InSite

CWLS Magazine

November 2007 Issue 3 Volume 26

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InSite

CWLS Magazine November 2007

Issue 3 Volume 26

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The CWLS InSite is printed by Littlerock of Calgary, Alberta, Canada four times annually which is included as a part of your yearly membership fees.

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Cover Photos: *Wireline Field employees working in Southern Alberta*
Photo courtesty of John Hull

Night-time logging ops in Dawson, Alberta - January, 2003
Photo courtesty of Robert Bercha

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.Maksymchuk@can.apachecorp.com or Kelly.S.Skuce@conocophillips.com. Include a short description of the photo with your submission.

The 2007 - 2008 CWLS Executive:

Front row (l - r): Greg Schlachter, Cindy Guan, Jeff Taylor, Kelly Skuce.
Back row (l - r): Roy Benteau, Peter Kubica, Vern Mathison, Tyler Maksymchuk, Gordon Uswak.

President's Message

Your Pipeline to the Top

I hope everyone had a great summer and has also been enjoying this great fall; all reserves have been now booked, next year's budgets are mostly done and now it's time to tackle the winter drilling season.

It's time to ask for volunteers. The CWLS is an organization run by volunteers, and we are in need now. There are a number of ways that you can help and currently we are looking for people to:

- Run for the executive next year – contact Peter Kubica, cwls.org
- Be Session Chairs for the 2008 C3Geo Convention – contact Brian Glover, www.geoconvention.org
- Coordinate the Short Courses for the 2008 C3Geo Convention – contact Brian Glover, www.geoconvention.org
- Look after the advertising for the InSite magazine – contact Tyler Maksymchuk or Kelly Skuce, cwls.org (Mike Eddy has been doing this for doing this for the last 3 years – thanks!)

September opened at the CWLS with a great talk by Mike Sullivan of Chevron where he spoke about "Calibrating Permeability in Reservoir Models of Complex Carbonate Systems using PLT logs". Octobers talk was by Yanping Niu whose University of Calgary graduate thesis earned her a $5000 CWLS award. Her thesis, and her talk in October is entitled "Determining the Content of Bitumen, Water and Solids in Oil Sands Ore using Low-field Nuclear Magnetic Resonance."

At the September Technical Luncheon, University of Saskatchewan undergraduate Chad Glemser was presented with a cheque for $2000. This CWLS student award was for his MSc thesis proposal "Petrophysical and Geochemical Characterization of Carbonate Hydrocarbon Reservoirs using Synchrotron Microtomography." His research project will utilize synchrotron-based x-ray computed micro tomography to extract physically realistic images of carbonate rock cores for the evaluation of porosity and mineralogy in the Mississippian Midale Beds of the Weyburn Oilfield.

This project is part of the investigation of increased oil recovery by CO_2 miscible flood as well as CO_2 storage in geological formations.

The Canadian Well Logging Society announces yearly awards for engineering and earth sciences undergraduate and graduate students in Canada. See the CWLS.org website for more details.

So what else is the CWLS up to? Up to no good, up to our armpits in alligators, up to .....

- Helping organize the CSPG/CSEG/CWLS "Back to Exploration" 2008 C3Geo Convention. Brian Glover (at Petro-Canada) is the CWLS coordinator. We are still looking for 1 or 2 people for Session Chairs as well as Short Course Coordinators. Contact Brian at BGlover@petro-canada.ca. More info at www.geoconvention.org
- Liaising with other societies and committees such as; APEGGA's Geoscience Committee and the Canadian Federation of Earth Science.
- Increasing our focus on students and attracting and educating people new to formation evaluation. The CWLS has also recently partnered with the University of Calgary Petroleum Club. In addition, we are increasing the manpower in our Student Liaison Committee.

One last plea to our members; we are in need of presentations for the luncheons and technical papers for the InSite magazine. Please contact any of the CWLS executive if you can help or know of someone who might be able to contribute.

See you at the next luncheon.

Jeff Taylor, P.Eng.
CWLS President

Editor's Note

Welcome everyone to this edition of the CWLS InSite. First off we want to apologize for the delay in this issue. Without making excuses, this issue has been a struggle to complete and although the quantity of material may be somewhat restrained, we are confident that our membership will enjoy the paper and the various additions in this Insite. We as publications co-chairs are finding it very difficult to retain or gain material to print from our membership. You have heard and are now reading again and again our pleas for additions that you or your colleagues may view as applicable. Our reputation for putting together quality newsletters is on the line here. So with that I ask if you have a paper or article to contribute to the InSite, please feel free to contact Kelly or Tyler or any of the current executive and we will be more than happy to include them in the next print of the InSite.

