

Core Analysis By Low-Field NMR¹

Christian Straley and Dan Rossini
Schlumberger-Doll Research Center
Harold Vinegar and Pierre Tutunjian
Shell Development Co.
Chris Morrise
Schlumberger Wireline and Testing

Abstract: NMR core measurements have been made customarily in high magnetic fields and have emphasized T_1 for pore-size evaluation or have used chemical shift spectroscopy for quantitative differentiation of oil and water. However, new NMR logging tools use T_2 measurements made at low field strengths, and these measurements should be supported by core analysis. This paper illustrates that low-field NMR T_2 measurements made on water-saturated rock cores can be used to measure total porosity and extract T_2 distributions. The T_2 distributions are shown to be closely related to pore-size distributions. Our experiments demonstrate that low-field measurements are quantitative, even for cases where high-field measurements fail. T_2 distributions from water-saturated plugs are used to estimate producible fluids for sandstones and carbonates and to estimate clay bound water and matrix permeability. Although chemical shift spectroscopy is not feasible at low fields, a method is demonstrated on native state diatomites that permits the measurement of oil, water, and gas saturation. In the case presented, it is also possible to determine in-situ oil viscosity.

INTRODUCTION

Hydrogen (^1H) nuclear magnetic resonance (NMR) is a rapid, nondestructive measurement that can provide a wealth of information about the fluids in oil- and water-saturated rock. This paper illustrates many applications of low-field NMR measurements to core analysis. Low-field NMR has been found to be more accurate in measuring water and oil volumes than high-field NMR for rocks that have large internal magnetic field gradients. Moreover, low-field measurements are of great interest since the new pulsed NMR logging tools (Miller et al., 1990; Kleinberg et al., 1992; and Morrise et al., 1993) are able to generate fields only in the range from 120 to 550 gauss.

Low-field NMR measures three properties: the equilibrium nuclear magnetization, M_n , and the two principal NMR relaxation times, T_1 (longitudinal relaxation time) and T_2 (transverse relaxation time). M_n is proportional to the fluid-filled porosity, and T_1 and T_2 have been correlated with petrophysical properties such as pore size, producible fluid, and permeability. Although T_1 measurements are more common in the literature, they are more time consuming to measure than T_2 measurements. Hence, the new pulsed NMR logging tools preferentially measure T_2 for faster logging speeds and increased wellsite efficiency.

Traditionally, quantitative analysis by NMR has used high-field rather than low-field measurements. The use of high field, H , increases the available signal as indicated by its relationship to the nuclear magnetization,

$$M_n = \chi_n H, \quad (1)$$

where χ_n is the static nuclear susceptibility caused by the hydrogen. Higher magnetic fields result in a stronger signal; hence, greater signal-to-noise ratio and faster measurements. At higher field, larger chemical shifts permit differentiation of oil and water signals (Vinegar et al., 1991).

For fluids in porous media, however, the increased field that improves the signal also causes higher internal gradients, G , that degrade the measurements (Brown and Fantazzinie, 1993). When a rock is in an applied field, the gradients arise from magnetic field inhomogeneity, ΔH , caused by the susceptibility contrast between rock grains and pore fluids,

$$\Delta H \approx \Delta \chi_e H, \quad (2)$$

where $\Delta \chi_e$ is the difference in susceptibilities (resulting primarily from electronic contributions). In rocks, the internal gradients resulting from field inhomogeneity are a complicated function of microgeometry but are on the order of ΔH divided by the grain size. G can frequently exceed

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100 gauss/cm at 20 kilogauss (85 MHz ^1H Larmor frequency). The same rocks would have gradients of only 2.5 gauss/cm at 500 gauss (2.1 MHz ^1H Larmor frequency).

To understand why large internal magnetic field gradients can cause complications it is necessary to consider the three T_2 relaxation mechanisms in rocks. These are due to molecular motion in fluids, surface relaxivity at the pore wall, and molecular diffusion in the internal gradients.

The first mechanism, caused by local motions such as molecular tumbling, is equally effective whether or not the fluid is in a rock. This is called bulk liquid relaxation. The bulk liquid T_2 decreases as fluid viscosity, η , increases (Bloembergen et al., 1948):

$$T_{2B} \sim \frac{T}{\eta}, \quad (3)$$

where T is the absolute temperature.

The second mechanism is the relaxation of ^1H nuclei when they closely approach paramagnetic ions such as iron or manganese, which reside on grain surfaces. Fluid molecules diffuse to the surface, have a probability of being relaxed there, and then diffuse away. For water in an individual pore the relaxation time constant is (Cohen and Mendelson, 1982)

$$T_{2S} = \frac{1}{\rho_2} \left(\frac{V}{S} \right), \quad (4)$$

where (S/V) is the surface-to-volume ratio of the pore and ρ_2 is the transverse surface relaxivity.

The third mechanism is a result of the diffusion of molecules in magnetic field gradients. Using the Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence, the relaxation time resulting from diffusion (T_{2D}) is

$$T_{2D} = \frac{3}{\gamma^2 G^2 D \tau^2}, \quad (5)$$

where γ is the ^1H gyromagnetic ratio, D is the diffusion coefficient, and τ is the Carr-Purcell pulse spacing. The CPMG sequence produces a closely spaced train of spin echoes whose decay is analyzed to determine T_2 . The interecho spacing, 2τ , can be varied and is an important experimental parameter (Kleinberg et al., 1993 and Kenyon, 1992).

The time dependence of the signal, $A(t)$, from all three processes and measured at the peaks of the echoes (Kleinberg et al., 1993 and Kleinberg and Horsfield, 1990), is

$$A(t) = A(0) e^{-t/T_{2B}} e^{-t/T_{2S}} e^{-\gamma^2 G^2 D \tau^2 t/3}. \quad (6)$$

$A(0)$, the signal at time = 0, is proportional to M_n and therefore fluid-filled porosity. For quantitative analysis $A(0)$, T_{2B} and T_{2S} measurements are of interest; the gradient

diffusional relaxation is considered a nuisance. In rocks with potentially high internal gradients (e.g., very shaly sands) or measurements made at high field, the extrapolation to find $A(0)$ can be inaccurate and the relaxation curves for the bulk fluid or surface relaxation can be completely obscured. Fortunately, the relaxation from the gradients can be minimized by shortening τ as seen in Equation (6). However, because of spectrometer hardware constraints at high field it is not always possible to achieve the required interecho spacing, and for many rocks it is better to work at low magnetic field strengths (where G is also smaller).

