850
Calgary, AB T2P 2S5

403-645-3484 (Office)
403-620-1418 (Cellular)
403-645-2453 (Fax)
gordon.uswak@encana.com

Membership Chair
Michael Stadnyk
Talisman Energy
Suite 3400,
888 - 3rd Steet SW
Calgary, AB T2P 5C5

403-237-1260 (Office)
403-860-5623 (Cellular)
403-231-2851 (Fax)
mstadnyk@talisman-energy.com

Message from the Vice-President

Nintendo Petrophysics

I flip the switch and the big screens begin to wake up. I'm looking at a computer that I fear is way smarter than me. Apologies to 2001: A Space Odyssey ...

"I'm sorry, Jeff. But this analysis is far too important for me to allow you to jeopardize it."

"But HAL, your Vsh calculations will result in missed pay!"

"My probabilistic analysis indicates that the reservoir will pass through the collocated cokriging with minimum uncertainty. Please press the highlighted CONFIRM button. ...... Daisy, Daisy ....."

My fear is that eventually these darned G&G apps will simply become too complicated. Is this simply an old geezer issue? Is the new generation that's coming along right behind us any better able to cope? I mean, evolution has already provided them with longer and more pointed thumbs.

I don't think the issue is generational - it is the increasing number and complexity of tools available for geoscientists that can lull us into losing track of the basics. We have started to believe that computers find oil and gas.

Garbage In ....

Fields are becoming harder to find and develop, so it's more important than ever before to maximize the geoscience interpretation effort. And this can be harder to do with the workstation. How?

The workstation environment often means working isolated in cubicles and a downsizing of collaborative work space. Has this workspace stifled our ability to collaborate, challenge and integrate?

For example, I rarely see much effort given to a good lithological interpretation. Subtle differences between logs on different wells or between different contractors, the requirement to know the properties of the lithologies and which of these are present makes a standardized lith model almost impossible. This information would almost always help the geologist understand the section better. However, the ever present need to do more, faster means that it's rarely done and the geologist's need not well conveyed.

There is also a tendency to overlook the need to rigorously load information about data quality into the workstation. As this information is missing, the tendency is to believe whatever's on the screen is the truth.

Byte Me ....

So what can we do to ensure that we are honoring our data appropriately and accurately? A few simple things - know your data quality, utilize paper and pencils and ask for help. It is important to encourage less experienced geoscientists to feel comfortable in asking others for their ideas and to test their own ideas against colleagues.

I recommend that you bring your junior personnel to the wellsite. Get them dirty, climb all over the rig, have them run the brake for a few meters. Go over the logging tools with your hands, have them tighten a standoff. Until you can put yourself into the mud with a logging tool, your understanding of data quality will be limited.

My first trip to a rig was at the invitation of the Company Man. With some hesitation I asked, "What is it like?"

"It'll be great. A big party. Lots of fun, food, gratuitous sex. You'll have a blast."

"Who all will be there?"

"Just you and me." He said with a disturbing twinkle in his eye and then laughed.

Now I bring others to the field to do some mud wrestling with the loggers. This is almost always a steep and worthwhile learning experience.

Digital data and software/hardware available today are more powerful and provocative than ever before. When combined with the best quality data and an understanding of the data quality and its limitations, we can generate better geoscience than ever before. But first get away from the workstation and collaborate in order to learn how use it better.

The future of Formation Evaluation is probably safe - but you still need to get away from the workstation to make it so.

Jeff Taylor
CWLS Vice-President
Tel: 699-4311
jeff_taylor@nexeninc.com

New Members

Amine Khelil, ENSP
Frank Tadgell, Niska Gas Storage
Dave Amendt, ConocoPhillips
Robert Barba, Integrated Energy Services Inc
Mohamed Hadjali, Ryder Scott Company
Linda Oukil, Ryder Scott
Randy Smith, RPS Energy Canada
Jeff Durand, U of A
Melissa Signeira, U of C
Aiman Bakharj, U of A
Mike Mcara, U of C
Marc Boulet, U of C
Travis Todd, U of C
Heather Schijns, U of A
Todd Bown,
Kayla Maloney, U of A
Xun Qi, U of A
James Ostrikoff, U of A
Kristian Hermann, Student - University of Calgary
Judith Chan, U of A
Helen Yam, U of A
Mark Jeroncic, U of A
Cory Meeuwisser, U of C
Wynn Whitney, U of C
Kevin Bianchini, U of A
Brenner Ryan, U of C
Piercy Spencer, U of C
Catherine Ng, U of C
Curtis Lentz, Recon
Jennifer Wells, Seven Energy
Phebe Chung, U of C
Michael Lam, MCL Resources Ltd
Bruce Wrightson, Rocky Layman Energy Inc

The Role of the Modern Petrophysicist

Bandar D. Al-Anazi

Petrophysics touches every aspect of the petroleum business. It provides universal, concise and comprehensive descriptive information on reservoirs. Petrophysics can be defined as "the study of formation rocks with their interaction with formation fluids". It is about describing the oil and/or gas distribution and the production flow capacity of reservoirs, from interpretations of several types of logs and integration of these interpretations with other petrophysical data and analysis from other sources like cores and well tests. Petrophysics answers the most important questions associated with exploration, development and production. These questions are: Are there any hydrocarbons? If so, how much? If a reasonable amount, will they flow?

To answer these questions, porosity, permeability, fluids saturation, reservoir lithology, fractures, original fluid contacts and other reservoir parameters should be estimated under reservoir conditions. However, these parameters rarely can be measured directly. They can only be interpreted from a multitude of indirect measurements such as Resistivity, Density, Gamma ray and Neutron logs. Here comes the role of the well logging and the petrophysical interpretation to collect and analyze these indirect measurements in order to provide rock and fluid properties and find hydrocarbons zones.

Logging tools have been developed to measure electrical, acoustic, radioactive, electromagnetic and other properties of rocks and their contained fluids.

Basically, there are two types of well logging: wireline logging and logging while drilling LWD. The wireline well logging consists of lowering a 'logging tool' on the end of a wireline into a well. This type of logging requires removing the drill string. This is why Wireline logging is usually performed at various intervals during the drilling of a well and when total depth is reached. Data is recorded to a printed record called a 'Well Log' and is transmitted digitally to office locations. Wireline logs have been and continue to be one of the most critical widely available tools for characterizing and managing reservoirs.

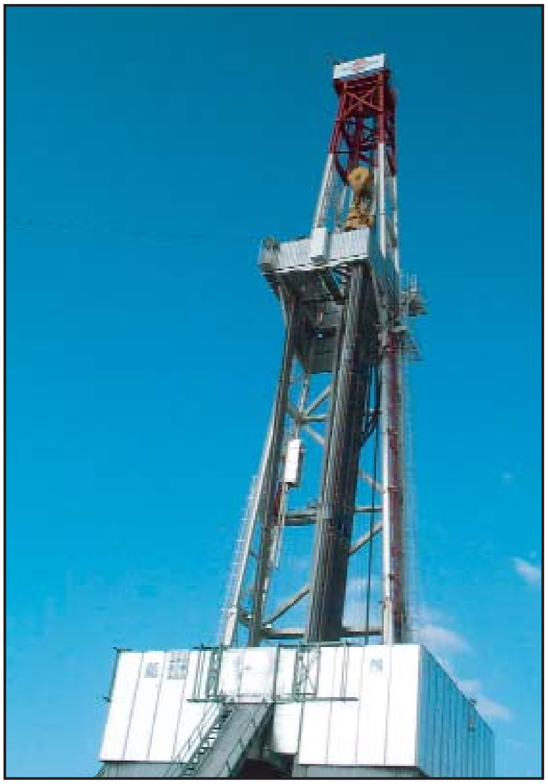
In the recent years, LWD has been introduced. The LWD tools are attached to the drill string and measurements are made while the well is being drilled. LWD real-time data are very helpful in terms of goesteering and horizontal or directional drilling considering the fact that LWD provides virgin and invaded formation evaluation. This data is transmitted to the surface via pressure pulses through the drilling mud. In addition, it can be retrieved from the memory of the tool when the drill string is removed from the hole.

Petrophysicists utilize their skills and use advanced log processing software to analyze and interpret the data. They integrate this data with the goal of reducing risk and uncertainty in the in-place hydrocarbon calculation, maximizing recoveries and optimizing productions. Their interpretations are used for tracking reservoir depletions, planning workover operations and enhanced recovery strategies, and diagnosing production problems such as water influx and injection water breakthrough.

About the Author

Bandar D Al-Anazi is a student in King Saud University in Petroleum and Natural Gas Dept. He joined KSU in 2003 and is a member of the Society of Petroleum Engineers (SPE), the American Association of Petroleum Geologists (AAPG), the Society of Exploration Geophysicists (SEG), the Dhahran Geosciences Society (DGS), the Candidate Fellowship the Geological Society of London, the Society of Petrophysicists and Well Log Analysts (SPWLA), the European Association of Geoscientists & Engineers (EAGE), the Canadian Society of Exploration Geophysicists (CSEG), the Edinburgh Geological Society (EGS), and the Geological Society of South Africa (GSSA). He was a secretary of SPE-KSU chapter from 2004-2006 and he is currently president for the chapter for 2006-2007

P.O Box 122331, Riyadh 11721, Saudi Arabia
E-mail: Oil_qas@yahoo.com



Archeological dig just outside a rig which is located in a national park in Italy. Archeologist were uncovering roman ruins. Photo courtesy of Andy Hill.

Fundamentals of the Pickett Plot

Bandar D. Al-Anazi

When Dick Pickett introduced his plot he emphasized that it should not merely be used as a graphical substitute for calculations that could be done with a slide rule. Instead, it was to be a means for pattern recognition, so that trends and discriminations within the clouds of cross-plotted points could be related to pay zone evaluation and reservoir structure. Even today, the same plots are displayed on computer monitor screens as a reconnaissance device to recognize reservoir patterns and to validate the values of parameters used in log analysis equations. Newer concepts of textural controls on productivity can be evaluated immediately on these plots and used in the distinction of potential pay and assessment of likely water cut. Contour lines of bulk volume water may be plotted directly as cut-off boundaries for immediate decisions concerning testing or abandonment. Some interpretations of permeability are also possible in favourable situations.

These more perceptive uses of crossplots reflect a clearer understanding of the role of pore size and geometry in the determination of reservoir characteristics. This knowledge has come from geological studies of the relation between rock textures and the depositional and diagenetic history of the rock, as well as engineering studies of productivity as related to porosity, water saturation, and rock type. New insights have gone a long way to the explanation as to why some zones that appear to be wet have significant production, while other, supposedly good pay zones, produce only water.