I am happy to say that in this InSite we have one new paper. This paper comes from Mr. John Doveton of the Kansas Geological Survey, University of Kansas. His paper entitled Borehole Petrophysical Geology in a University Curriculum was prepared and presented at the SPWLA 48th Annual Logging Symposium held in Austin, Texas in June of this year. If you did not have the chance to hear Mr. Doveton speak, we are pleased to provide you the paper for your perusal with published permissions courtesy of the SPWLA and its authors.

Next, we would like to take some time to remind our readers of a couple of important events coming up for the society. The first is the annual CWLS Fall Social to be held on November 28th, 2007. Please contact our Vice President, Mr. Roy Benteau with questions and details regarding this great event. Secondly, the SPWLA (Society of Petrophysicists and Well Log Analysts) is preparing for a very special and very large annual conference in 2008 in the beautiful country of Scotland, more specifically in the city of Edinburgh. It will commence on May 25th, 2008 and run through to the 28th. Please check our website at www.cwls.org for a link or you can search the conference website itself at www.spwla2008.com for information and latest news regarding this event.

We are also continuing to make additions and behind the scenes upgrades and changes to the website. If you have any suggestions or comments, or would like to inform the membership of upcoming events please contact any of the executive to discuss and have this information posted on the website. As well please continue to check for latest news, coming up towards the end of November and into December.

Lastly we want to say THANKS once again for all the attendees to the technical luncheons, and we look forward to seeing our membership at our next luncheon tentatively scheduled for December 13, 2007.

Please note that we will always be in need of technical papers for future editions of the InSite and any information that you believe is appropriate and relevant to the daily work of our membership, will be submitted, reviewed and likely published. Thanks very much for your attention to the CWLS InSite publication and if you have any comments, concerns or questions please contact either Kelly or Tyler at the email addresses below.

Enjoy this edition of the InSite!

Tyler Maksymchuk & Kelly Skuce
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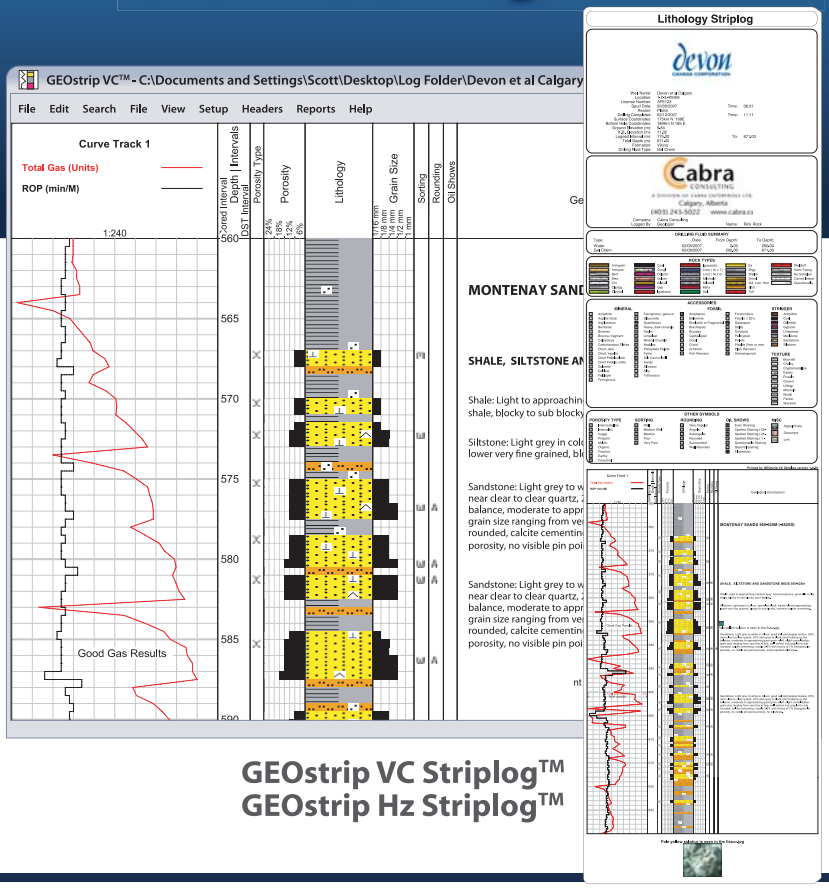

