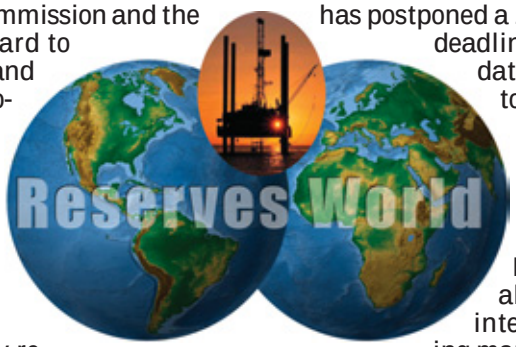
RESERVOIR SOLUTIONS

A quarterly publication of Ryder Scott Petroleum Consultants | December 2004–February 2005/Vol. 7, No. 4

Industry asking SEC to consider revising year-end pricing rule

Some oil and gas producers in U.S. markets want the U.S. Securities and Exchange Commission and the Financial Accounting Standards Board to issue a "standardized measure" oil and gas pricing schedule annually in October for use in year-end reserves reports. Currently, the SEC mandates that public oil and gas companies calculate year-end reserves using spot market prices, adjusted for location and quality, as of Dec. 31.



A change would allow issuers to complete their reserves reports by year end without requiring that they re-estimate all reserves and cash flows after January 1 and then file a complete 10-K report in less than 60 days, the final phase-in period for acceleration of periodic report deadlines. (The phase-in period has been postponed this year for accelerated filers. See article on next column of this page.)

Those producers also say that using prices based on historical averages rather than a one-day "snapshot" would add stability by eliminating the possibility of having to use a cataclysmic- or weather-driven price spike. In related news, Dow Jones news service reported on Nov. 19 that "many energy companies and even some outside consultants dislike the year-end rule, because it gives too much weight to a single day."

The article quoted a spokesperson at Exxon Mobil Corp. as saying that it is continuing "to view long-term pricing, rather than year-end pricing, as an 'appropriate' way to book reserves."

March 15 is deadline for filing annual reserves reports

The U.S. Securities and Exchange Commission has postponed a 15-day acceleration of reporting deadlines, making March 15 the cutoff date for public oil and gas companies to file annual reports and year-end reserves estimates. "Accelerated filers" now have 75 days to update year-end reserves information and file rather than 60 days.

The SEC postponed the March 1 deadline for one year to allow time for filers to focus on internal controls over financial reporting mandated by the Sarbanes-Oxley Act.

SEC reaffirms that flow testing exception applies to GOM

Mark Mahar, assistant chief accountant at the U.S. Securities and Exchange Commission, reaffirmed on Oct. 29 that the agency's flow-testing exclusion applies only to the Gulf of Mexico deep water. In April, the agency said that it would not object to the use of seismic, logs, cores and wireline formation tests to estimate proved reserves in lieu of flow testing.

Please see SEC exception on Page 3

The "Three Kings" pump jacks in the Zutica field in Croatia hover over personnel from Industrija Nafte d.d. Zagreb and Ryder Scott. Ryder Scott is evaluating the feasibility of CO_2 injection in Zutica. See article on Page 4.

Inside Reservoir Solutions newsletter

In Memoriam

Donald T. May, 92, a technical pioneer who was hired in 1935 as the first employee of Ryder Scott, died Aug. 24 in Muleshoe, TX. He worked with founders **Harry M. Ryder** and **David Scott** in Bradford, PA, and managed the Ryder Scott research laboratory — the first in the world devoted to solving oilfield waterflood problems.

Right after he was hired, May originated chip-coring analysis to provide accurate petrophysical data from a single plug of sand. As a result, Ryder Scott boosted waterflood recoveries several fold for producers in the Bradford oil field in Pennsylvania. That success fueled the overnight growth of the consulting firm to about 40 employees.

In the 1950s, May engineered secondary recovery of oil in Texas, especially for the Waggoner estate, at Ryder Scott offices in Wichita Falls, TX. He retired from Ryder Scott in 1967. May received a BS degree in chemistry from Carnegie Institute of Technology.