The principles of the Pickett plot will be illustrated with the hypothetical data set of resistivity and porosity values logged in the Rottweiler Sandstone, with "Archie rock" properties and a simple reservoir profile (Figure 1). The example consists of a pay section at irreducible water saturation (zones A-E), a transition zone (Zone F), above a water leg (zones G-J). The sandstone has been logged in the hypothetical wildcat, Toto

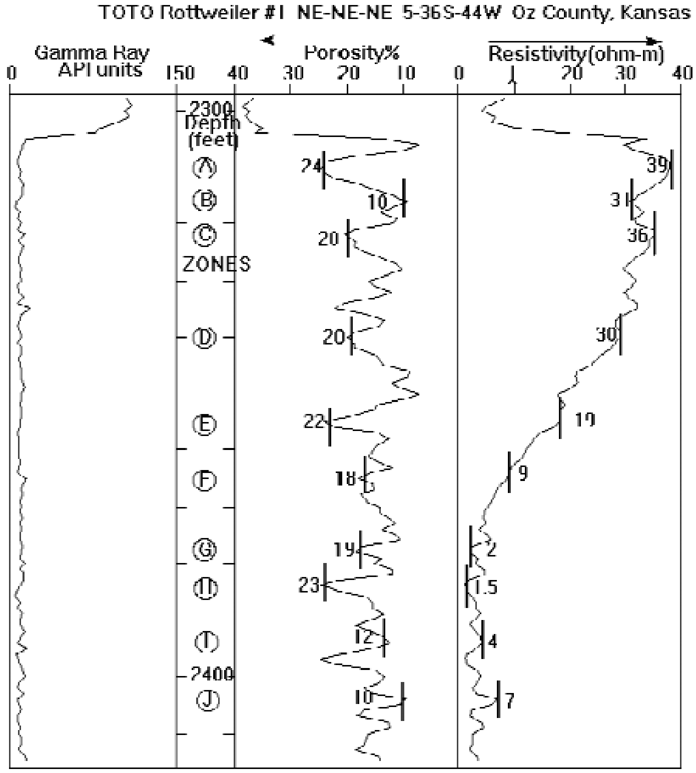


Figure 1: Gamma ray, porosity and resistivity logs of a section of Rottweiler Formation (Triassic), a hypothetical oil-productive sandstone

Rottweiler #1. We will suppose that the log analyst has no idea concerning either the formation water resistivity, or any other parameter values that he or she would need to solve the Archie equations. However, the log analyst is very familiar with the Pickett plot and sets to work to evaluate the section.

The Pickett plot is made on conventional double logarithmic (to base ten) scale graph paper. An examination of a crossplot of the porosity and resistivity values of the ten zones (Figure 4)

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Fundamentals of the Pickett Plot *… continued from page 11*

shows a pattern that is easy to interpret. Zones A to E have much higher resistivities than zones H to J, even though they have similar porosities, and suggests that these zones may have appreciable hydrocarbon content. Zone F is intermediate between these two clusters, and its depth relationship to them indicates that it may be in a transition zone. The zone H-J trend of a systematic decline in resistivity with porosity also favours their interpretation as possible water zones.

These qualitative generalizations can be made considerably more specific, using the mathematical properties of the graph form and its ability to represent many useful petrophysical relationships. The basic method for the plot that bears his name was described by Pickett (1966). In a later paper, Pickett (1973) described in detail the pattern recognition properties of the plot, which made it a particularly powerful method for log interpretation. The mathematics of the Pickett plot are simpler than those of the Hingle plot (Hingle, 1959), and is another transformation of the Archie equation:

Rearranging the Archie equation and substituting the resistivity index, I, gives :

$$S_w^n = \frac{aR_w}{\phi^m R_t}$$

Taking logarithms, the equation becomes:

which describes a family of parallel lines for different resistivity

$$R_t = \frac{aR_w I}{\phi^m}$$

index values whose slope is the negative of the cementation ex-

$$\log R_t = \log(aR_w) - \log I - m\log\phi$$

ponent (-m). When the resistivity index, I is unity, the line is the water line with an intercept equal to a*Rw. Other resistivity lines are displaced to the northeast and are drawn easily as lines parallel to the water line and with resistivities which are the water line resistivities multiplied by the index at common values of porosity.

In common with most visual methods, these concepts are more obvious when sketched out graphically, as in Figures 5 to 7. The water line can be established by eye, or numerically, by stipulating the formation water resistivity, Rw, and the Archie constants of a and m (Figure 5). Many log analysts prefer to work with the value of a held at a value of unity. Using this convention, the intercept is equated directly with Rw, and the slope of m becomes an average estimate of cementation factor within the reservoir. If a trend of (relatively) low resistivity points is suspected to sketch out a water line, then the exact position can be established through the selection of water resistivity and Archie constants that are most compatible with pre-existing

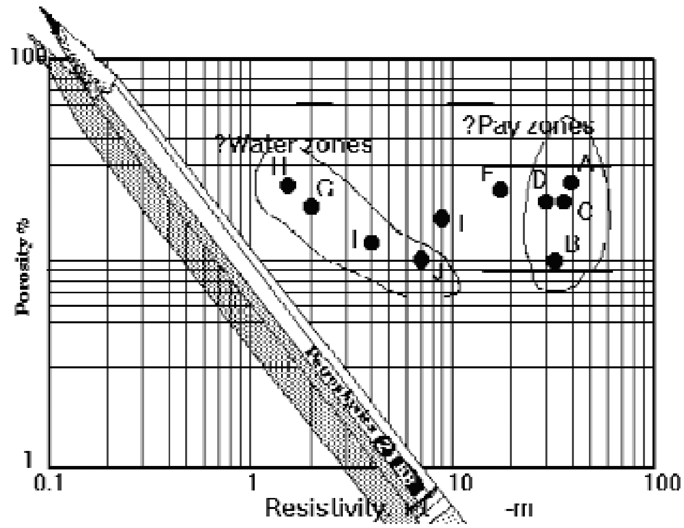

Figure 4: Plotting zones on a Pickett Plot

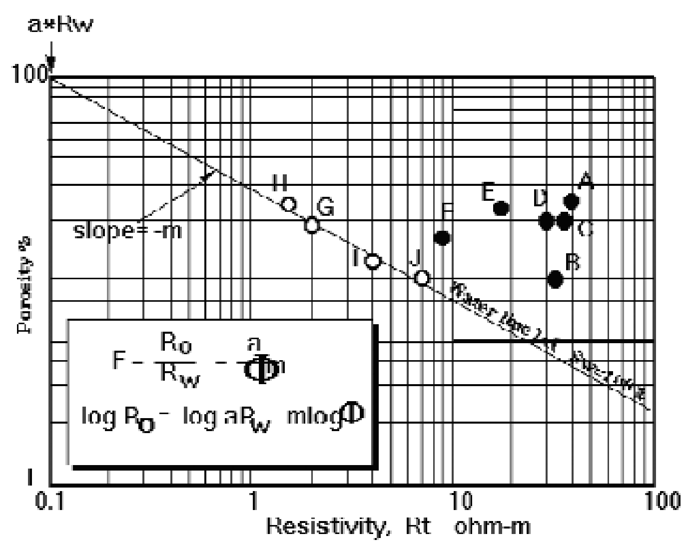

Figure 5: Location of the "water line"

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Fundamentals of the Pickett Plot *… continued from page 12*

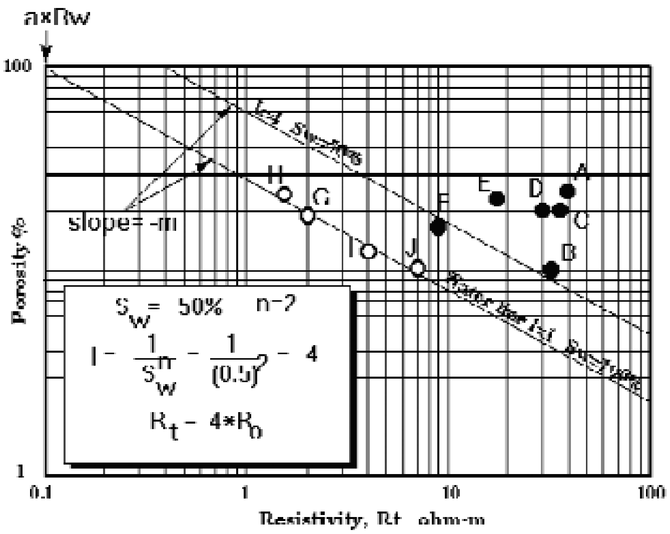

Figure 6: Location of the 50% saturation water line

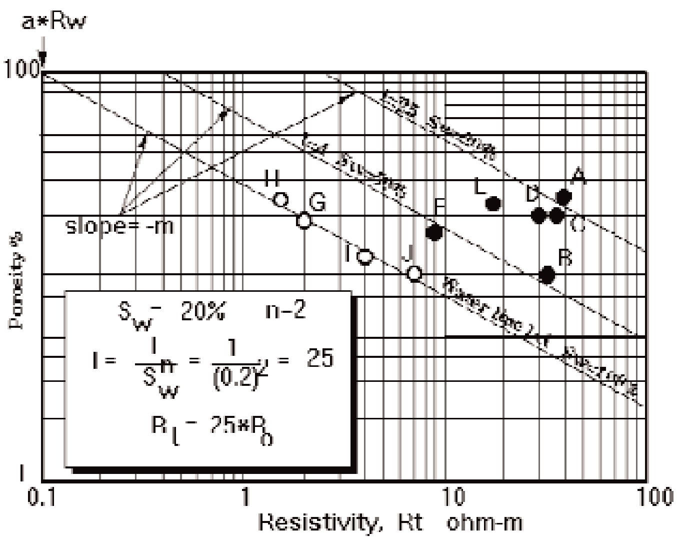

Figure 7: Location of the 20% water saturation line

knowledge, while simultaneously honouring the graphed data points in a convincing manner. The use of an interactive graphics computer program is most effective for this type of operation.

In our hypothetical example, the intercept of the water line predicts a formation water resistivity of 0.10 ohm-m and a cementation factor, m, of 1.8 (assuming the a constant to be one). In a real analysis, these numbers would have local implications that could be assessed for credibility. The cementation factor of the "Rottweiler sandstone" implies that the sandstone is moderately cemented; the formation water resistivity would be compared with available measurements of Rottweiler water resistivities in the immediate area.

The location of other water saturation lines will be on the higher resistivity side of the water line (which is the 100% water saturation line). They all have the same slope of -m, and so are parallel. The resistivity index, I, for any given water saturation determines the value of Rt on the associated line at any porosity as a multiple of Ro on the water line at the same porosity. This concept is explained graphically on Figures 6 and 7.

Cross-plotted points that lie above the water line have water saturations of less than 100% and complementary hydrocarbon saturations. However, their location on the plot does not immediately answer the question concerning the fluids the zones will produce when either tested or perforated. Water free hydrocarbons, water-cut hydrocarbons or water alone are all possibilities. The product of porosity and water saturation is the bulk volume of water (BVW), which can give important clues to producibility when related to pore character and reservoir type.

As an additional feature, each pair of contiguous zones on Pickett plots are generated by a straight line segment. Taken collectively, these lines sketch out a trace that is the reservoir "trajectory" in the depth dimension of the co-variation of resistivity and porosity. Trends, deviations, cutbacks and other features of the trajectory give important clues regarding hydrocarbon column structure, reservoir heterogeneity, cyclic repetition, and changes in pore size.

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About the Author

Bandar D Al-Anazi is a student in King Saud University in Petroleum and Natural Gas Dept. He joined KSU in 2003 and is a member of the Society of Petroleum Engineers (SPE), the American Association of Petroleum Geologists (AAPG), the Society of Exploration Geophysicists (SEG), the Dhahran Geosciences Society (DGS), the Candidate Fellowship the Geological Society of London, the Society of Petrophysicists and Well Log Analysts (SPWLA), the European Association of Geoscientists & Engineers (EAGE), the Canadian Society of Exploration Geophysicists (CSEG), the Edinburgh Geological Society (EGS), and the Geological Society of South Africa (GSSA). He was a secretary of SPE-KSU chapter from 2004-2006 and he is currently president for the chapter for 2006-2007

P.O Box 122331, Riyadh 11721, Saudi Arabia
E-mail: Oil_qas@yahoo.com

Integrated Approach for Development of a Hydrocarbon Reserves

Dr. Serge V. Galley, Caspian Gas Corp.