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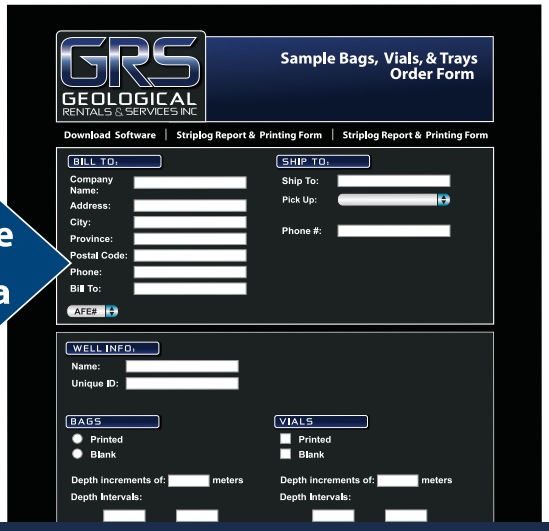

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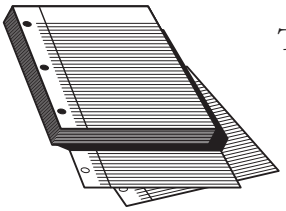

The CWLS is always seeking materials for publication. We are seeking both full papers and short articles for the InSite Magazine. Please share your knowledge and observations with the rest of the membership/petrophysical community. Contact publications co-chairs Tyler Maksymchuk (Tyler.Maksymchuk@can.apachecorp.com) at (403) 261-1258 or Kelly Skuce (Kelly.S.Skuce@conocophillips.com) at (403) 260-1931

Borehole Petrophysical Geology in a University Curriculum

John H. Doveton,
Kansas Geological Survey, University of Kansas

Reprinted with permission of the SPWLA and authors. Paper originally prepared for presentation at the SPWLA 48th Annual Logging Symposium held in Austin, Texas, United States, June 3-6, 2007.

Abstract

The scope of petrophysics courses at universities is expanding beyond a tight focus on formation evaluation of hydrocarbon reservoirs to more generalized interpretative borehole geology. Instruction in subsurface geology has long included the use of electric logs for correlation and structural mapping. However, the formation matrix properties measured by nuclear tools also record lithological composition between formation tops. Digital data are increasingly available and allow detailed compositional analysis to complement paper logs used for stratigraphic correlation. The rock studies of traditional geology may be awkwardly presented in an electronic teaching medium, but logging measurements are numerical and so are well suited to computer methods of petrophysical data transmission, log display, and geological analysis. A web course can link textual material on html pages with course libraries of log and core raster and vector files. In addition, java applets can be designed for students to engage in interactive geological interpretation of petrophysical data. In summary, the progression from log correlation to geological log analysis moves coursework beyond a basic topology of formation surfaces to a richer, virtual subsurface geology.

Introduction

The teaching of petrophysics at many universities has traditionally been offered as part of a petroleum engineering curriculum and attended only by those geology students who look for employment in the energy industry. In large part this situa-

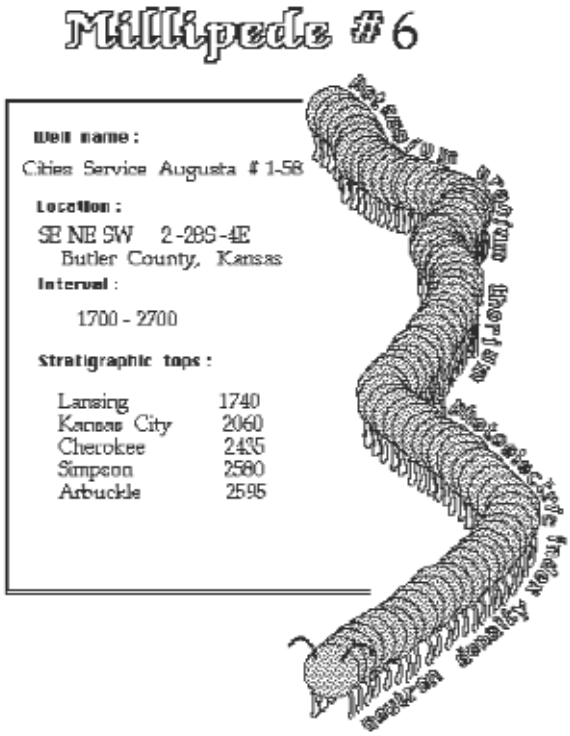

Figure 1. Example of a title sheet of a "millipede" project detailing well location and stratigraphy of a thousand foot section logged by lithodensity-neutron and spectral gamma-ray tools.