For the purposes of this paper, low field means a CPMG sequence with $H\tau \approx 0.1$ gauss-s. Consider the extreme case of water ($D = 2 \times 10^{-5}$ cm $^2/\text{s}$) in an internal gradient of 10 gauss/cm (from a 500 Gauss applied field). If $H\tau = 0.1$ gauss-s is maintained, gradient diffusional relaxation will be negligible for T_2 values as high as that of bulk water. When gradient diffusional relaxation is negligible, T_1 and T_2 contain the same petrophysical information, and the ratio of T_1 to T_2 has been shown to be approximately 1.6 for a collection of sandstones and carbonates (Kleinberg et al., 1993).

NMR transverse relaxation data can be expressed as a sum of exponentials

$$A(t) = \sum_i A(0)_i e^{-t/T_{2i}}. \quad (7)$$

Equation (7) can be inverted into a T_2 relaxation time distribution, where the T_{2i} are a preselected basis set of relaxation time constants and the $A(0)_i$ are the signal amplitudes associated with each time constant by fitting (Gallegos and Smith, 1988; Fordham et al., 1994; and Freedman, 1994).

Single-component fluids are characterized by a single value of T_2 . For example, bulk water has a T_2 of 3 s at room temperature. Multicomponent fluids such as crude oils often display a distribution of relaxation times (Morris et al., 1994).

In water-saturated rocks, the bulk water relaxation is often negligible, and the distribution of T_2 arises from the distribution of surface-to-volume ratio of the pores, as shown in Equation (4) (Kenyon, 1992). Because T_2 depends linearly upon pore size, the T_2 distribution corresponds to a pore-size distribution with the largest pores having the longest relaxation times.

When oil and water coexist in the pore space, the general principle is that the relaxation of fluid in contact with grain surfaces is enhanced by those surfaces. See Equation (4). Conversely, fluid that does not wet the surface relaxes at its bulk rate, as relaxation does not occur at the oil-water interface. Because oil and water have similar ^1H density, the

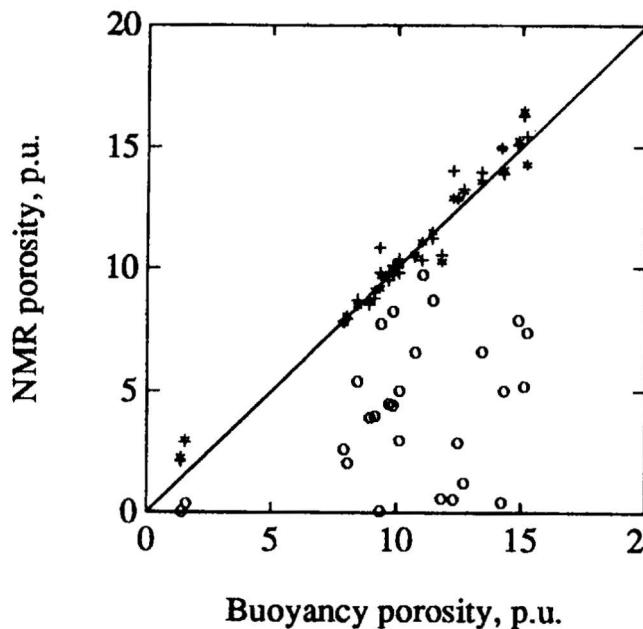


Figure 1: Comparison of NMR porosity measured at three field strengths to buoyancy porosity. o is 85-MHz data; + is 2-MHz data; * is 1-MHz data.

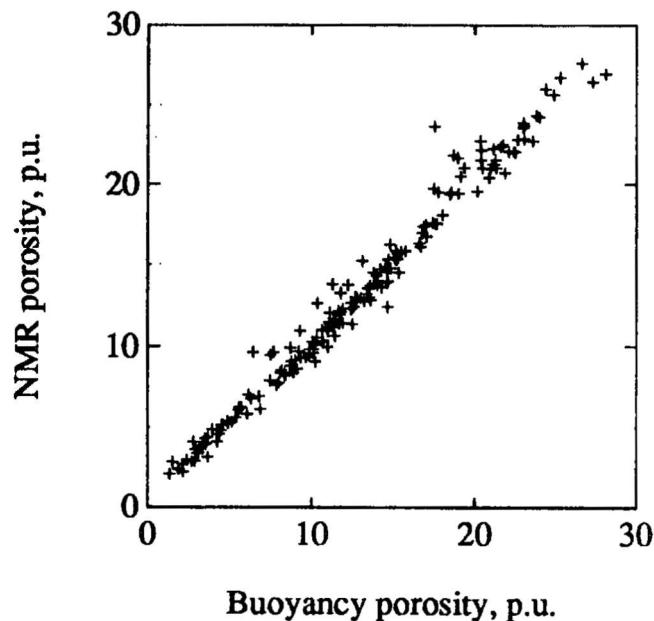


Figure 3: Comparison of 2-MHz NMR porosity with buoyancy porosity for 192 sandstones.

T_2 distribution is a linear summation of the individual contributions from the oil and water.

RESULTS AND DISCUSSION

Porosity

Evidence of internal gradients and their dependence on magnetic field can be seen in porosity measurements on a suite of shaly sands and shales from the Shell Johnson City test well. Figure 1 compares porosity measurements made at 85, 2, and 1 MHz with Carr-Purcell pulse spacing (τ) of 0.25, 0.08, and 0.25 msec, respectively. These values of τ were the shortest that could be achieved with the instruments. The unknown porosity, ϕ_{unknown} , is determined by comparing the signal, $A(0)_{\text{unknown}}$ from Equation (6), to the values for a standard sample:

$$\phi_{\text{unknown}} = \frac{A(0)_{\text{unknown}}}{A(0)_{\text{standard}}} \times \phi_{\text{standard}} . \quad (8)$$

The 85-MHz data were collected on a GE CSI-2T spectrometer, the 2-MHz data on a custom-built Schlumberger spectrometer, and the 1-MHz data on the NUMAR Core-Spec 1000.¹

Clearly, the porosity from the 85-MHz measurement

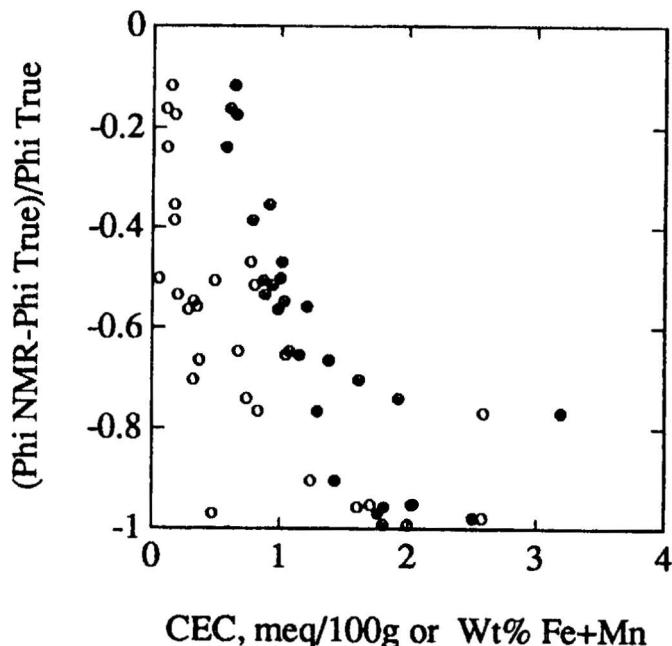


Figure 2: The relative error in 85-MHz NMR porosity crossplotted with CEC and paramagnetic impurities. The open circles indicate CEC values and the solid circles are weight percent Fe plus Mn.