Abstract

This case study demonstrates the advantage of an integrated approach for development of a shallow gas field in Western Kazakhstan. The gas saturated intervals are represented by laminated shaley sand sediments accumulated in a beach and shore face environment during multiple transgression and regression cycles. Seismic, Testing, Petrophysical and Core data are all integrated for development of a geological model, a saturation map, calculation of reserves and design of a production well pattern. This significantly increases the project value compared to conventional analysis done by a reserves audit company.

Brief Description of Shagyrly – Shomyskty Field

Shagyrly – Shomyshty (SS) is a shallow gas field located 95 km NE from Beyneu railroad station (Fig. 1.1.) Geologically it is related to the North Ustyurt basin.

The general presentation of the North Ustyurt petroleum system is shown on Fig. 1.2. There are three major source rocks: 1) Carboniferous and Devonian, 2) Lower Jurassic and 3) Paleogene. It is not clear at the moment which is the primary source of the SS field gas accumulation, it is either thermogenic gas migrated through tectonic faults and paleo-rivers channels or it is biogenic gas matured in marsh environment of Paleogene deposits.

The Shagyrly – Shomyshty gas play is deposited in shaley silts and sands of Eocene age, which stratigraphically belongs to the Kumsky Horizon. The hydrocarbon seal is provided by clays and shales of the Beloglinsky Horizon. Underneath the Kumsky Horizon, water saturated silty sands and shales of Kerestinsky Horizon were penetrated by most wells drilled during 1960 – 1970. There are more than 60 wells in the area, but only 35 were perforated and tested. Core samples were cut from most of the old wells while porosity, clay content and permeability analysis were run on these core samples at that time. These core analysis results were used as benchmarks for estimation of old logs interpretation quality, where this subject is described in more detail later.

The Kumsky formation represented by beach, shore face and shallow marine siltstones and sandstones, was deposited during a periods of sea level fluctuations within a shallow shelf environment.

Figure 1.1 Shagyrly – Shomyshty field location.

Stratigraphy and rock description, as well as well # 104 design details are shown in Fig. 1.3 on page 17. On the right side of Fig 1.3, typical mud logging responses and open hole logging curves are displayed. Experience from four new wells that have been drilled show the mud logging curves do not have any sharp changes across the Eocene gas horizon and the field geologist had a difficult time picking proper intervals for cutting core.

Major challenges:

- Shallow gas formation, usually disregarded by seismic processing specialists as a weathering zone.
- Low resistivity pay zone, gas saturated interval is about 0.85 – 2.0 ohmm, while adjacent shales are about 0.8 ohmm.
- No correlation between gamma-ray and shale content due to high percentage of feldspars.
- SP in most cases is not a good shale content indicator when wells drilled with KCl/Polymer drilling fluid.

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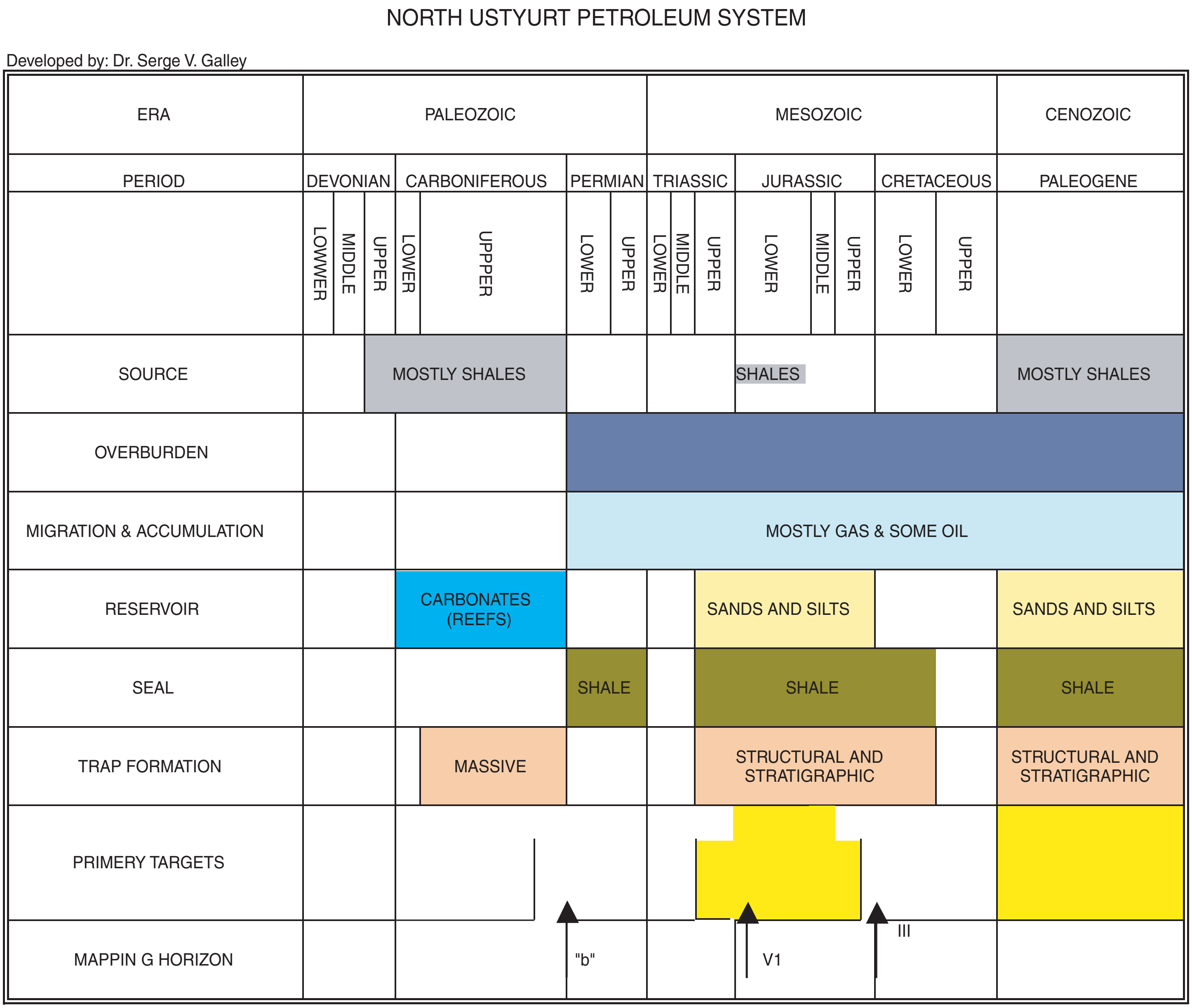

Figure 1.2. Petroleum system of North Ustyurt basin.

Water Salinity Analysis

The ultimate goal of any Petrophysical analysis is to obtain accurate water saturation (S_W) values. This parameter shows what portion of pore space is occupied by water and what portion is occupied by hydrocarbon. In order to calculate this parameter it is necessary to obtain accurate data on porosity and water mineralization. A common equation for calculation of the water saturation, using resistivity, porosity and water salinity, is the Archie formula, which works well for clean reservoirs and its modifications take into account shale conductivity. One of the key parameter, in all these formulas is water resistivity, which depends of water salinity and formation temperature. Sometimes, when there are clean water saturated beds available in the interval being evaluated Petrophysically; it is possible to evaluate water resistivity based on statistical approach, SP or water chemical analysis. Water chemical analysis is always the most preferable.

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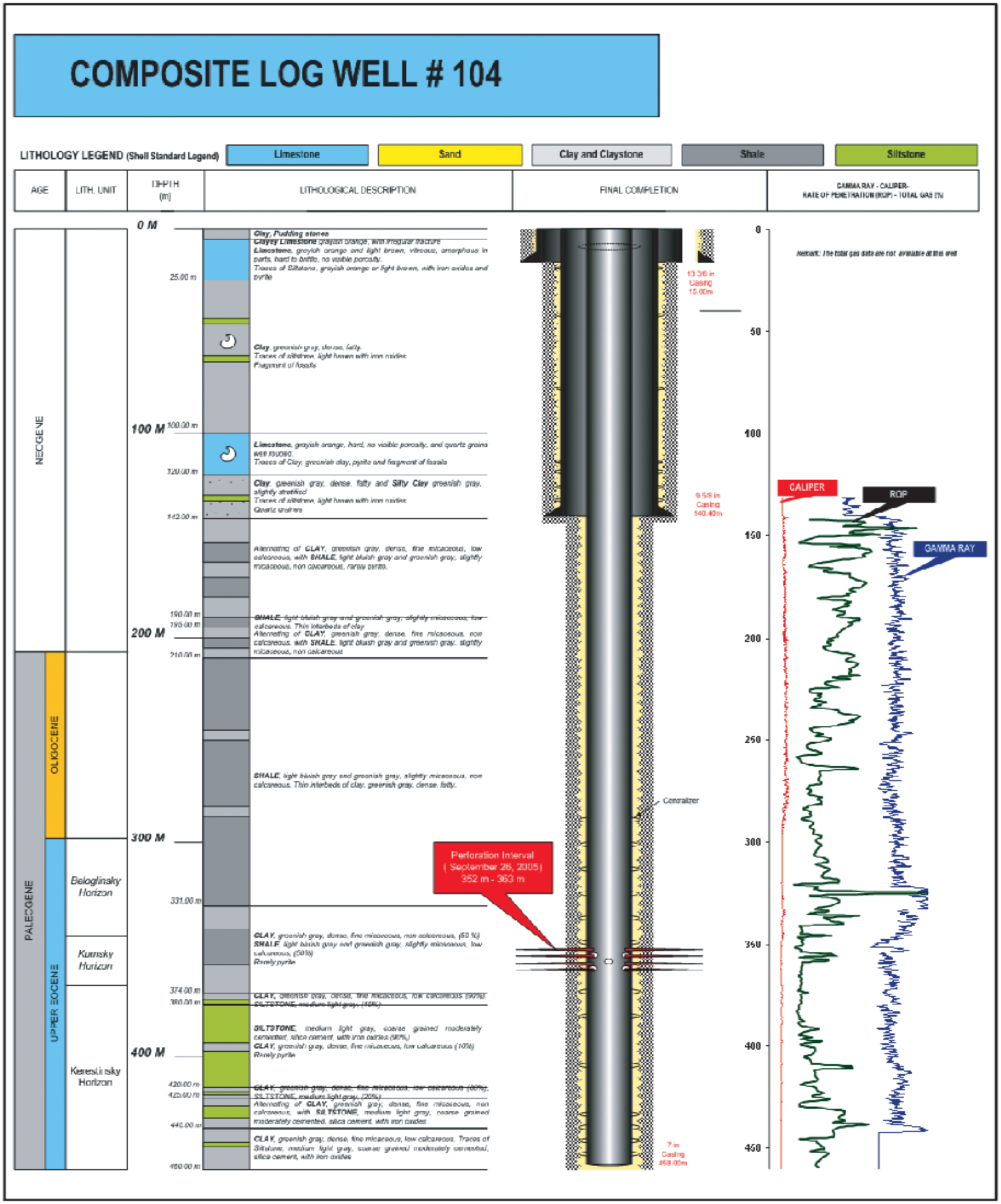

Figure 1. 3 Typical cross-section of Shagyrly – Shomyshty field in well # 104.