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Borehole Petrophysical Geology … *continued from page 10*

tion was caused by the restriction of older, mostly electrical, logs to estimations of pore volumes and fluid saturations. The principal use of logs for geologists has (and continues to be) the correlation of subsurface units on the basis of visual matching of log curve features. Nuclear tools have added measurements which are sensitive to rock framework properties and have enabled estimations of mineral volumetric compositions and sedimentary and diagenetic facies.

"Downhole geology" based on petrophysical logs can be taught in a similar manner to conventional geology except that the students' observations of the rock are remotely located and based on sensory inputs other than conventional sight and touch. Logging measurements of the borehole rockface can be understood using the same geological reasoning as would be applied to an outcrop. Geology students at the University of Kansas are trained first in geological interpretation of petrophysical logs using log overlays, crossplots, and compositional analysis methods. Each student selects a "millipede" project (Figure 1), which consists of a thousand-foot interval logged by spectral gamma-ray (potassium, uranium, thorium), photoelectric factor, neutron, and density tools.

The student drafts an interpreted lithological strip log, using essentially the same skills that they would use in the field description of an extensive cliff exposure (Figure 2).

The conceptual shift from traditional outcrop geology could be compared with modern astronomy, which is no longer restricted to optical observations but ranges across the much broader electromagnetic spectrum from X-rays to radio waves. So, for example, the invisible gamma-ray spectra of shales often show them to be considerably more interesting than their "monotonous" optical aspect would suggest, much as apparently

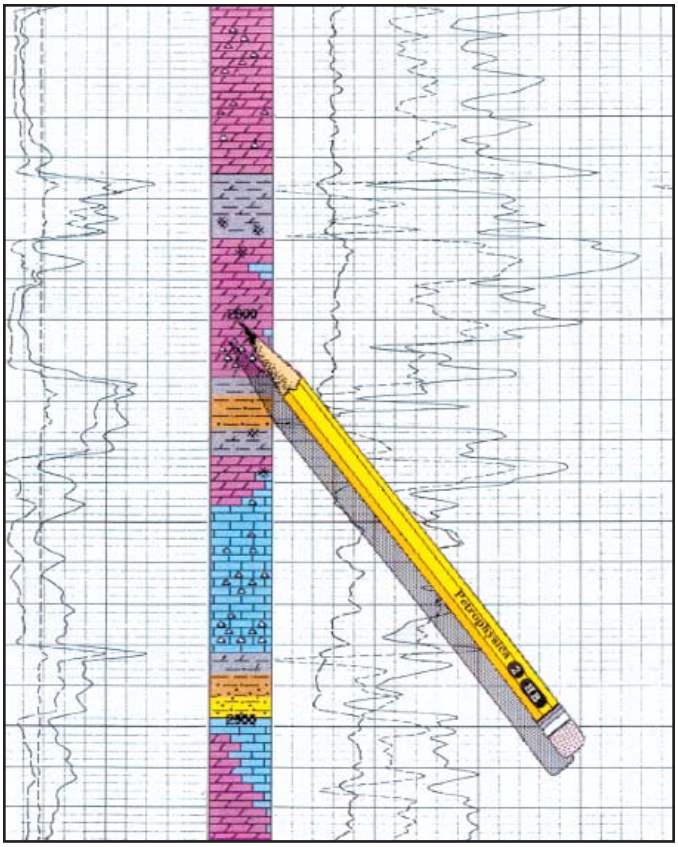

Figure 2. Lithological strip log interpreted from log overlays and crossplots.

nondescript stars have shown distinctive characteristics when studied by orbiting gamma-ray observatories.

The quantitative nature of the logging data allows numerical estimations of mineral composition to be made through a sim-

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Acquiring Density Data … *continued from page 11*

ple computer program that applies inverse matrix algebra processing. Thirty years ago, students ran this program in FORTRAN as a punched card deck submitted to a large mainframe computer with lengthy turn-around times (Doveton, 1978). Over the years, the program medium has evolved successively through time-sharing interaction with a mainframe computer, a BASIC-coded program on a PC, to the current version which is an EXCEL spreadsheet application (Figure 3), described by Doveton (2000). In the immediate future, the program will migrate onto the web as a JAVA applet application.