The long-lost innovator contacted Ryder Scott in 2000 and provided an early history of the firm, including identifying photos of Ryder. "Don helped fill in some very big missing pieces of our early chronologies," said **Ron Harrell**, CEO. "We are indebted to him not only for that but for his early contributions that literally launched Ryder Scott into the consulting business."

May's colorful stories are a permanent part of Ryder Scott's corporate history. *Reservoir Solutions* published newsletter articles on May in September 2000 and September 2001.

Don May in 2000 as he examined historical archives of Ryder Scott.

Publisher's Statement

Reservoir Solutions newsletter is published quarterly by Ryder Scott Company LP. Established in 1937, the reservoir evaluation consulting firm performs hundreds of studies a year. Ryder Scott multidisciplinary studies incorporate geophysics, petrophysics, geology, petroleum engineering, reservoir simulation and economics. With 100 employees, including 61 engineers and geoscientists, Ryder Scott has the capability to complete the largest, most complex reservoir-evaluation projects in a timely manner.

Reservoir Solutions

Editor: Mike Wysatta
Business Development Manager

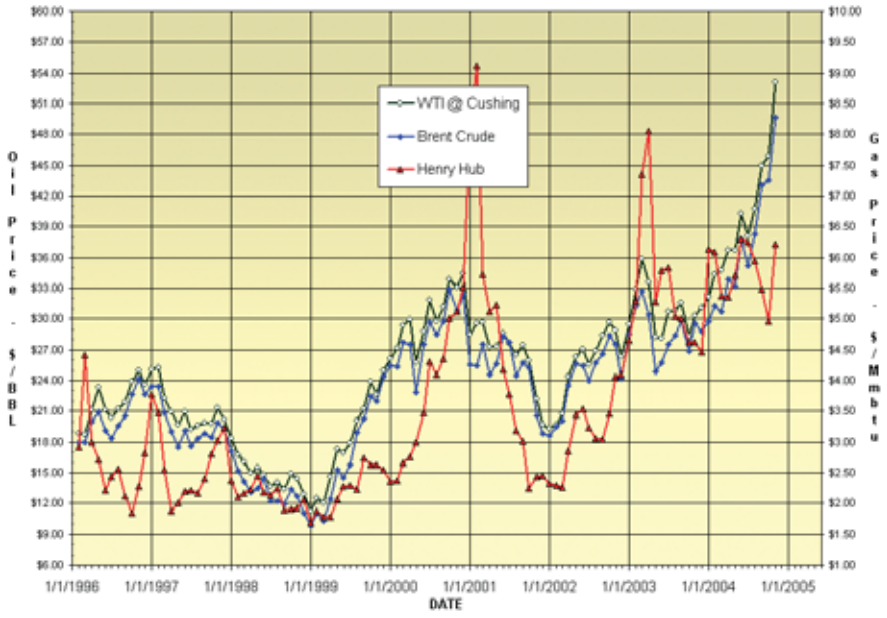
Ryder Scott Company LP
1100 Louisiana, Suite 3800
Houston, Texas 77002-5218
Phone: 713-651-9191; Fax: 713-651-0849
Denver, Colorado; Phone: 303-623-9147
Calgary, AB, Canada; Phone: 403-262-2799
E-mail: info@ryderscott.com
Web site: www.ryderscott.com

Survey of Canada's Top 100 O&G Companies

	Yes	No
Do you have a separate reserves committee?	74%	26%
If no, do you use your audit committee?	85%	15%
Is the majority of RAC members independent?	96%	4%
Do you use outside experts to advise the RAC?	32%	68%
Do you have written reserves rules for the RAC?	86%	14%

Source: Harris Consultants, Calgary

Price history of benchmark oil and Henry Hub gas



The historical price chart shows published, monthly-average, cash market prices for WTI crude at Cushing (NYMEX), Brent crude and Henry Hub gas.

SEC Exception—Cont. from Page 1

However, the SEC said its interpretation applies to properties in the deepwater GOM only.

Mahar said that the SEC has received inquiries from producers seeking clarification of the "will not object" language. "The interpretation does not apply to areas outside of the Gulf of Mexico because those areas lack suitable analogs," he said, referring to a bullet point, "Transferability of the Gulf of Mexico rules (SEC)."