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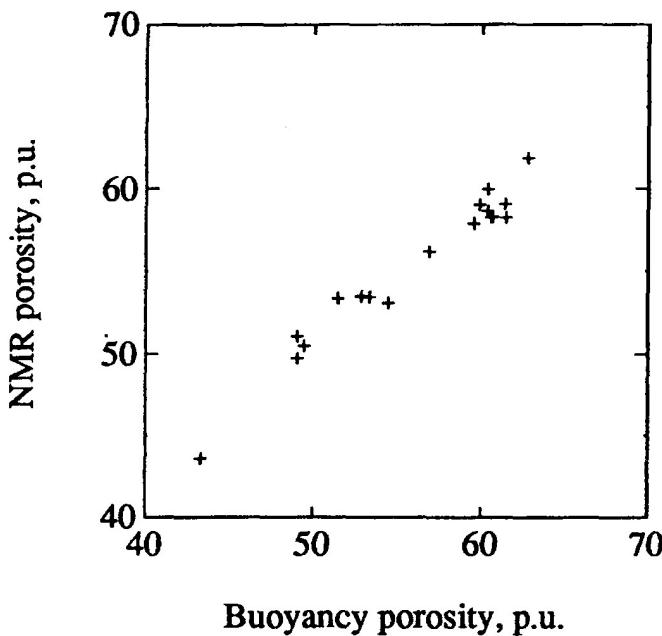


Figure 4: Comparison of 2-MHz NMR porosity with buoyancy porosity for 18 high-porosity diatomites.

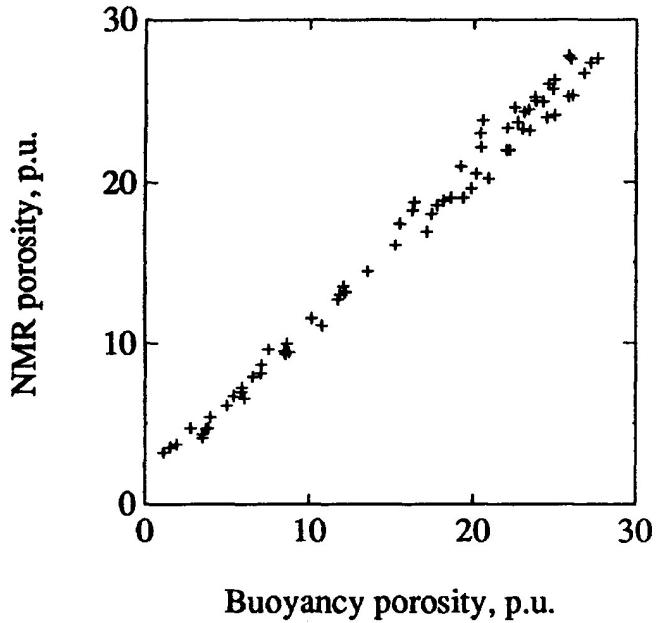


Figure 5: Comparison of 2-MHz NMR porosity with buoyancy porosity for 71 carbonates.

significantly underestimated the gravimetric porosity for all samples, whereas the porosities from the 1-MHz measurement are in good agreement even though the same value of τ was used. As expected, because of the low field and very short τ values, the 2-MHz porosities are also in good agreement with gravimetric values.

The fractional error in the 85-MHz porosity is strongly correlated with the weight of paramagnetic impurities (iron and manganese) and similarly with the cation exchange capacity (CEC) values (Figure 2). This is expected since iron and manganese, the most common paramagnetic impurities and largest contributors to grain susceptibility, are often associated with clay minerals. Clay minerals have large surface area and high magnetic susceptibilities leading to large internal gradients and extremely short values of T_2 .

At low field, porosity can be accurately measured for both sandstones and carbonates. This is illustrated in Figures 3, 4, and 5, where 2-MHz NMR porosities are compared with gravimetric porosities for 281 samples.

The sandstone suite has 210 samples, including 18 diatomite plugs with porosities ranging from 45 to 65 p.u. The regression has a slope of 0.98, intercept of 0.5 p.u., and standard deviation of 0.8 p.u. A significant source of experimental error is the nonuniform sample size.

There are 71 carbonate samples. The regression has a slope of 0.97, intercept of 1.4 p.u., and standard deviation of 0.8 p.u. The higher intercept is due to two factors. First,

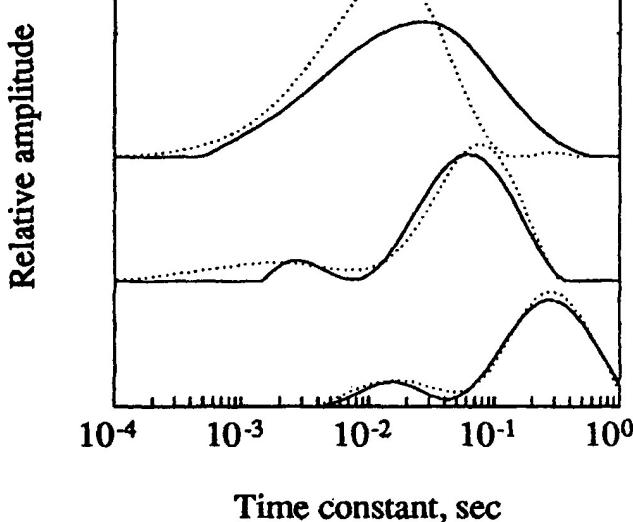


Figure 6: T_2 (dotted) and T_1 distributions (solid) for four sandstones measured at 2 MHz. The T_1 curves have been shifted by a factor of 2/3.