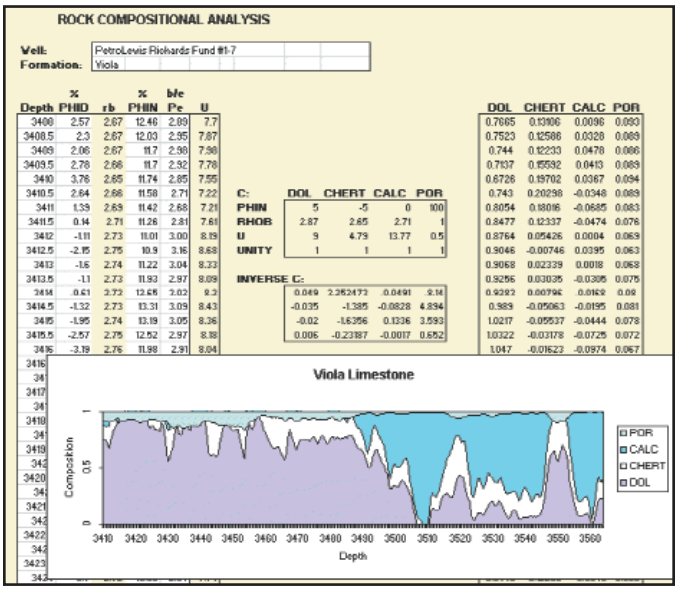

Figure 3. Spreadsheet compositional profile of a Middle Ordovician Viola Limestone section in terms of dolomite, calcite, chert, and porosity, based on density, neutron porosity, and photoelectric factor.

Web Resources and e-Petrophysics

The teaching of traditional geology through a webbased learning environment provides only a poor substitute for a conventional course. Geological fieldwork takes place in the great outdoors, where the student geologist attempts to make sense of rock relationships in space and time using all scales of direct observation. However, in most subsurface studies, the transition to "virtual geology" has already been made whenever a geologist comes to conclusions on the basis of a wireline log, irrespective as to whether a formation top is picked or a formation lithology is identified. In contrast to the direct surface geological observation, the subsurface log measurement is quantitative, remotely sensed, and so is ideally suited to the digital medium of the internet environment.

Logging data sets used in the teaching of log analysis at universities are now increasingly available as digital files on the web. This reflects not only the increased computer and web-based course component of university curricula but trends within the logging industry itself. Although hard-copy analog logs continue to be the immediate source of information for most geologists, digital files are increasingly common, originally on magnetic tape, then on diskette, and now transmitted over the internet. In addition, the introduction of the readable ASCII standard of the Canadian Well Logging Society LAS format to supplement the inscrutable binary coding of service companies has made logging data accessible to a much wider audience. As a consequence, university students can read digital log files by standard word-processing software or download the data into spreadsheet for both analysis and graphic display.

The digital forms of both petrophysical data and their software analysis tools make them natural elements of a petrophysics

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Acquiring Density Data … *continued from page 12*

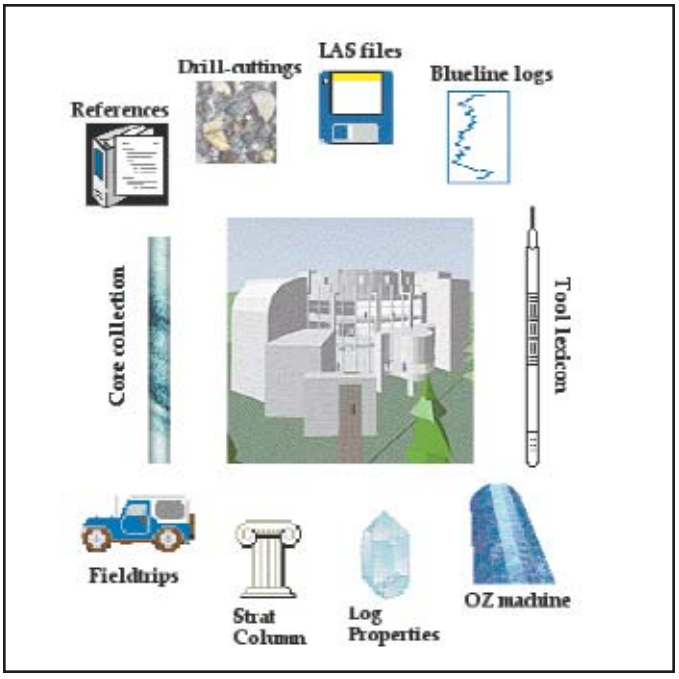

Figure 4. Site map of a virtual petrophysical campus.

course taught on a web-based medium. The conventional structure of a multibranched sequence of static html pages linked with gif and jpeg images can be supplemented by interactive JAVA applets that engage students in learning activities. In its current form, the narrative structure of the petrophysics course is embedded within a conceptual "campus" (Figure 4) where students can access data sources used by the course modules.

The "campus buildings" house:

- a core barn that contains core jpeg images,
- a library for literature references,
- a drill-cuttings directory of raster strip log images,
- a digital database of LAS log files,
- a collection of raster image analog logs,
- a tool lexicon of common logging tools,
- a database of log responses for common minerals,
- a stratigraphic column of Kansas geology to locate course examples, and
- a fieldtrip collection of outcrop images of the surface expressions of subsurface sections examined in the course.