As reported in the June *Reservoir Solutions* newsletter, multinational oil and gas companies have questioned the SEC decision to limit its interpretive position to a geographical area. Shortly after the initial SEC decision, **John Browne**, BP CEO, criticized the agency for excluding non-GOM areas, reported the *London Times*.

Mahar made his remarks at a conference on reserves estimates in financial reporting hosted by the Professional Development Institute at the University of North Texas and PricewaterhouseCoopers.

Standard & Poor's calls for detailed reserves disclosures

Credit rating agency Standard & Poor's called for more transparency in petroleum reserves reporting Oct. 1, citing inconsistency in reporting and saying, as a result, it will give greater weight to proved developed reserves. S&P referred to the Ormen Lange gas field as a "recent example of how much proven (sic) reserves bookings can differ among partners working on the same field."

Numerous investors, analysts, government agencies and politicians have called for more detailed disclosure in reserves reporting. Credit rating agencies, however, can do their job to some degree without full public disclosure, because they routinely request and receive confidential information from oil and gas companies — information that is not provided to the public under the Fair Disclosure or FAS 69 regulations.

So it is significant that S&P wants even more transparency from companies in spite of the fact that it has an advantage over the public in what it sees.

Ron Harrell, CEO at Ryder Scott, told *Platts Oilgram News*, "It's the messenger, not the message, that makes this significant. When the rating agencies speak, companies listen, because those agencies determine the cost of borrowing in the debt market."

S&P also said it would welcome additions to current disclosure requirements that include more frequent use of external petroleum engineers, detailed explanations about year-to-year revisions, aging tables for undeveloped reserves, per-country and per-field breakdown of proved reserves and information about probable and possible reserves.

The agency also said that the U.S. Securities and Exchange Commission should consider revising its guidelines, citing the new, stricter Canadian regulations as a model.

Calpers, Knight Vinke urges outside reserves audits

The largest U.S. pension fund, California Public Employees' Retirement System, and the Knight Vinke Asset Management fund said in November that they want oil and gas companies to commission independent consultants to fully audit corporate petroleum reserves. This would "help eradicate inconsistencies in the application of SEC's standards …that have helped undermine the market's confidence in the sector," said **Eric Knight**, managing director at Knight Vinke.

He also urged more consistent standards for calculating 2P reserves, saying that companies should publish this information. "Performance metrics, such as the reserve replacement ratio and reserve life, are meaningless when calculated solely on the basis of 1P reserves," Knight remarked.

Roesle at Pacesetter's Conference

Roesle says consultants' services changing in post-SOX

Don Roesle, president at Ryder Scott, told an audience at a John S. Herold event in late September that oil and gas companies are increasingly engaging third-party consultants to ensure regulatory compliance under the Sarbanes-Oxley Act (SOX) at varying levels of involvement—from training reserves personnel to conducting reserves evaluations of 100 percent of the property portfolio. "This includes performing audits and studies of one-third of the client's properties every three years to annual full-scale evaluations," he remarked.

He cited increased pressure for higher productivity within E&P companies and reduced evaluation time for internal staffs as shortcomings in the internal reserves estimating process. "Internal staffs are paid to find oil and gas, not to spend a lot of time on reserves," he told the audience at the Pacesetters Energy Conference in Old Greenwich, CT. Roesle stressed that the term "independent" should apply to internal as well as external reserves engineers and geologists.

"As part of an effective internal process, the

Please see Roesle on Page 8

Ryder Scott assessing whether U.S. Permian-bred CO_2 flood technology is feasible in Croatia

Ryder Scott is conducting an independent study funded by the U.S. Trade and Development Agency to determine if CO_2 flooding is a commercially feasible recovery option to squeeze incremental production from three flagging oil fields in Croatia. The Ivanic, Zutica and Benicanci fields are candidates for CO_2 flooding in part because the reservoirs have shown good response to waterflooding.

CO_2 miscible displacement is a tertiary recovery technique born and bred in the Permian Basin oil patch. If found to be feasible in the subject fields, CO_2-enhanced production will lessen the country's dependence on imported oil. If not, then Croatia will have to consider other areas for CO_2 flooding or find new sources outside the country, analysts say.