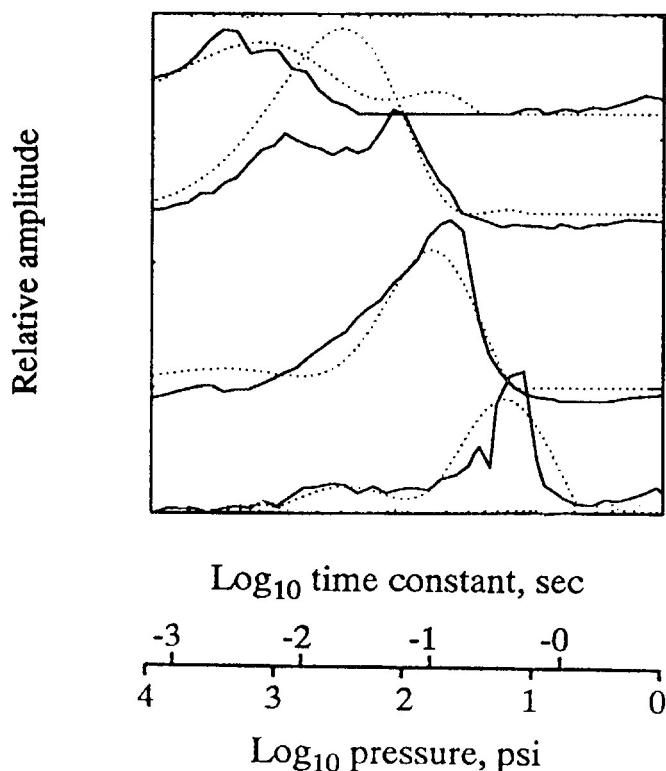


Figure 7: Differential mercury injection curves (solid) with the T_2 distributions (dotted) for the samples shown in the previous figure.

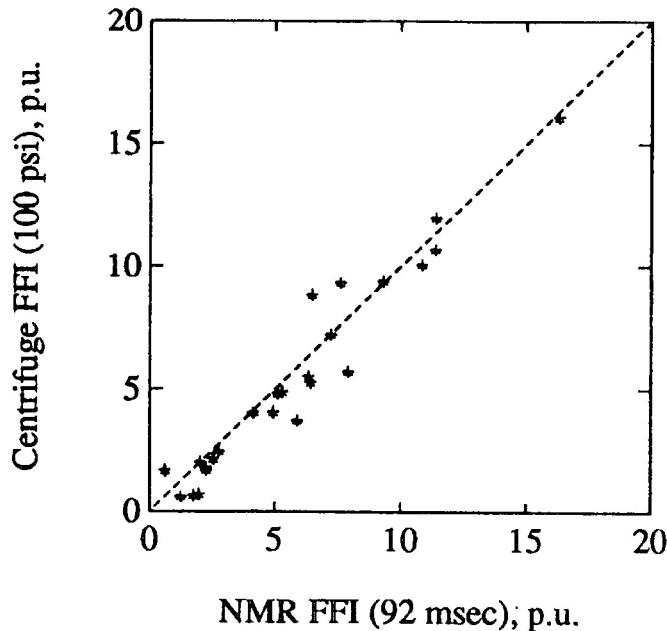


Figure 9: The volume of fluid expelled by centrifuging at 100 psi versus air plotted against the NMR free-fluid porosity calculated using 92-ms cutoff for a suite of carbonates. The dashed line is 1:1.

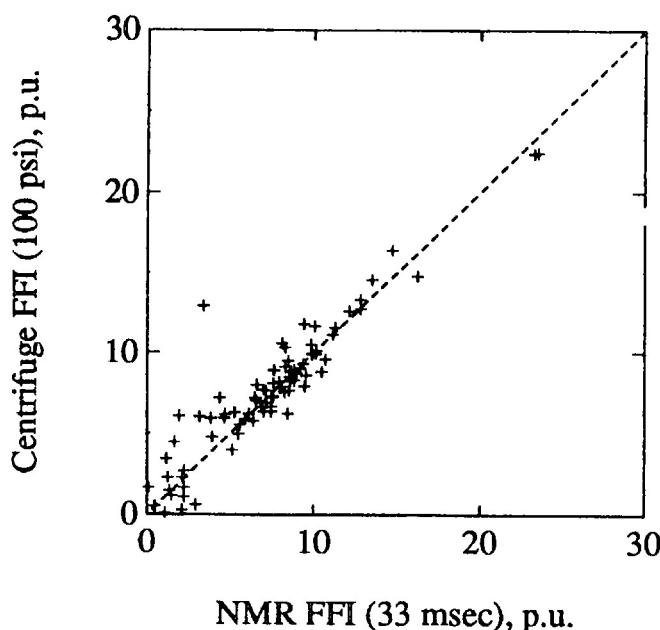


Figure 8: The volume of fluid expelled by centrifuging at 100 psi versus air plotted against the NMR free-fluid porosity calculated using a 33-ms cutoff for a suite of sandstones. The dashed line is 1:1.

about one-third of the samples were known to be incompletely cleaned of hydrocarbons. This residual hydrocarbon is included in the NMR measurement, but not in the gravimetric measurements. Second, many of the samples have surface vugs that were not completely dried prior to the NMR measurements.

PORE SIZE DISTRIBUTIONS

T_2 distributions from low-field CPMG data are similar to T_1 distributions and to pore-size distributions from mercury porosimetry measurements (Kleinberg et al., 1993; Morriss et al., 1993; Morriss et al., 1994). T_1 and T_2 distributions for four sandstone samples from different formations are displayed in Figure 6 to illustrate the similarity. The T_1 distributions have been shifted to shorter times using a factor of 2/3. This shift is required to roughly compensate for the different surface relaxivity for T_1 and T_2 processes.

Figure 7 compares T_2 distributions and differential mercury capillary pressure curves for the same four sandstone samples. The curve overlay is based on a correspondence of $T_2 P = 5.33$ s-psi. Similar results have been reported for other sandstones and diatomite samples (Morriss et al., 1993; Morriss et al., 1994).

FREE-FLUID POROSITY

T_2 distributions can be used to estimate the volume of

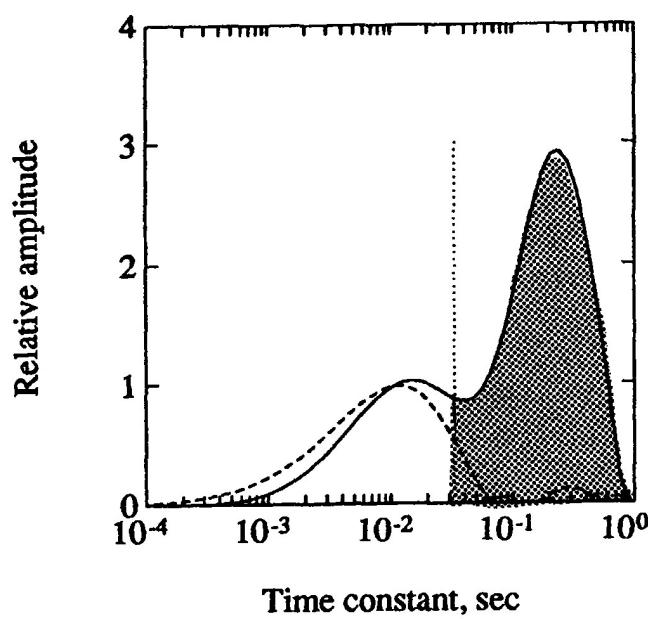


Figure 10: A vertical cutoff on a T_2 distribution separating the distribution into the long T_2 porosity (shaded) and the short T_2 porosity. The solid curve is the distribution for a fully saturated sandstone. The dashed curve shows the same sample after centrifuging at 100 psi versus air. The dotted vertical line is located at a cutoff of 33 ms. The long T_2 porosity found in this manner is called the free-fluid porosity.

producible fluid in a manner similar to that described for T_1 distributions (Straley et al., 1991). The NMR estimate of producible porosity is usually referred to as the free-fluid porosity, or free-fluid index.