Finally, an "Oz machine" is located on the web campus where students can learn and hone their geological log interpretation skills, using a JAVA applet that generates synthetic lithologic successions and their equivalent logs.

The "engine" of the Oz machine is a Markov Chain transition probability matrix (Figure 5) designed to produce lithological sequences that have broad similarities with Paleozoic successions in the U.S. Midcontinent.

The sequences are more "accelerated" than their real equivalents, by presenting more lithological variability over relatively short intervals rather than the common real-world experience of monotonous lithological repetition. However, the purpose of the simulator is to train the student in log interpretation and this aim is aided by accentuating the challenge. The transition probability values are arbitrary but chosen to generate sequences that conform reasonably with natural stratigraphic successions. The main diagonal values (transitions of a state to itself) control the thickness distribution of lithologies. Inevitably, the thickness variability will be artificial, because the probability model dictates a geometric distribution (Krumbein and Dacey, 1969), while the observed distributions are more closely matched by a lognormal distribution (Pettijohn, 1957).

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Acquiring Density Data … *continued from page 13*

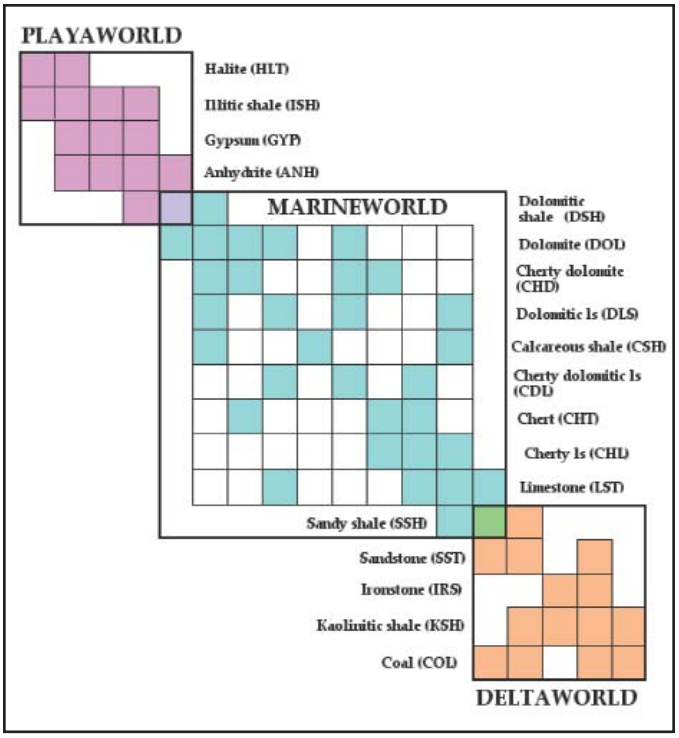

Figure 5. The Oz machine engine: a transitional probability matrix that links lithologies deposited in Playaworld, Marineworld, and Deltaworld.

However, this aberration is not noticeable on the relatively sequences presented to the student. The transition probability matrix is subdivided into three major regions: "Playaworld" for evaporite sequences, "Marineworld" for marine carbonate-shale successions, and "Deltaworld" for clastic coal-bearing successions. The transition probabilities of the "portal states" of dolomitic shale which links Playaworld with Marineworld, and sandy shale which links Marineworld with Deltaworld controls the typical duration of a succession within each facies domain.

The Oz machine generates an infinite variety of stratigraphic successions from the transition probability matrix. The simulation operates at a frequency of two steps per foot of depth, to match the standard digitizing frequency of conventional wireline logging suites. At each step, fractional volumes of mineralogy and pore fluid are then generated by random number interaction with compositional ranges appropriate for each lithology. The model lithological sequence is then transformed to gamma-ray, density, neutron, and photoelectric factor logs through forward-modeling of standard mineral and fluid log responses applied to compositions generated by the model. The student is presented with the log sequence for a one-hundred foot section plotted in standard conventions. By this means, the student will develop a comfortable familiarity with "reading" logs in addition to pattern recognition skills of geological log interpretation. The lithology palette to the right of the log exercise is used by the student to complete a strip log within the depth track (Figure 6).