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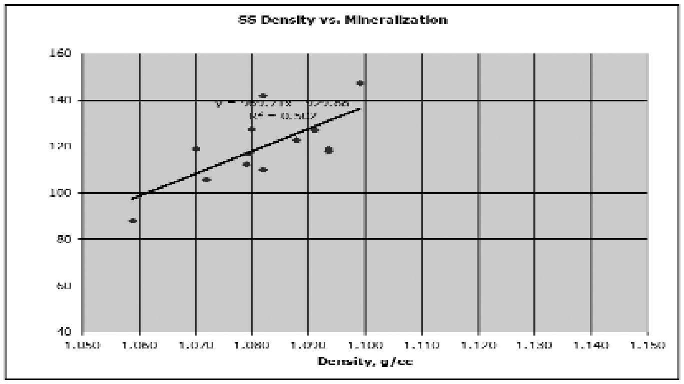

Figure 2.1 Weak correlation between density and mineralization of water samples raises a question about quality of salinity measurement.

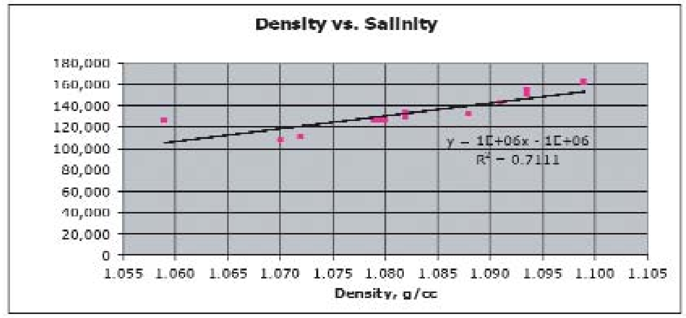

Figure 2.2 Analytical method of water salinity calculation show much stronger density and salinity correlation.

Analysis of available data highlighting water salinity in the Shagyrly – Shomyshty (SS) field (Exhibit 2) described in the 1970's "Reserves Calculation Report" shows that there is no strong correlation between specific gravity of water samples taken from Eocene horizon, in 14 wells drilled outside of gas water contour area, and mineralization of these samples.

There is no description of a technique used in 1960 for determination of water salinity, and taking into account reliability of density measurements (due to its simplicity) it was assumed that density of water samples are the true ones. Another indirect indication of unreliable water salinity measurements were drastic changes of water mineralization laterally, from one well to another. It could be explained by substantial size of the SS field (about 30 x 30 km) but it would have to be verified by a geological model (i.e. presence of alluvial, fluvial and lacustrine conditions in different portions of the field).

Current understanding of the geological model of the SS field is that its Eocene silt and fine grain sand sediments were accumulated in shoreline environments. The best parts of the production horizon coincide with high energy conditions, having morphology of beaches which were moving in SW-NE directions according to regression and transgression cycles.

In order to convert water density into water salinity and further into water resistivity special conversion tables [Ref. 1, 2, 3, and 4] were used. This method produced much better results and shows a strong tie between water density and salinity but still have some uncertainty due to the reason that Ca/Na ratio has been taken from Reserves Calculation Report tables and have not been confirmed by any new study. Lack of reliable data on Ca/Na ratio explains why the correlation coefficient on Fig.2.2. is about 0.71.

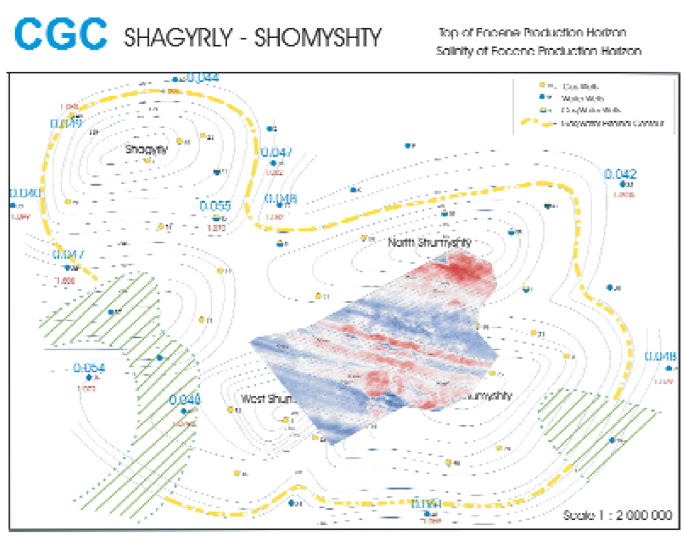

Fig.2.3 Map of water salinity around Eocene horizon of Shagyrly – Shomyshty field demonstrates its general uniformity with insignificant fluctuations associated with accuracy of Na/Ca ratio measurements. Blue numbers represent water resistivity and red water density. Each quadrant related to one of new wells beginning from 105 in NW corner and 101, 104, 103 wells counter clockwise.

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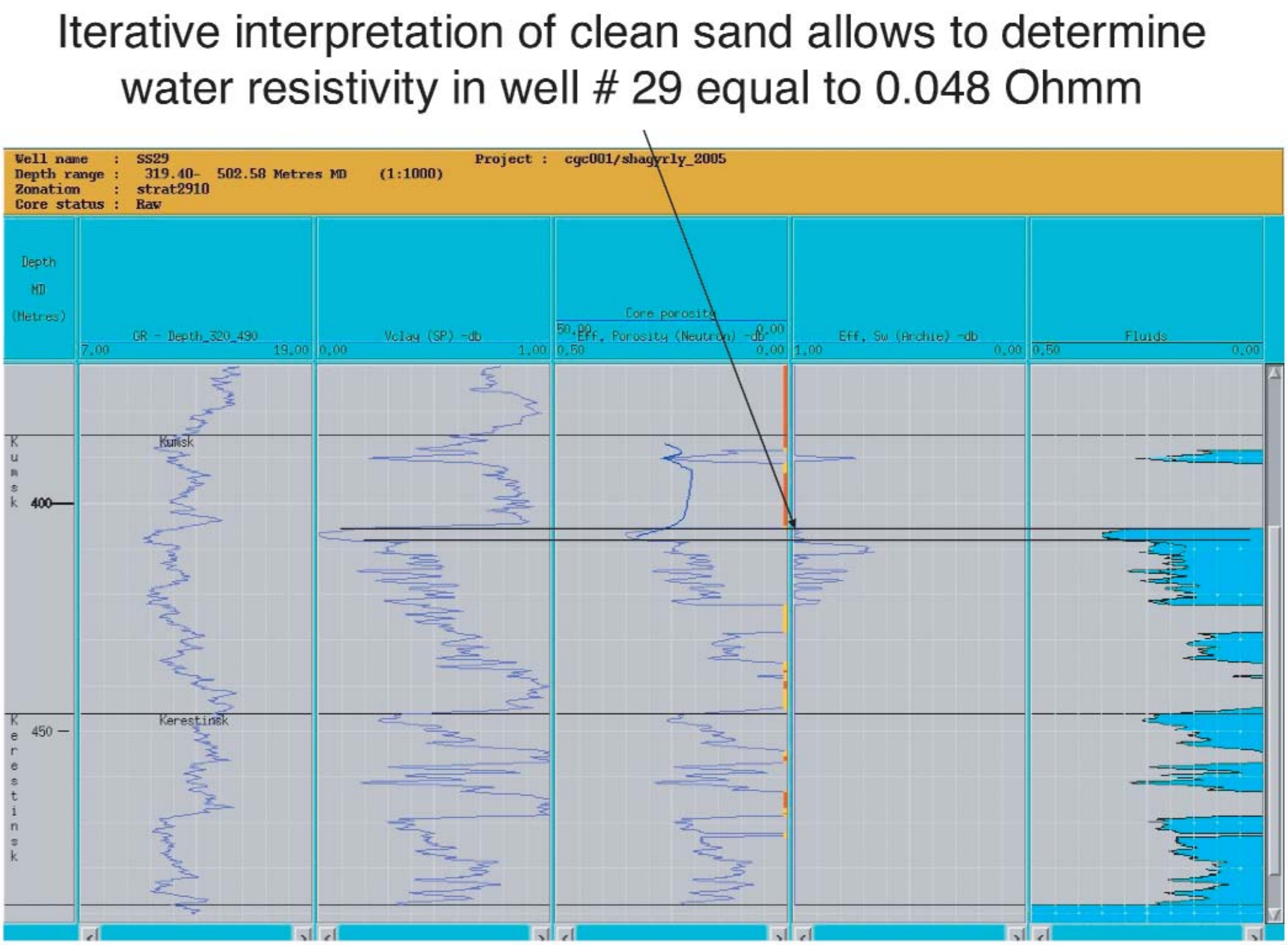

Figure 2.4 Interpretation of water well # 29 with R_w = 0.048 Ohmm shows 100% S_w. Porosity calculated from logs has good match with core porosity data.

Water resistivity data obtained by the analytical method were posted on the map and analyzed together with seismic data (Fig. 2.3.). It was expected that the water resistivity may coincide with different transgression and regression cycles which could be seen on a 3D seismic amplitude map located in the central portion of the map. It is worth noting that the production rate of the old wells coincides with high seismic amplitude areas. However, it turns out that the actual spread of water resistivity around the field is within 0.04 – 0.061 ohmm range and it does not have much in common with transgression and regression cycles. For interpretation purposes R_w = 0.048 ohmm was assumed as a correct value.

To validate the use of this value of water resistivity, all the old wells which have Neutron Gamma Log data were analyzed and clean water saturated sand has been found in well # 29. Water saturation in this well has been confirmed by perforation and test. Interpretation of old logs was done by a step by step iteration process using different R_w values and usage of R_w = 0.048 ohmm generates a value of S_w = 100%, which is a good indication of validity of water resistivity value (Fig. 2.4). Lower values of R_w equates Sw values lower than 100%, which in turn can be explained by residual gas saturation, but for purposes of this study R_w = 0.048 ohmm has been chosen.

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Petrophysical Analysis of New Wells

An extensive set of logs were recorded in four new wells drilled recently:

1. Platform Express (PEX) set of logs, including Array Induction, High Resolution Laterlog (only in well # 104), Compensated Neutron, Photoelectric Density, SP, Gamma Ray & Caliper
2. Elemental Capture Spectroscopy Tool (ECS)
3. Full Wave Dipole Sonic (DSI)
4. Combinable Magnetic Resonance (CMR)
5. Formation Micro Imager (only in well # 104)
6. Vertical Seismic Profiling (VSP) in wells # 104 and 105

Environmental corrections were carried out in the field and all logs were depth matched in real time acquisition. The overall quality of all data is good, except washed out areas in some parts of the borehole were borehole diameter prevents good contact of density pad with hole wall. Neutron data quality was also affected in these areas. No other corrections were applied to the logs.

Shaley-Sand method of interpretation was used for all four wells. Matrix, Clay, Shale and Fluid parameters were picked up from Neutron – Density x-plots and from technical specifications of drilling fluid and old core analysis available in the Reserves Calculation Report.