This technique is based on an expectation that the producible fluids reside in the larger pore spaces, whereas the bound fluids are held in the smaller pores. Hence, a T_2 cutoff (i.e., a pore-size cutoff) may be applied to the T_2 distribution that divides the total NMR porosity into bound- and free-fluid porosity. The value of the T_2 cutoff is determined by the best agreement between the free-fluid porosity and the volume of fluid that is centrifuged from the sample at 100 psi air-brine equivalent capillary pressure. Good agreement is obtained with cutoff values of 33 ms and 92 ms for sandstones and carbonates, respectively. Results are shown in Figures 8 and 9 for 86 sandstone and 25 carbonate samples.

T_2 distributions obtained for samples after centrifuging show that the bound, or irreducible, fluids are held in the small pores that have short T_2 values. For example, Figure 10 compares T_2 distributions for a sandstone sample before and after centrifugation under air. After centrifuging, the longest T_2 values correspond roughly to the 33-ms cutoff.

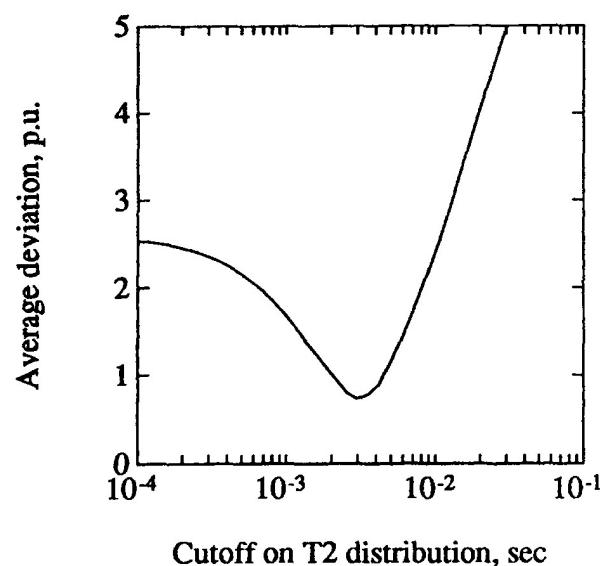


Figure 11: The minimum in the average deviation, at 3 ms, indicates the best agreement between clay-bound water volume from membrane potential measurements and the T_2 distribution porosity for the smallest pores.

CLAY-BOUND WATER

Estimation of clay-bound water volume from the T_2 distribution is based on an assumption that clay-bound water has the shortest T_2 values in the distribution; clays have high surface area and small pores. Hence, the pore volume with T_2 values shorter than a certain cutoff can be correlated with clay-bound water estimates from electrical or other measurements.

Cation exchange capacity/pore volume (Q_{ve}) was determined from electrical membrane potential measurements (Yuan and Diederix, 1987) for 45 oilfield sandstones from North America, South America, and Europe. Clay-bound water volumes were then calculated from the Q_{ve} values using the Hill-Klein-Shirley equation (Hill et al., 1979). Comparing these bound-water volumes with the cumulative porosity along the distribution, the best agreement with Q_{ve} measurements occurs at a cutoff of 3 ms (Figure 11). This results in a minimum error of 0.75 p.u. A crossplot of the NMR estimate versus clay bound water is shown in Figure 12. These NMR measurements were made at 2.1 MHz using $\tau = 80 \mu\text{s}$.

PERMEABILITY

$k = T_1^2 \phi^4$ and similar expressions have been used to estimate matrix permeability in sandstones (LaTorra et al., 1993). Applying this equation with porosity as a decimal fraction and T_1 in milliseconds gives permeability esti-

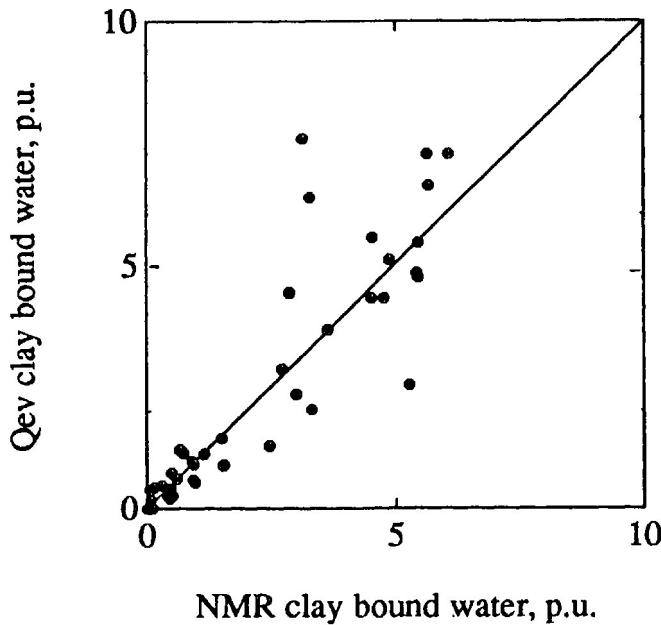


Figure 12: The clay-bound water volume from membrane potential measurements compared with the cumulative porosity up to 3 ms on the T_2 distributions.