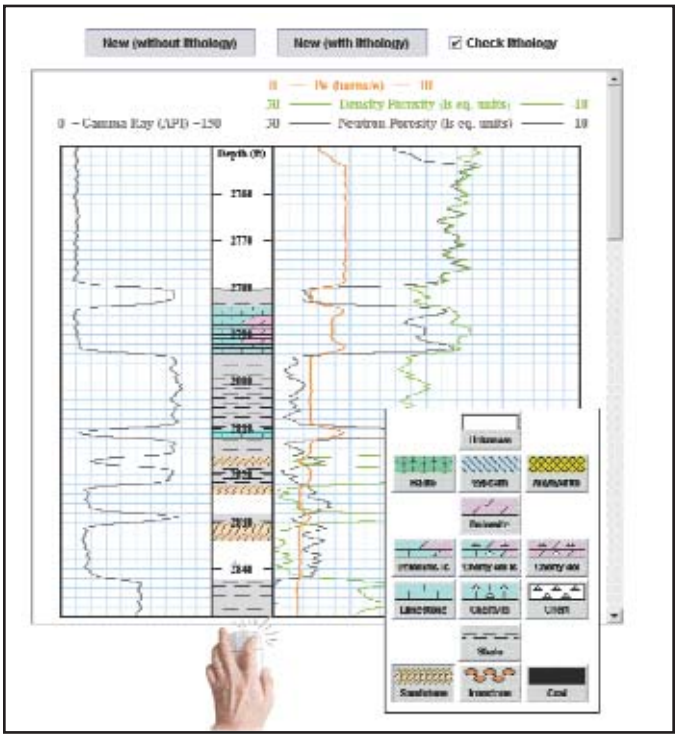

Figure 6. Interacting with the Oz machine engine: completing a lithology column, using a mouse in conjunction with a palette.

The Oz machine is freely available for use at http://www.kgs.ku.edu/PRS/ReadRocks/portal.html and is described in detail by Bohling and Doveton (2006). The output simulates stratigraphy modeled on the geology of subsurface Kansas and contiguous states. However, the machine could be modified easily to simulate successions elsewhere by replacing the transition probability matrix with lithology states and probabilities keyed to the geology of other regions. Furthermore, the probability values could be either hypothetical estimates or empirical observations from core or outcrop. The web-based petrophysical "campus" is currently under construction, but is making steady progress towards a system that will be functional and ever-changing, but never complete.

Conclusions

Web-based courses with interactive components have great potential for the training of future geologists in the geology of petrophysics. These skills supplement the traditional training of

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Acquiring Density Data ... *continued from page 14*

field geology, by extending arealy-restrictive outcrop studies over great distances into the subsurface. This integration of surface and subsurface data in an expanded spatial framework provides valuable information for studies such as basin history and sequence stratigraphy.

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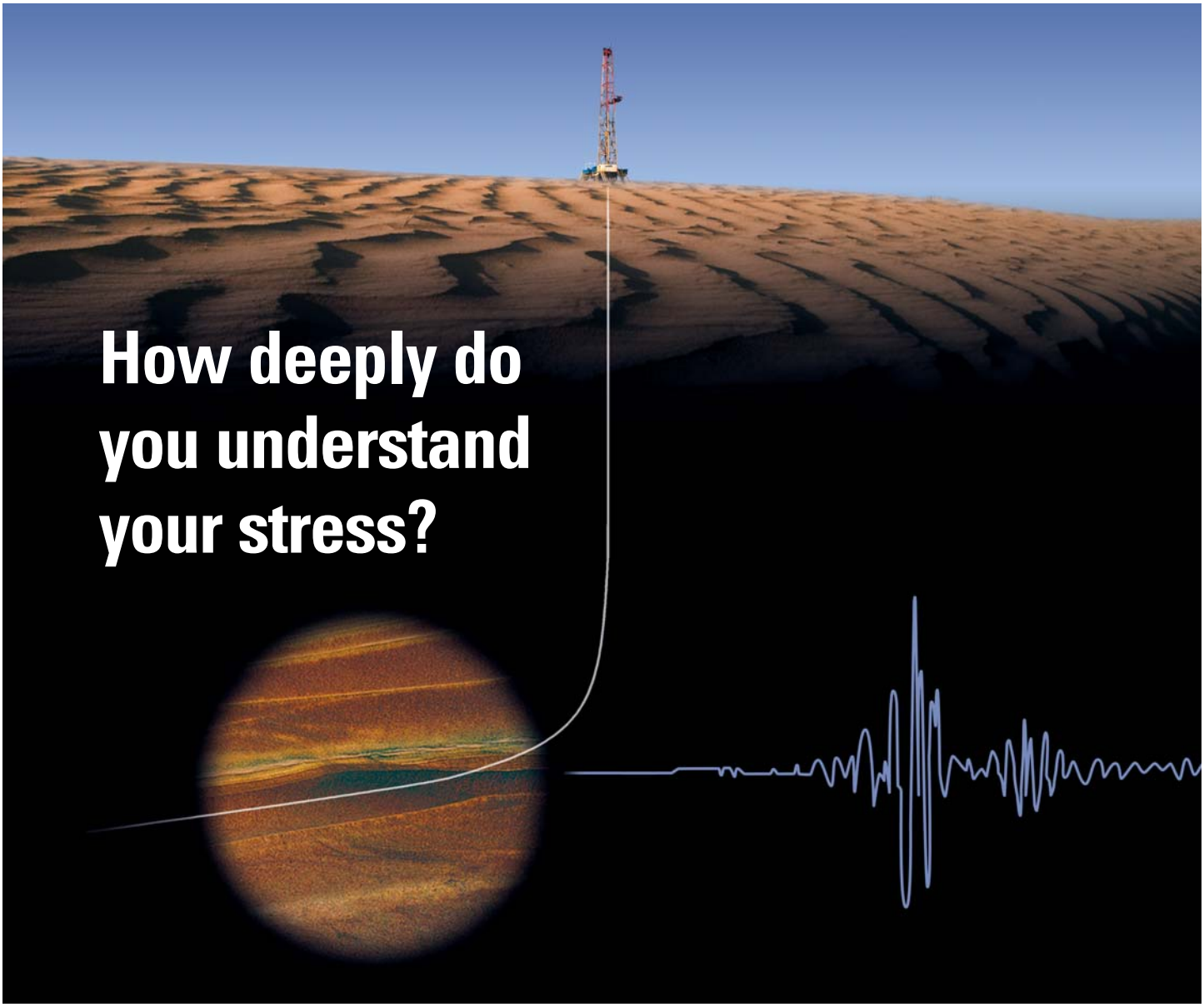
About the Author