Interpretation parameters

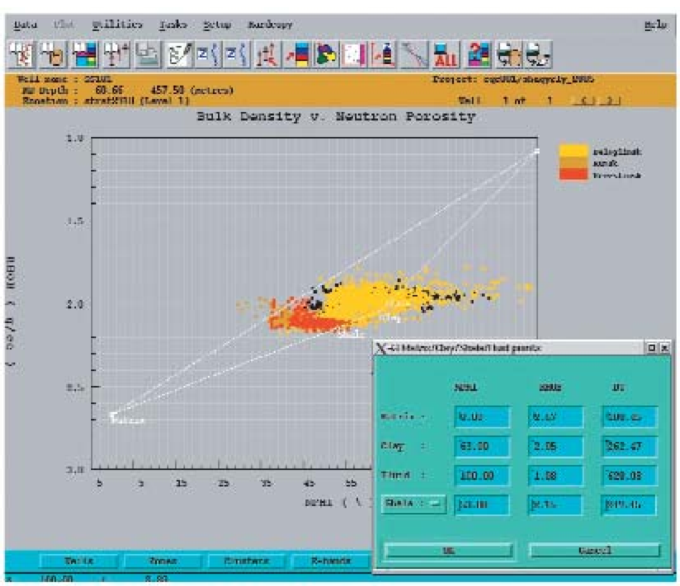

Figure 3.1 Well # 101 interpretation parameters.

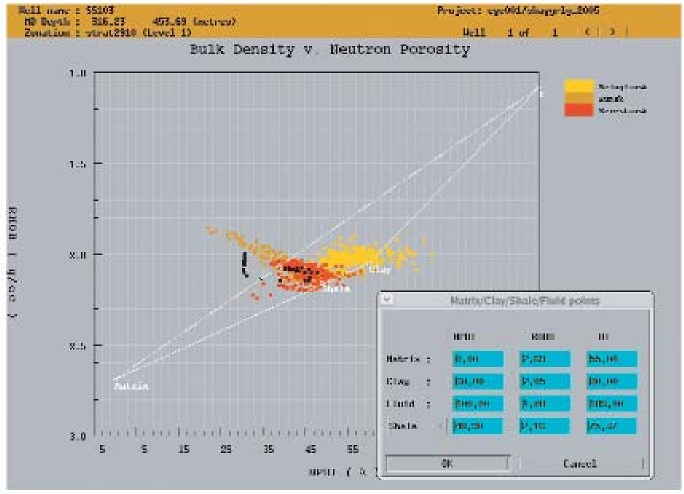

Figure 3.2 Well # 103 interpretation parameters.

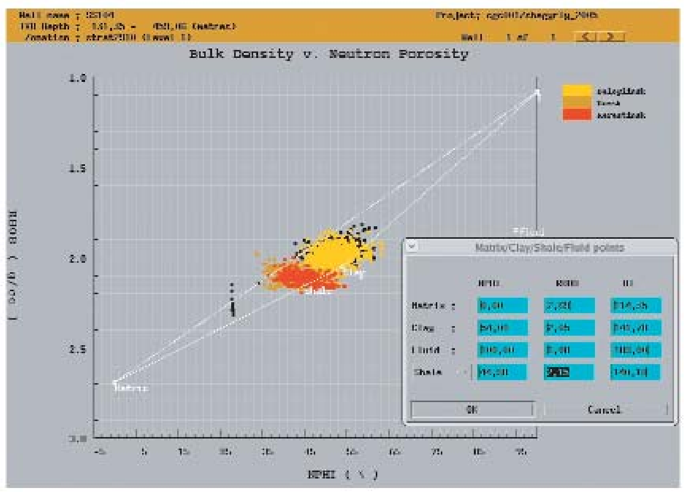

Figure 3.3 Well # 104 interpretation parameters.

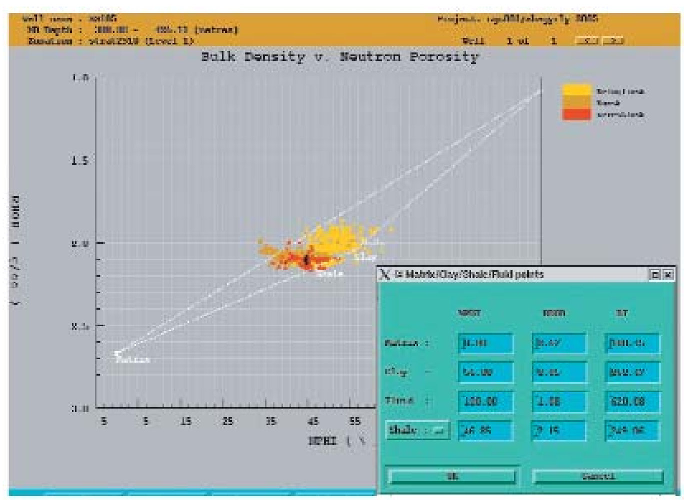

Figure 3.4 Well # 105 interpretation parameters.

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An Indonesia Equation has been used for calculation of water saturation, for which clay resistivity readings opposite of clays beds were used for each stratigraphical zone. ECS, DSI and CMR data were used for qualitative assessment of rocks properties.

Normalization of Old Wells Data

A major problem encountered by Soviet log analysts was absence of a porosity log. Analysis of Neutron Gamma Tool (NGK) data recorded in old wells shows that normal distribution of signal sometimes has a magnitude of difference from one well to another.

At that time it was impossible to obtain porosity from NGK tool by any reliable way due to (a) absence of normalization method and (b) lack of any reliable porosity logs, like compensated neutron, density or sonic, which could be used as basis for normalization. Analysis of raw NGK data from different wells (Fig. 4.1) shows a difference in order of magnitude between NGK signals recorded in the same stratigraphic interval in two wells. Clearly it is not possible to use such data for any type of interpretation.

Based on test data and core analysis result from the 52 old wells, and taking into account two postulates of petrophysical interpretation (1) Neutron Gamma Log signal depends on hydrogen content in the rocks and subsequently has information on amount of clay and porosity; (2) Spontaneous Potential signal has information on clay content; normalization process of old logs were developed. Old Neutron-Gamma Log data were normalized using "squeeze-and-stretch" technique [Ref. 5] on the basis on Compensated Neutron Log recorded in new wells. Fig. 4.2 demonstrates histogram of compensated neutron log signal recorded in well # 103, which has been used for normalization of old neutron log10 signal from wells # 3 and 10 on Fig. 4.1. This approach allows obtaining neutron porosity for old wells. Of course accuracy of such normalization depends on how close the normalized well is located to the base well and interpretation of the wells within Shagyrly structure in NW portion of the field has a lower accuracy than interpretation of the logging data for other wells.

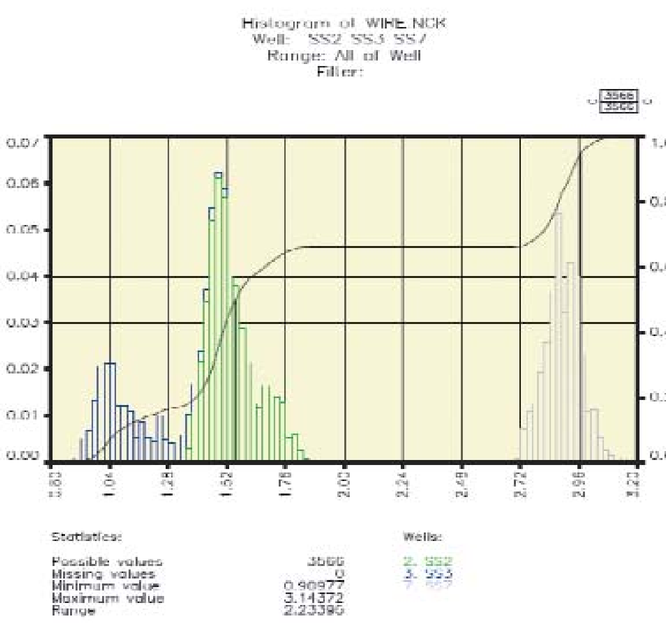

Figure 4.1 Histogram of NGK signal from wells # 2, 3 and 7 shows significant range difference while shape of all three signals is similar.

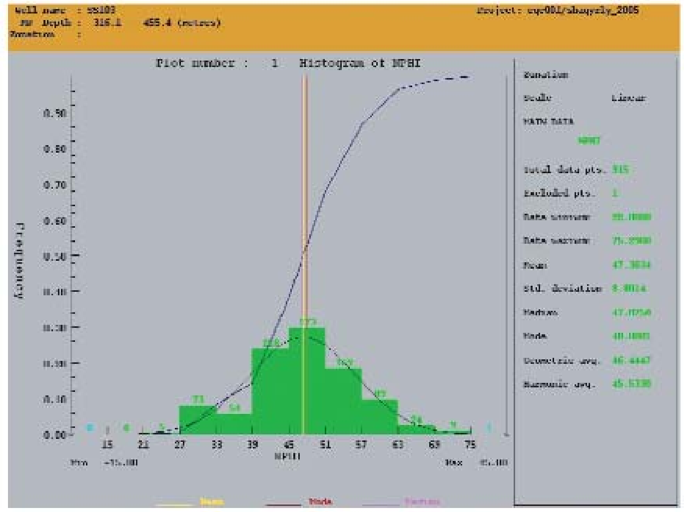

Figure 4.2 Histogram of NPHI from well #103 recorded in same stratigraphic interval as wells # 3 and 10 above.

As long as during the process of interpretation only relative values of Gamma-ray and SP were used, raw GR and SP data were not normalized, as well as the resistivity data due to following reasons: (a) BKZ (set of normal and inverse resistivity sondes of different length) technique generates true resistivity value based on a set of empirically obtained charts; (b) in each well a different set of sondes have been used (as in term of length, as well as electrodes combination).

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Petrophysical Analysis of Old Wells

As it was described above, the first step of the interpretation process was normalization of old neutron data into compensated neutron signal. The whole field was divided into four quadrants (Fig. 2.3) and each of the new wells 101, 103, 104 and 105 was used as basis to convert the NGK logs into NPHI logs. It is necessary to emphasize that all logs were reading in the same stratigraphic intervals and tops and bottoms of old and new logs were cut off from the normalization process.

Traditional approach of SP logs interpretation was used in order to obtain clay content values. Clay and Sand lines were drawn for each stratigraphic interval based on common trend and minimum and maximum log values. Clay and Sand lines were swapped in some wells, where the SP signal has been reversed. Clay content obtained from logs was compared with clay content obtained from cores, for all the wells where core data were available; using the "Tigress" overlay technique in Petrophysical Interpretation panel.

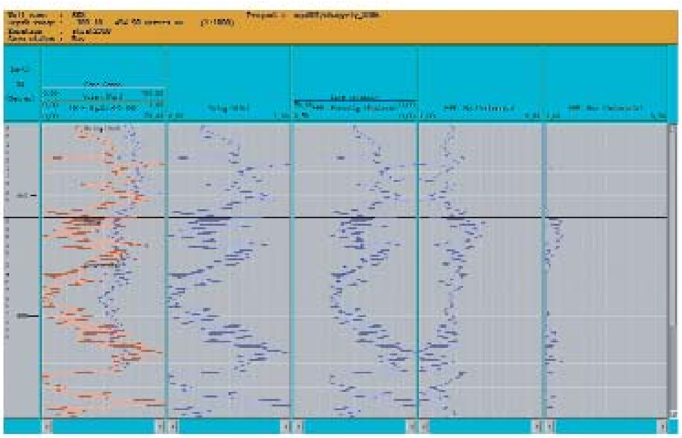

Figure 5.1 Good match of core and log porosity and clay content in well # 8.

In some wells, where SP data were distorted, Gamma-Ray data was used for clay content calculation and built-in Tigress technique of volume of clay calculation as a minimal of volume of clay obtained from SP and GR was used.

Core porosity in shaley intervals are about 20% higher than porosity obtained in resultant interpreted logging data, while both the core and logging porosity in clean non shaley sands are very close. This difference is a result of a procedure of core samples preparation for analysis, when the samples were heated at temperature 105°C. As a result of heating the shaley core samples, a loss is observed with respect to a significant portion of physically bound water and porosity and is close to the lower end of the total porosity. In clean non shaley intervals both effective and total porosity are equal.