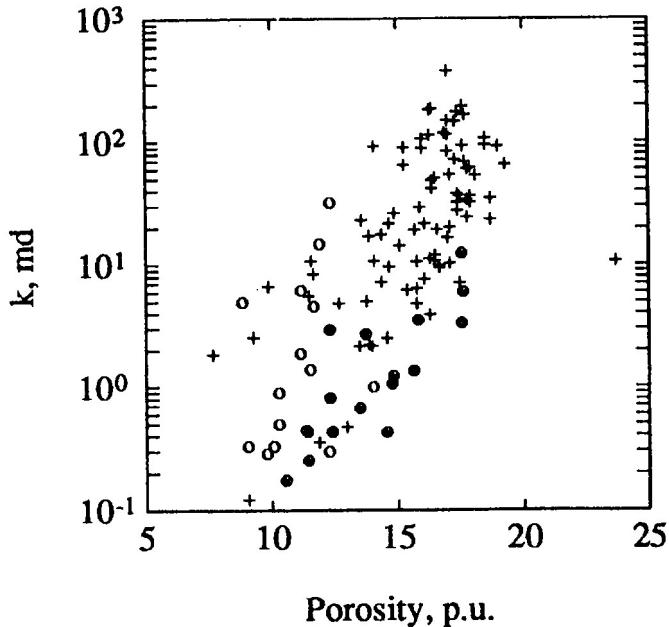


Figure 14: Permeability plotted against the total porosity for the three sandstone suites used in the previous plot.

mates in millidarcies. Analogously, permeability may be estimated using

$$k = CT_{2ML}^2 \phi^4. \quad (9)$$

The logarithmic mean T_2 , T_{2ML} is the value of T_2 that

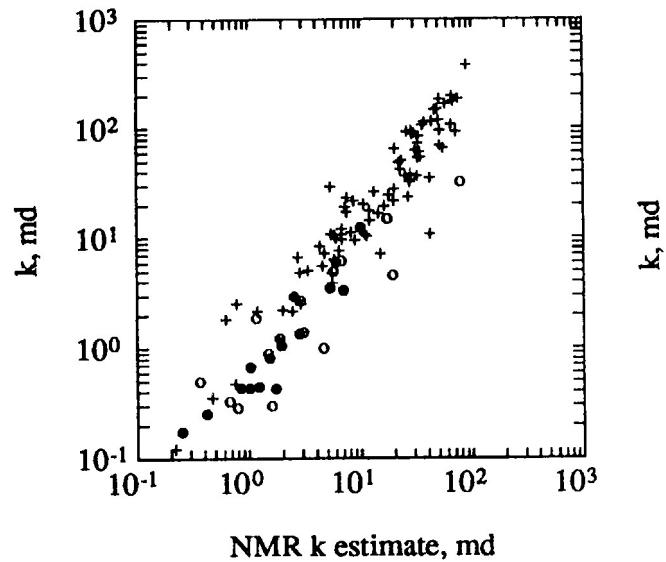


Figure 13: The measured permeability for three sandstone suites versus the permeability estimated by $4.6T_{2ML}^2\phi^4$.

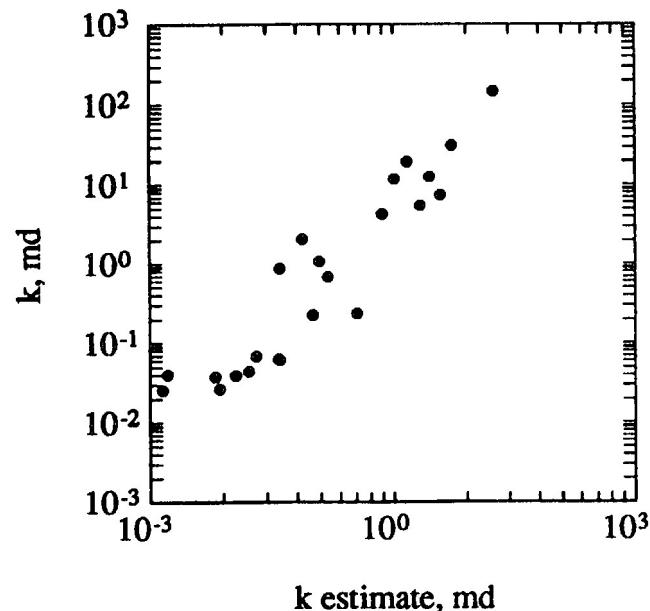


Figure 15: Crossplot of the NMR permeability estimate and the measured permeabilities for 23 Clearfork dolomites. This estimate is from the short- T_2 portion of the distribution that yielded the smallest error (see Figure 16).

bisects the area under the T_2 distribution curve and is given by

$$T_{2ML} = \exp(\langle \log T_2 \rangle) = \exp\left(\frac{\sum \phi_i \log T_{2i}}{\sum \phi_i}\right). \quad (10)$$

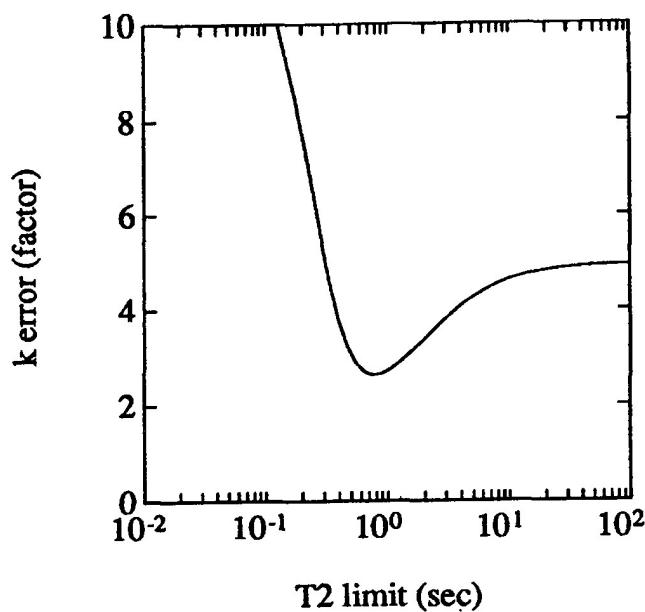


Figure 16: Variation in error from log-log crossplots of the measured permeability versus the NMR estimate calculated using a limited extent of the distributions (as indicated on the x-axis).

The NMR permeability estimate, using Equation (9) and a premultiplier (C) of 4.6, gives good agreement with air permeability for 110 sandstones from three reservoirs (Figure 13). Better agreement can be obtained by adjusting the premultiplier for each reservoir. The improvement using the NMR estimate rather than porosity alone is evident from a comparison of Figures 13 and 14.

In vuggy carbonates, a straightforward application of Equation (9) results in more scatter because of a greater variation in pore-body to pore-throat ratio. Use of the T_2 distribution allows discrimination of the separated vuggy porosity, which has a weak contribution to the permeability (Chang et al., 1994). Figure 15 shows the permeability computed from Equation (9) for 23 vuggy dolomite samples from the Clearfork formation using an upper T_2 cutoff of 750 msec. That is, values of both porosity and T_{2ML} are computed from that portion of the distribution below 750 msec. The dolomite samples are the same samples described in the free-fluid porosity section. By using a truncated T_2 distribution rather than the entire distribution, the error in permeability estimation was reduced from a factor of 4.8 to a factor of 2.6, as shown in Figure 16.