John Doveton is a Senior Scientist at the Kansas Geological Survey and Adjunct Professor at the Geology and Petroleum Engineering departments at the University of Kansas. After graduating with a bachelor degree from Oxford and PhD from the University of Edinburgh in geology, he was an Exploration Geologist for Mobil Oil in Canada. He has taught petrophysical log analysis at the University of Kansas since 1975, as well as for academia, industry, and technical societies in North and South America, the Middle East, Europe, Asia, and Australia. He has been a Distinguished Speaker for the SPWLA and received a Best Paper Award from "The Log Analyst". He was also honored with the Griffiths Teaching Award by the International Association for Mathematical Geology and has written three textbooks in log analysis.



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BIOGRAPHY:

Munir Sharar (P.Eng. CWLS) is currently working as a Cased Hole Log Analyst with the Calgary Weatherford Engineering & Geosciences group. He has over 25 years industry experience and worked for a major logging company as a Field Engineer and Field Service Manager before joining the Weatherford Geosciences group in Calgary. He is mainly involved in Production Log and Casing Inspection analysis. He is currently focused on Casing Integrity Analysis which involves the use of in-house TVisionTM and CITVisionTM software.

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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

November 19-22, 2007
2007 Rio2007 Conference and Exhibition

Tenth International Congress of the Brazilian Geophysical Society (X CISBGf), Rio de Janeiro, Brazil

November 28, 2007
CWLS Fall Social

Contact Roy Benteau at roy_benteau@eogresources.com for more information

December 11th, 2007
CSPG Technical Luncheon

Understanding the Nature of Upper Mannville Coals in Central Alberta

Calgary, Alberta Telus Convention Center
www.cspg.org/events/events-luncheons.cfm

December 13, 2007
CWLS Technical Luncheon

The Changing Demographics of our Professional Members in Alberta

Calgary, Alberta Palliser Hotel
www.cwls.org/luncheons.php?menu_id=9

May 25-28, 2008
2008 SPWLA Annual Symposium
Edinburgh, Scotland
www.spwla2008.com

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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.

For information on advertising in the InSite, please contact either of the publications co-chairs:

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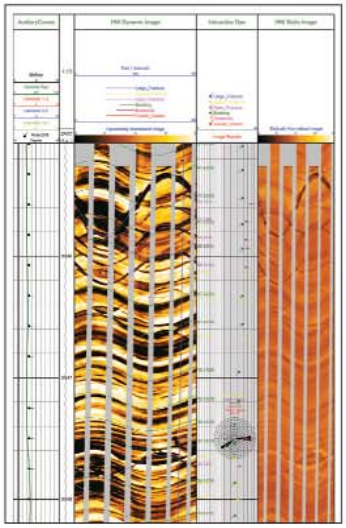

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