Analysis of core and logging data shows that usually the top portion of Eocene horizon is clear and we have a "coarsening up" or "funnel" case of sedimentation which happens in shallow marine environment like barrier bars or beaches. Taking into account a fact that Eocene horizon rocks are represented by grains from fine sands (about 50%) to fine and very fine silts (about 35%) which contains a significant amount of physical bound water, it was obvious that clay conductivity has to be taken into consideration for purposes of Sw calculation.

At the moment of preparation of this study there was no data on cation exchange capacity and it was decided that determination of the water saturation parameter has to be done using the Indonesia equation.

One if the major difficulties in a process to obtain true resistivity from BKZ set of normal and inverse resistivity sondes is the fact that the responses of such sondes are asymmetrical and its shape depends of resistivity and thickness of not only the bed under investigation at any particular moment, but also of the adjacent beds hole size and resistivity. In order to overcome this predicament normal and inverse 2 meter long "standard" sondes were used for the determination of the top and bottom of a layer under investigation and true resistivity log as well as flushed zone resistivity log have been picked up from a table "True resistivity logs table" from "Reserves Calculation Report" dated 1970. This table also contains data on mud filtrate resistivity. During the depth match process of all old logs the asymmetrical sonde was stretched in such way that it covers the whole interval uniformly.

It is worth to note that in all the interpreted wells, the saturation was a known parameter due to tests done after perforation which, taking into account the limited set and poor quality of old logging data, drastically helps with interpretation. However, one correction that has to be applied for all NGK logs is correction for the methane content. This conclusion has been made based on two observations (a) in most gas saturated wells core porosity is higher than logs porosity while core and logs shale content has a good match, and (b) it is recommended by all manuals for Neutron-Gamma Log interpretation [Ref. 7].

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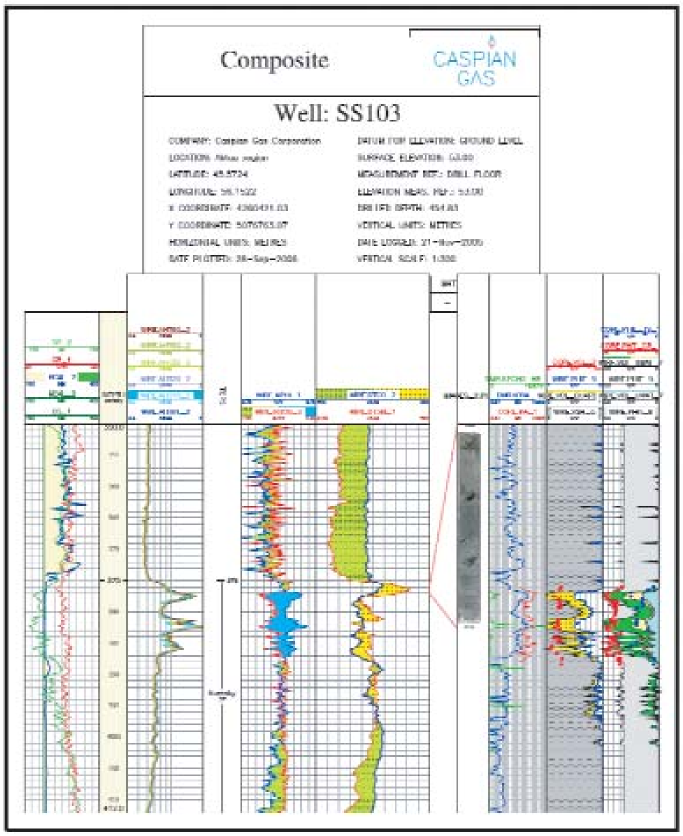

Figure 6.1 Results of logging data interpretation in well # 103.

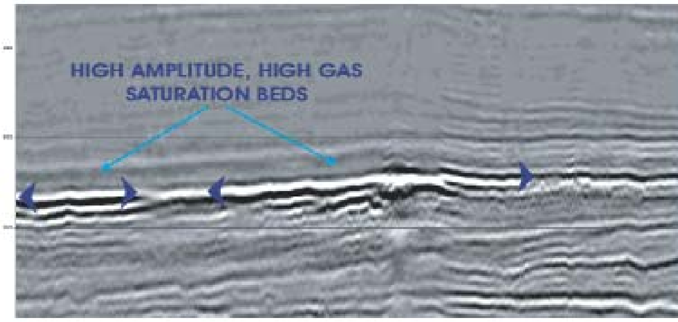

Figure 6.2. Example of 3-D seismic data over high and low productive areas demonstrates relationship between production rate and seismic amplitude.

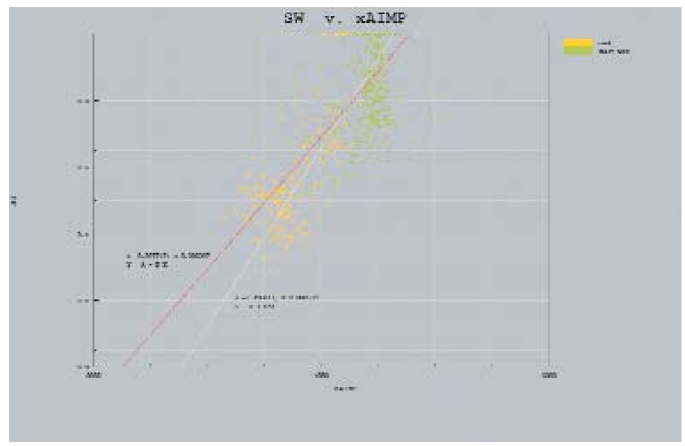

Figure 6.3. Strong relationship between water saturation and compressional waves acoustic impedance allows to obtains S_w from whole set of seismic data.

Seismic Inversion

One of the critical requirements for seismic inversion is reliable shear and compressional velocities. Full wave dipole sonic tools have been utilized for direct measurement of such data in all four wells. Overlay of shear and compressional interval travel time shown on track 6 on Fig. 6.1 demonstrates significant difference between a gas saturated interval and shale intervals above and below. This encouraging sign leads to conclusion that it is possible to utilize near and far offset seismic data in order to delineate gas saturated horizons. Results of core analysis show good match between porosity, saturation and permeability measured on core samples and obtained by means of the Petrophysical interpretation.

Production Wells Pattern for the Field Development

The initial geological model, reserves calculation report and field development map was prepared by a worldwide known reserves audit company. As an outcome of its job the following map (Fig. 7.1) was generated:

The cost of drilling then tie-in of these wells was barely economical, and even though all the seismic and logging data were provided to the contractor, these data sets were not used for development of a geological model. At this time seismic inversion allowed to generate a water saturation map (Fig. 7.2) and develop a production well pattern where drilling has to be con-

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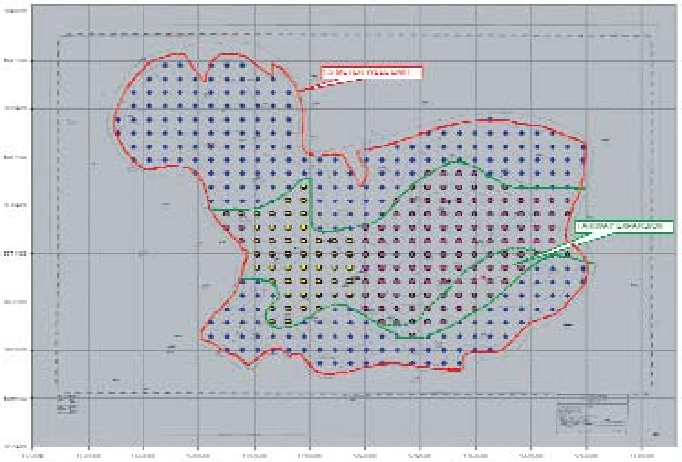

Figure 7.1 Production well pattern recommended by a contractor calls for drilling of 438 wells, which makes the project barely economical.

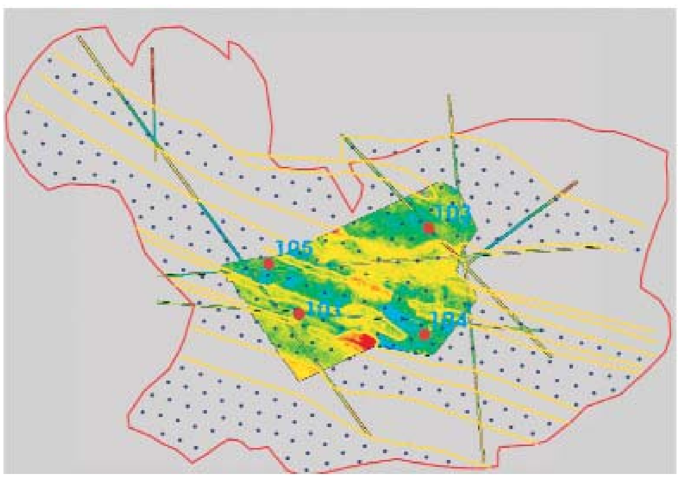

Figure 7.2 Production well pattern based by results of seismic inversion calls for drilling of 292 wells. Economic of the project significantly improves.

centrated on high production portions of the reservoir where major part of the gas reserves accumulated. Low productive thin and low porosity zones have to be disregarded, at least during initial phase of field development.

Such approach has allowed to significantly decrease drilling costs as well as improve the economics of the project and increase its' value.

Conclusions

- Shaley-Sand model generates most appropriate results for Petrophysical interpretation of the new wells.
- Water resistivity R_w = 0.048 ohmm shall be utilized for petrophysical interpretation until modern core analysis results will be obtained.
- It is possible to calibrate old logs in order to get G/N pay zone, porosity and saturation using normalization technique and old core data.
- Accuracy of the interpretation depends on input data quality which is questionable mostly due to the fact that original logs have been lost and composite displays available have resistivity data presented in inadequate scales
- Seismic inversion allowed developing a sound well pattern and consequently improved the economics of the project.