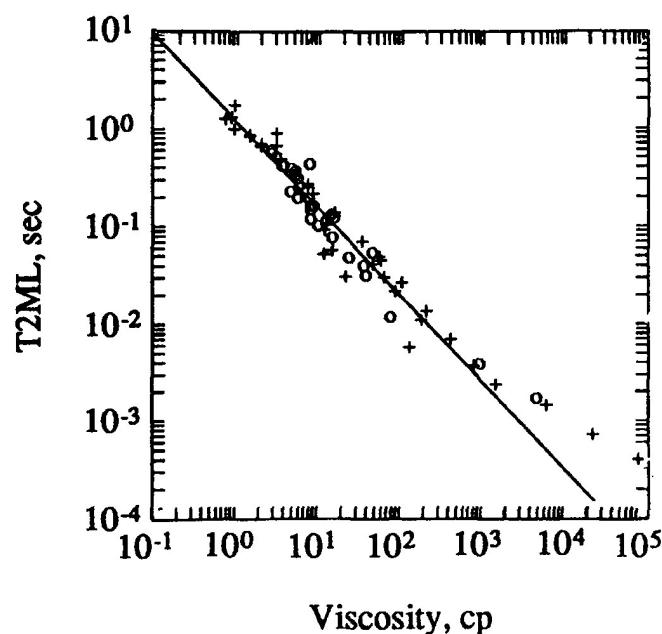


Figure 17: The measured oil viscosity is plotted against T_{2ML} . Belridge samples are indicated by \circ and other oil samples are indicated by $+$. The fit (solid line), for the data from 0.7 to 1,000 cp, is given by a power law; i.e. $T_{2ML} = 1.2/\eta^{0.9}$.

OIL VISCOSITY

T_2 distributions were determined for 64 bulk oil samples and values of T_{2ML} were determined from their distributions. Many of these crudes could not be characterized by a single time constant and T_{2ML} is used to approximate T_{2B} . As expected from Equation (3), values of T_{2ML} vary inversely with oil viscosity (see crossplot, Figure 17). The best fit of the data from 0.7 to 1,000 cp is given by $T_{2ML} = 1.2/\eta^{0.9}$.

OIL SATURATION

Low-field NMR measurements were used to determine the oil saturation and oil viscosity for diatomite samples from the Belridge field, Kern County, California. The laboratory measurements were used to evaluate logs recorded on the well with an experimental logging tool, the CMR¹ Combinable Magnetic Resonance tool. The results of the log and laboratory measurements are described by Morris et al. (1994).

The diatomite samples were measured three times. The first measurements were made in their native state condition (i.e., prior to cleaning), at which time the pore fluids consisted of connate water, gas, and native crude oils. The second measurements were made after displacing the gas with brine by placing the samples under brine with a light

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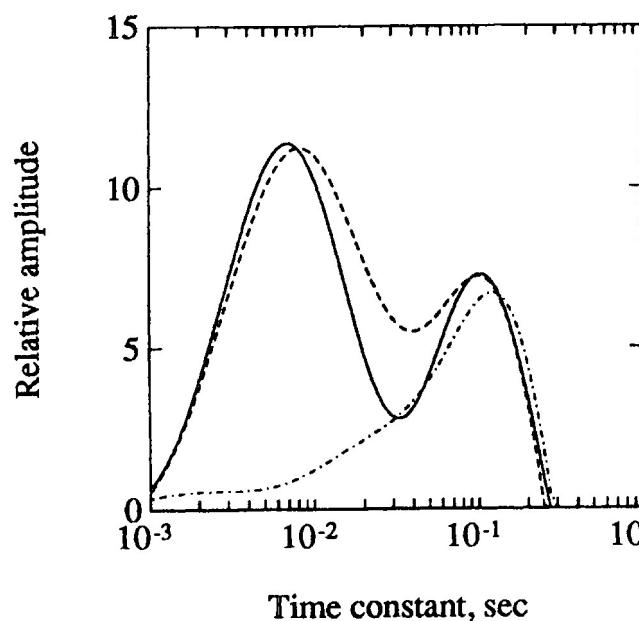


Figure 18: The plot shows 2-MHz T_2 distributions for a diatomite sample. The difference between the native state material (solid) and the fully saturated samples (dashed) shows gas saturation. The dash/dot curve is the distribution for oil measured after the H_2O signal was eliminated by dilution with D_2O .

vacuum. Hence, differences between T_2 distributions from the first and second measurements, shown in Figure 18, indicate the volume of gas present at the time of the native state measurement.

The samples were then soaked in D_2O . During this procedure the D_2O diffuses into the sample and dilutes the concentration of H_2O to a negligible level. After repeated soaking, the remaining NMR signal originates entirely from the crude oil, since D_2O does not contribute an NMR signal at the operating frequency of the laboratory spectrometer. These T_2 distributions (Figure 18) were found to be similar to T_2 distributions for the bulk oils.

Hence, surface effects are not apparent; this indicates that the diatomite samples are predominantly water wet. Because of the absence of surface effects, oil viscosity can be estimated from T_{2ML} of the distribution using Figure 17.

The NMR porosity after D_2O diffusion is a direct measure of the volume of oil in the sample and was found to be in very good agreement with oil volumes determined from Dean-Stark extraction (Figure 19).

CONCLUSIONS

Low-field NMR measurements can be obtained rapidly, in about 20 minutes, on both native state and cleaned samples. Although not as well established as other core testing

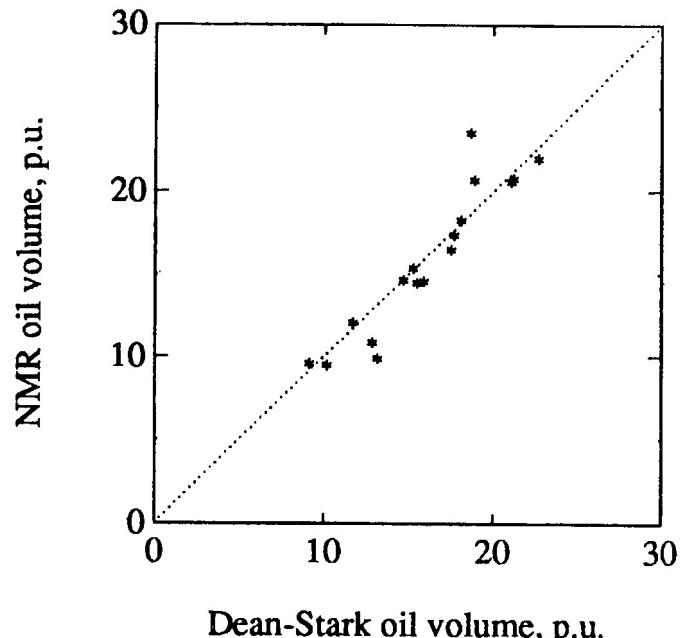


Figure 19: Comparison of oil volume determined by NMR with Dean-Stark extraction made subsequent to NMR analysis.

methods, low-field NMR is capable of quantifying a wide range of petrophysical properties with one nondestructive measurement.

- NMR measurements using low magnetic fields give accurate porosity values for both sandstones and carbonates. Low fields have $H\tau \leq 0.1$ gauss-s.
- Low-field T_2 distributions show good agreement with T_1 distributions and correspond to pore-size distributions from mercury porosimetry.
- Free-fluid porosities calculated using cutoffs of 33 and 92 ms for sandstones and carbonates, respectively, predict the producible fluid.
- In sandstones, clay-bound water can be estimated from T_2 distributions using a 3-ms cutoff.
- Sandstone permeability can be estimated with $4.6T_{2ML}^2\phi^4$. For some vuggy carbonates, the NMR permeability estimate is improved by excluding the long T_2 porosity that is associated with the vugs.
- Measurements on a large suite of crude oils and viscosity standards established that $T_{2ML} = 1.2/\eta^{0.9}$, where T_{2ML} is in seconds and η is in centipoise.
- Using D_2O diffusion, NMR can measure S_o and S_w in native state core. This method allows oil viscosity to be estimated in situ for water-wet rocks.

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NOMENCLATURE

<i>A</i>	signal amplitude
CEC	cation exchange capacity
<i>D</i>	diffusion constant of water
<i>G</i>	magnetic field gradient
<i>H</i>	magnetic field strength
<i>k</i>	permeability
<i>M_n</i>	net magnetization resulting from hydrogen
<i>Q_{ve}</i>	cation exchange capacity/pore volume
<i>S</i>	surface area
<i>t</i>	elapsed time
<i>T</i>	absolute temperature
<i>T₁</i>	NMR longitudinal relaxation-time constant
<i>T₂</i>	NMR transverse relaxation-time constant
<i>T_{2ML}</i>	NMR mean logarithmic <i>T₂</i>
<i>T_{2B}</i>	bulk fluid transverse relaxation-time constant
<i>T_{2S}</i>	surface-induced transverse relaxation-time constant
<i>V</i>	volume
<i>τ</i>	Carr-Purcell pulse spacing, one-half the echo spacing in a CPMG
<i>χ_e</i>	electronic magnetic susceptibility
<i>χ_n</i>	nuclear magnetic susceptibility caused by hydrogen
<i>η</i>	viscosity
<i>γ</i>	gyromagnetic ratio for hydrogen
<i>φ</i>	porosity

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ABOUT THE AUTHORS

Christian Straley has a BS degree in chemistry from Washington and Lee University and an MS degree from the University of Delaware with an emphasis in physical chemistry. He has worked at Schlumberger-Doll Research for 10 yr and is presently associated with the Interpretation Sciences Department. His primary research interest is the NMR properties of rocks and nuclear magnetism logging; he has also worked on the low-frequency electrical properties of fully and partially saturated rocks and on clay properties.

Mr. Straley may be contacted at his e-mail: straley@ridgefield.sdr.slb.com.

Dan J. Rossini is Manager, Health, Safety, Environment and Facilities for Schlumberger-Doll Research. Prior to this position he worked on NMR properties and CMR support at SDR. Dan holds a BS degree in mechanical engineering and is currently finishing work on a MS degree in environmental engineering.

Harold J. Vinegar is a research advisor with Shell Exploration and Production Technology Company in Houston. Since joining the Shell Bellaire Research Center in 1976, his research interests have been in shaly sand evaluation, NMR logging, CT and NMR imaging, enhanced recovery processes, and environmental reme-

diation. He holds MA and PhD degrees in physics from Harvard University and a BA from Columbia. He served as president and vice-president technology of the Society of Core Analysts. Harold is an associate editor for *The Log Analyst* and was coorganizer of the 1994 SPWLA Forum on Well Logging Applications of Nuclear Magnetic Resonance. He received the SPWLA Distinguished Technical Achievement Award in 1992.

Pierre Tutunjian is a senior research chemist at Shell Development Company. His research has been in the application of electron spin resonance and NMR spectroscopy and imaging techniques for products and exploration and production R&D. He holds a BA degree in chemistry from New York University and a PhD degree in physical chemistry from the Massachusetts Institute of Technology.

Chris Morris graduated from the University of Aston, Birmingham in 1975, with a BSc degree in civil engineering. After joining Schlumberger in 1978, he worked in Canada as a field engineer, log analyst, sales engineer, product development engineer, and interpretation development manager. He is presently marketing development engineer for the Electrical Engineering Department, Schlumberger Well Services in Houston.

Summary: Petrophysics in Three Dimensions Topical Conference

Submitted by: Gary Beck and Paul Worthington

ANISOTROPY IS GOOD FOR YOU!

The 1996 SPWLA Topical Conference on Petrophysics in Three Dimensions, was held in Taos, New Mexico, during the period 13-17 October, 1996. The meeting was attended by 43 technical participants, 10 accompanying persons, and the spirit of Kokopelli, the mischievous pied piper adopted by the Pueblo Indians as their god of fertility.

The stimulating technical debate and the high degree of resonant synergy has re-opened the question of the level at which the number of attendees should be set. Most attendees felt that at this meeting the numbers were ideal for productive discussion of such a pioneering topic.

In broad terms, the discussions dwelt on the concept of an expanded 3D reservoir framework based on seismic interpretation, with progressively sharper spatial resolutions, dove-

tailing with a clearer insight into the ordering role of geological architecture. Petrophysics was identified as the fulcrum of this contemporary philosophy, its function being partly in response to advances in logging and drilling technology, with requirements for 3D interpretation of anisotropic formations. Attendees therefore gained a contemporary insight into the direction of petrophysics as we approach the millennium.

It was proposed that an SPWLA committee be established to capture the current evolution of the subject and to formulate it into a modern syllabus to guide the teaching of formation evaluation in universities. In that way, it was argued, the spirit of the meeting would live on by contributing to the development of those in whom our future is vested.

Many thanks to Vicki for all her organizational input and to the attendees whose cross-fertilization generated such a memorable and contributive technical event. Kokopelli would have been proud of you.

SPWLA HAS A NEW CHAPTER-AT-LARGE

The Board of Directors approved the petition and bylaws of *The International Society of Downhole Imagers, A Chapter-at-Large of the SPWLA* at the December 9, 1996 Board meeting. For more information please contact Laird Thompson: telephone 972 851-8259.