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Acknowledgements

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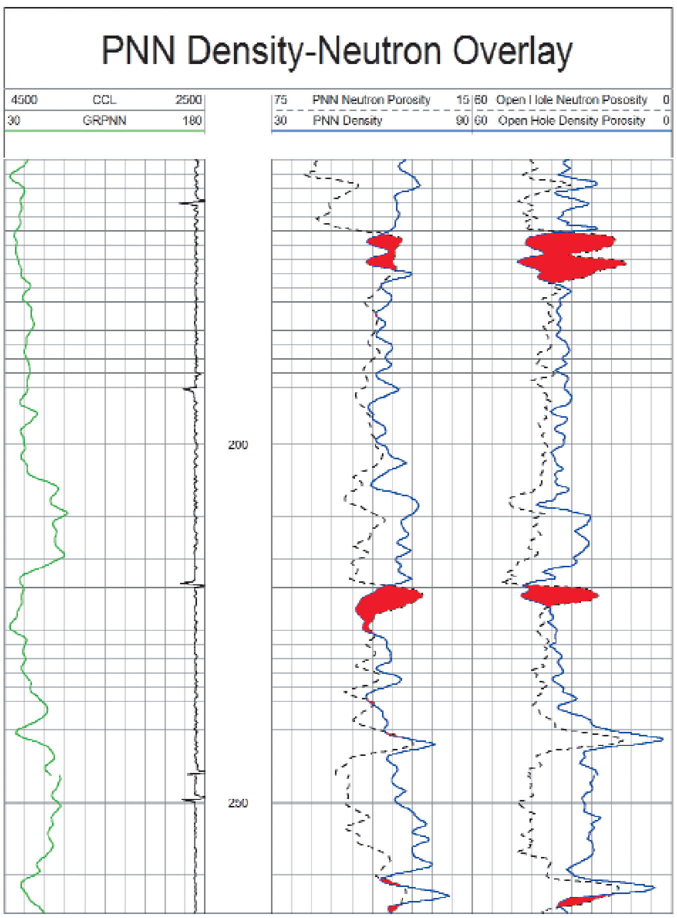
About the Author

Sergey V. Galley is a Petroleum Geophysicist/ Petrophysicist with 22 years of experience in the oil and gas exploration and production industry. He has received his Ph.D. in 1991 at Soyuzpromgeophysica Institute in Russia. He did a lot of exploration work globally based primarily in Kazakhstan since the early 1990's with companies like Western Geophysical conducting offshore seismic acquisition for six major oil companies consortium over North Caspian Sea. Dr. Galley also worked with the American International Petroleum Corporation as Operations Manger for two projects in Kazakhstan involved in planning and conducting the company's exploration strategy as well as managing drilling, logging, testing operations and preparation of feasibility studies for all new projects. For the last 3 years he has worked for the Caspian Gas Corporation in Kazakhstan as Head of G&G Department and is now based in Calgary working for Oilfield Development Specialists.

Tech Corner – Through casing density measurement using pulsed neutron neutron (PNN)

John Hull E.I.T.
Hermann Kramer P.Eng.
Jinyi Zhang E.I.T.

Recognized as a porosity and saturation indicator, pulsed neutron tools have traditionally had problems differentiating between tight and gas zones. Recently, an innovative way to extract a curve using thermal neutron decay data from a PNN tool, that resembles the shape and response of an open hole density measurement, has been established. This 'pseudo-density' curve is not calibrated like an open-hole density curve, nor does the calculation carry through similar units, but the response is comparable, as shown;



The middle track shows PNN density-neutron overlay, the right track is open hole density porosity. The two gas zones shaded RED and the two tight zones at bottom show correlation between through casing PNN and open hole measurements.

The PNN density measurement does not utilize a pad device, hence the measurement is not dependent on pad to borehole wall contact. Instead, this measurement has the same physical advantages (ie depth of investigation) and restrictions similar to any neutron measurement. Being a time based measurement, early time channels relating to borehole effects are removed, providing a true formation measurement.

How is this measurement possible?

First of all, the theoretical relationship between neutron reaction rate and bulk density must be established: The reaction rate of neutrons in a formation depends on four parameters.

1. velocity of neutrons (v)
2. number of neutrons/volume (n)
3. Nuclear density of the particles with which the Neutrons will interact (Ni)
4. cross section for the particular reaction. (σi)

The reaction rate R (# of reactions /cm^3), with a particular element i, can be described by the following equation;

$$R = nv\sigma_i N_i \qquad \textbf{(eq.1)}$$

Ni, nuclear density of the measured particle, is related to bulk density by;

$$N_i = \frac{6.02\times10^{23}}{M}\rho_b \qquad \textbf{(eq.2)}$$

Combining these equations gives;

$$R = nv\sigma_i \frac{6.02\times10^{23}}{M}\rho_b \qquad \textbf{(eq.3)}$$

Taking into account the relationship between reaction rate and macroscopic cross section, Σi can be defined as the product of cross section in question σi times the number of atoms/cm^3, N, with A as the atomic weight.

This equation shows the relationship between thermal neutron cross-section and bulk density.

$$\Sigma_i = N\sigma_i = \frac{6.02\times10^{23}\rho_b}{A}\sigma_i \qquad \textbf{(eq.4)}$$

Continued on page 29…

Through casing density measurement using pulsed neutron neutron (PNN) … *continued from page 28*

Material	Description	Sigma (cu)
Sandstone	0% porosity	3.5
Limestone	0% porosity	7.0
Dolomite	0% porosity	6.8
Shale	Mineralogy	20 to 40
Gas	dependant	5-15
Oil	Depends on P.V.T.	22.2
Fresh Water	Dead crude (max)	22.2
Salt Water	0% NaCl (min)	31.7
Salt Water	30,000 ppm	56.0
Iron	100,000ppm	200.00
Portland Cement	Casing	13.0

Using this macroscopic cross section Σi, we now multiply by 1000 which gives us the physical property **sigma Σ** in capture units **(cu)**, which is the slope of the thermal neutron decay. This sigma value is a parameter intrinsic to each substance, and is used for determining through casing saturations and correlates to open hole resistivity data.

Trying to solve (eq.4) for bulk density still leaves 2 unknowns. In an ever changing borehole environment, it isn't feasible to assume constant values for these, as they too are a property of the substance being measured, hence a different method to extract this density information is required;

So how can this density data be extracted?

First, a brief explanation of Fast Fourier Transform (FFT).

FFT is a mathematical operation used in signal processing to analyze the various frequencies contained in a sampled signal. All signals in the time domain (time vs. amplitude) can be characterized by a series of various sinusoidal signals of different frequencies and amplitudes, or in the vector form of phase shifts and magnitudes. This process can be reversed, taking the frequency components and summing them together to re-construct the original signal in the time domain, which is called Fourier Synthesis.

A continuous signal (analog) can be separated into an infinite series by;

$$f(\nu) = \mathcal{F}_t[f(t)](\nu) = \int_{-\infty}^{\infty} f(t)\, e^{-2\pi i \nu t}\, dt.$$

In downhole logging applications however, the signal is frequently sent up-hole in the form of discreet digital signals in order to make data handling much easier. The discrete Fourier transform (DFT), sometimes called the digital Fourier transform, is used in the case of down-hole time spectrum measurements as the thermal neutron decay data is digitized into 60 discrete time channels. The sequence of N complex numbers x0, ..., xN−1 is transformed into the sequence of N complex numbers X0, ..., XN−1 by the DFT according to the formula:

$$X_k = \sum_{n=0}^{N-1} x_n e^{-\frac{2\pi i}{N} kn} \qquad k = 0, \dots, N-1$$

where e is the base of the natural logarithm, *i* is the imaginary unit (i2 = − 1), and π is Pi.

So how does FFT relate to a through casing measurement?

Once data is transferred from the time-domain to the complex frequency domain, many problems are greatly simplified and certain phenomena not noticeable in the time domain are often revealed. For example, mechanical engineers use this technique in non-destructive testing for cracks in composite materials. By using FFT, small attenuations in a signal being sent through a material may be observed. This attenuation has a linear relationship with the existence of cracks in composite materials.

Additionally, this technique is used in determining texture coarseness. Using FFT and auto-correlation methods, the function's central maximum will decay at different rates for fine and coarse finishes. Again, this method has the advantage of being non-evasive and has tested to be inherently accurate.

Other Industry applications include: linear systems, antennas, optics, random processes, probability, quantum physics, and boundary value problems.

Getting back to petrophysics; similar principles have allowed us to extract formation bulk density data from the decay spectrum of thermal neutrons by utilizing the magnitude and phase component of the FFT, and performing auto correlation methods on the power spectrum data.

FFT DIAGRAMS

Success is hard to measure as the comparisons between open hole and cased hole utilize a completely different physical measurement.

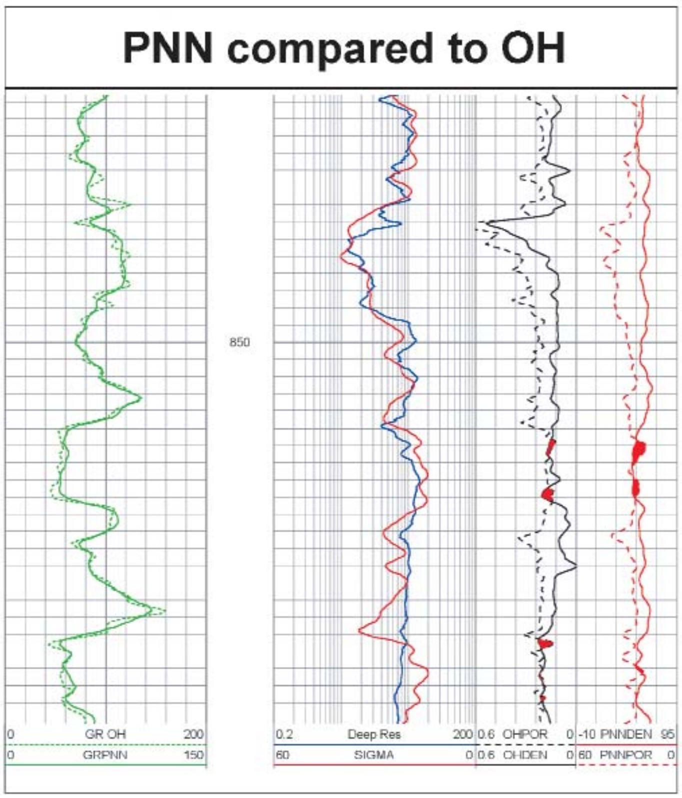
However, approximately 90% accuracy between open hole and cased hole using 10 harmonics has been achieved.

Continued on page 30…

Through casing density measurement using pulsed neutron neutron (PNN) *... continued from page 29*

New opportunities for through casing evaluation

With PNN's 'pseudo density' curve, it is now possible to have 3 independent measurements from one tool. This example shows another comparison of PNN neutron/density vs. comparable open hole data. PNN sigma is overlain with open hole deep resistivity curve to demonstrate correlation. This log suite gives operators new options for evaluating the formation behind casing when open hole data is not available, or of questionable quality.



Conclusion

The Fourier Transform promises to be an important technique for through casing formation evaluation using PNN data. Extracting other properties such as Sw has been proven for many data sets using FFT algorithms, however the method is still in the development stage. Presently, Sw can be calculated using the PNN sigma measurement via petrophysical analysis. However, FFT presents the opportunity for the saturation to be calculated without having to input constants for other unknowns in the Sw equation – similar to the situation with the density equation mentioned throughout this paper. Time spectrum decay data is packed full of information on the measured formation, it's just a matter of being able to decipher these clues mother nature provides.

Sources

Well Logging for Earth Scientists – Darwin V. Ellis.

http://en.wikipedia.org/wiki/Fast_Fourier_transform

PNN processing technique based on Fourier Transformation Authors; Goran Mancic, Zoran Marcovic – Hotwell International.

2007 CWLS Annual General Meeting
Tuesday, February 13th, 2007

at the Calgary Zoo (Safari Room)
5:00 pm Reception, 6:30 pm Dinner

with guest speaker Brian Keating,
Head of Conservation Outreach at the Calgary Zoo

About Brian Keating

Brian Keating is the Head of Conservation Outreach at the Calgary Zoo. In his job, he raises and spends the funds necessary to support a variety of local and international conservation projects. He has traveled on all 7 continents into some 45 countries, primarily as part of the "ZooFari" travel program that he began some 20 years ago.

He has been a regular weekly guest on local CBC Radio for two decades and has been a regular guest on the Discovery Channel for the previous six years. He completed a conservation-based hour-long documentary with Discovery in 2002, which recently won an Alberta film industry award for "Best Host". His first book, "Going Wild: Amazing Animal Adventures Around the World" has just been published and has been nominated as a 2005 Ontario Library Association Silver Birch Award official selection. It's the first in a series of 8 books celebrating nature, for children.

Of special note, in September of 2003, a significant title was awarded Brian during a powerful cultural ceremony in West Africa, making him an Honorary Chief of one of the villages near the Wechiau Hippo Sanctuary in Ghana. This honour was in response to his efforts in raising the necessary funds to develop the sanctuary, an area of important riverine habitat and biodiversity.

In addition to his full time job at the Zoo, he's an Adjunct Assistant Professor of Anthropology at the U of C, a pilot, naturalist, scuba diver, and mountaineer. Brian is always accompanied on his regional and international trips by his wife Dee, who is a local Calgary physician and keen naturalist.

Reservations by: February 9th, 2007
Book online or call 269-9366 to confirm a seat

Cost: Members Reserved Meal (w/confirmed seat): $50.00
Couple $90.00
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CWLS GENERAL INFORMATION

INCORPORATED – January 21, 1957

Objective

The objective of The Society (as stated in the Letter of Incorporation) is the furtherance of the science of well log interpretation, by:

(A) Providing regular meetings with discussion of subjects relating thereto; and

(B) Encouraging research and study with respect thereto.

MEMBERSHIP

Active membership is open to those within the oil and gas industries whose work is primarily well log interpretation or those who have a genuine interest in formation evaluation and wish to increase their knowledge of logging methods.

FEES

The CWLS fiscal year commences February 1, and all fees are due at this time.

Initiation Fee (including first year's membership fees) : $40.00
Annual Dues : $30.00
Student (no initiation fee) : $10.00

Memberships not renewed on or before June 30 of each year will be dropped from the roster and reinstatement of such a membership will only be made by re-application, which will require re-payment of the initiation fee plus the annual dues. All dues (Canadian Funds) should be submitted with the application or renewal of membership (Cheque, money order MasterCard, AMEX or Visa).

ACTIVITIES

The Society also furthers its objectives by sponsoring symposiums and exhibits.

Research committees encourage and support research on relevant problems.

The Society is the spokesman to industry and government on topics pertaining to well logging and formation evaluation.

The Society holds a monthly luncheon meeting (except July / August) to hear an address on a relevant topic.

Each active member will automatically receive the CWLS Journal, 'InSite' newsletter and Annual Report.

APPLICATION

Should our activities interest you we invite you to complete the attached application form and forward it to the CWLS membership Chair.

CWLS MEMBERSHIP APPLICATION FORM

To apply for membership to the CWLS, please complete this application form in detail.

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FEES

Please enclose initiation fees (Cheque, money order, MasterCard, AMEX or Visa) with the application of membership and mail to:

Membership Chairman
The Canadian Well Logging Society
2200, 700 – 2nd Street S.W.
Calgary, Alberta T2P 2W1
Canada

CANADIAN WELL LOGGING SOCIETY

2200, 700 – 2nd Street S.W., Calgary, Alberta T2P 2W1
Telephone: (403) 269-9366
Fax: (403) 269-2787
www.cwls.org

Wednesday, December 13th, 2006
CWLS TECHNICAL LUNCHEON PRESENTATION
FAIRMONT PALLISER HOTEL
133, 9TH AVE. S.W. CALGARY

TIME: 12:00 PM (COCKTAILS AT 11:30 AM)
RESERVATIONS BY: Friday Dec 8th, 2006 (NOON) - CALL 269-9366 TO CONFIRM A SEAT

COST: MEMBERS RESERVED MEAL: $30.00; NON-MEMBERS RESERVED MEAL: $35.00
(SPECIAL NEEDS MEALS AVAILABLE WITH ADVANCED BOOKING ONLY)

TOPIC: **NEXEN/OPTI OILSANDS RESERVOIR CHARACTERIZATION**

SPEAKER: Laurie Weston Bellman, Bellman Consulting Ltd.

ABSTRACT:
The Athabasca oil sands contain more than a trillion barrels of oil within the Cretaceous McMurray formation of NE Alberta. The McMurray formation is commonly known as an estuarine valley system characterized by multiple cuts and fills. It is bounded below by Devonian rocks at the pre-cretaceous unconformity and above by the widespread transgressive marine shales and sands of the Wabiscaw formation. In the Long Lake area, it can be 60 to 100 meters thick, with net pays of 40+ meters. Still, its complexity is legendary. Stacked channel deposition exhibits a high degree of reservoir variability both vertically and laterally making predictability difficult. Traditionally, at least eight and often many more vertical wells per square mile are drilled and cored to obtain enough data to be confident in defining a SAGD project area and even then significant variations can occur between wells. 3D seismic data has been used successfully in the past mainly to define the base of the reservoir (there is a strong reflector at the Cretaceous/Devonian boundary), and the gross thickness of the interval. Various attempts have been made to decipher the internal composition of the channeled interval with limited success.

This talk will describe the use and application of a technique of quantitatively extracting and classifying elastic rock properties from seismic data. The extraction process uses AVO (amplitude vs. offset) analysis to separate the compressional (P-wave) and shear (S-wave) components of the seismic data. The resulting components can then be used to calculate shear rigidity (mu) and incompressibility (lambda). These properties can also be measured directly in the borehole by a dipole sonic log, and assigned lithologies and fluid properties through core and log analysis. The measured properties are then used to calibrate and classify the seismically derived properties. The result is a seismic volume transformed to a detailed characterization of the reservoir within the zone of interest.

Applying this technique over a wide area allows more confident mapping of the channels and the reservoir quality and continuity within the channels. A few of the potential benefits in oil sands areas include fewer vertical wells required to define the resource area, and more confidently placed horizontal wells for optimal production.

BIOGRAPHY:
Laurie Weston Bellman graduated from the University of Victoria in 1986 with a B.Sc. in Physics. She started her oil industry career with Shell Canada in seismic processing and then interpreting plains data for Swan Hills targets before moving on in search of adventure. She moved to England for a position with LASMO in their Middle East and North Africa group where she was involved in exploration in the Euphrates Graben in Syria, the Ghadames basin in Algeria, and basin-scale reviews in Iraq, Iran and the Persian Gulf area. While in England, Laurie accepted a position with Wascana Energy doing geophysics for their operated acreage in Algeria, and non-operated areas in Europe and North Africa. When Wascana (now Nexen) closed their London office she was transferred back to Calgary.

After a brief hiatus where optimal seismic parameter took a back seat to children and family life, Laurie signed a 2-month contract with Can-Oxy to evaluate some old 2d data in an area that no one had been concerned with for years – the Athabasca Oil Sands. Can-Oxy became Nexen, the Oil Sands have become immensely important for Alberta, and she is still working in this extremely exciting area.

APEGGA MEMBERS:
CWLS Luncheons and courses qualify for APEGGA Professional Development Hours.
Please see the CWLS Website at www.cwls.org for information regarding a Corporate Network License for the recently published CWLS Formation Water (RW) Catalog CD.

Notes: Please forward this notice to any potentially interested co-workers. Thank you.

UPCOMING EVENTS

February 13, 2007
2007 CWLS Annual General Meeting
Calgary Zoo, Calgary, AB
Call 269-9366 to confirm seats.
See ad on page 31 for further information

March 19 - 20, 2007
1st India Regional Conference Formation Evaluation in Horizontal Wells
Hotel Grand Hyatt, Mumbai

March 25 - 29, 2007
Spring Tropical Conference
SPWLA/SCA Core-Log Integration for Improved Petrophysical Analysis
Sunriver Resort, Bend Oregon

April 15 - 19, 2007
1st Annual SPWLA Middle East Regional Symposium
Abu Dhabi, UAE

June 3 - 6, 2007
2007 SPWLA Annual Symposium
Austin, Texas

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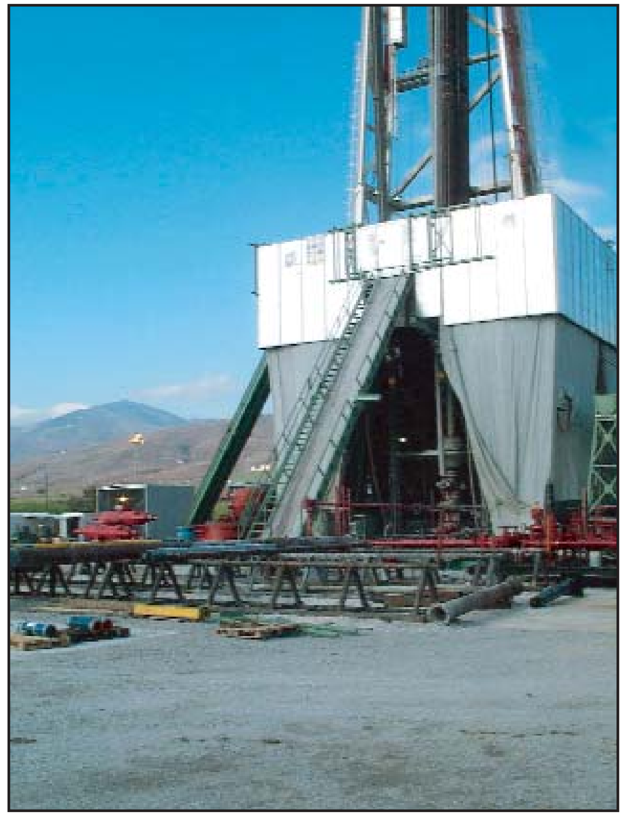
Discounts on business card advertisement for members.

A high resolution .pdf of the latest InSite is posted on the CWLS website at www.cwls.org. For this and other information about the CWLS visit the website on a regular basis.

Oilfield in Italy – 1940's Pumpjack in Field.
Photo courtesy of Andy Hill



Ground view of very large triple in Italy.
Photo courtesy of Andy Hill

Rig photo of Chinese rig in Thailand.
Photo courtesy of Andy Hill

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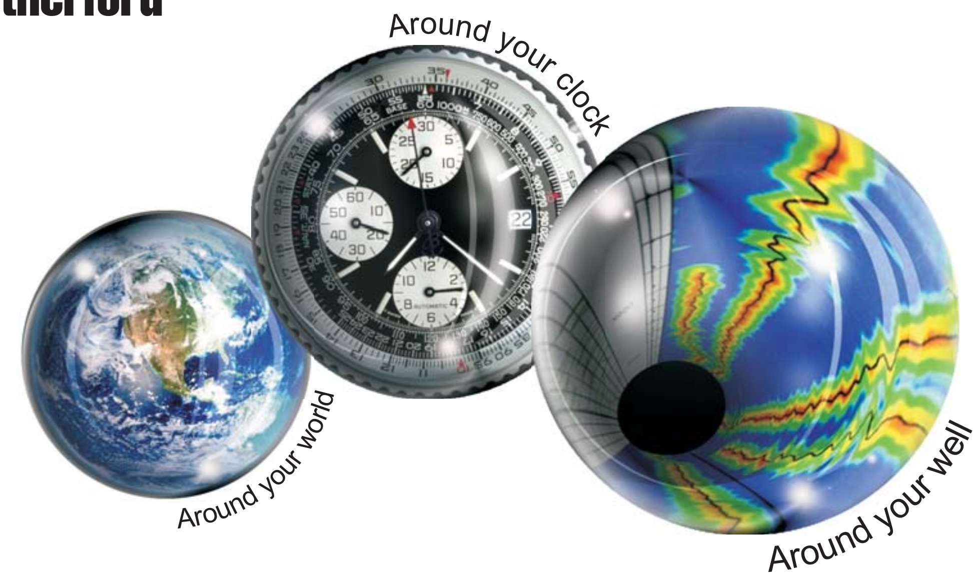

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