The TDA project is one of several federal projects aimed at exporting U.S. oilfield know-how overseas to developing countries.

Reservoir simulation: A critical part of the integrated study

The integration of Ryder Scott reservoir simulation models with a full-field model will be critical in predicting the performance of CO_2 injection schemes. Ryder Scott developed sector (or pattern-element) compositional reservoir simulation models to look at representative sections of the fields in greater detail while significantly reducing model run times typical of full-field models.

Dean Rietz, managing senior vice president and manager of the Ryder Scott reservoir simulation group, said that the team will use sector modeling to simulate and analyze pilot injection of CO_2 within a pattern. The team will history match the sector models to field-observed primary and waterflood production performance.

Ryder Scott will also calibrate the models to empirical CO_2 response from analog tertiary recovery projects in the United States, said Rietz. (See sidebar, "CO_2 experts rely on 'real world' experience, production histories for 'reality check.'")

Input parameters used in history-matched sector models become inputs for the full-field compositional model, which was built by state-owned Industrija Nafte d.d. Zagreb (INA). "Sector modeling to tune the full-field model is especially important in the INA project where very limited response has been observed," said Rietz.

As early as the late 1970s, INA used standard CO_2 flood screening methods in reviewing recovery factors, minimum miscibility pressures, porosities, effective permeability, oil gravity, etc. Ryder Scott has reviewed the INA full-field reservoir models and is validating the geological model, which is tied to the simulator. Ryder Scott has revised mapping, pay counts, water saturations and other parameters at the history-match stage. This will allow INA full-field models to more closely tie with the sector model and field analogs.

To facilitate maximum cooperation and knowledge transfer between INA and Ryder Scott, two Croatian simulation engineers, Snjezana Sunjerga and Igor Kruljac, spent the month of September working at Ryder Scott offices in Houston.

CO_2 experts rely on "real world" experience, production histories for "reality check"

With very little data from the reservoirs under pilot CO_2 flooding, INA is fine tuning its CO_2 injection model to analog fields carefully selected by Ryder Scott to yield more reliable predicted performance data. "The analogs serve as reality checks. We selected them based on similar rock and fluid properties, production histories and other factors," said **Thomas Wagenhofer**, a Ryder Scott petroleum engineer.

Since the early 1980s, the U.S. Permian Basin has provided a testing ground for CO_2 tertiary recovery technology, providing industry with two-and-a-half decades of production histories. Other U.S. areas with CO2 floods include the Northwest, Midwest and Southeast.

The CO_2 performance forecasts for the Croatia fields are being "tuned" to suitable CO_2-flood analogs selected by **Eric Hambly**, petroleum engineer at Ryder Scott. Hambly and petroleum engineer **Mike Stell**, a senior vice president and assistant group leader, have looked at the performance of nearly every major CO_2 flood in the world.

The Ivanic and Zutica fields produce from clastic reservoirs. "CO_2 floods in those reservoirs perform differently than ones in carbonate reservoirs where most of the world's CO_2 floods are located," said Hambly. "Since there are very few CO_2 floods in clastic environments, the number of good analog fields is limited."

Hambly worked several months to gather information about all of the CO_2 floods in clastic reservoirs. He pored through public data as well as exclusive private data provided by Ryder Scott clients approving the use of such data. Ultimately, Hambly chose six analogous CO_2 flood units in four different fields after gathering volumetric, reservoir property, production and injection data.

The ideal analog field has similar reservoir and development properties that consist of reservoir temperature, pressure and fluid properties (PVT); porosity; permeability and vari-

Please see Analogs on Next Page

Analogs—Cont. from Page 4

ability of permeability within the reservoir; relative permeabilities; degree of depletion and pattern configuration. "As you might expect, the six analogs that we've found have varying degrees of similarity with the Ivanic and Zutica fields. For example, when the permeabilities are similar, the pressure and temperature are somewhat different," said Hambly.

Ryder Scott has decided to look at the performance of all of the analogs to determine a range of performance that might be expected. By November, the firm had analyzed the performance of three of the six units. In those units, the CO2 flood performance has been similar, said Hambly. Ryder Scott has received data for the other three units and if the firm finds that those analogs perform similarly to the first three, then the evaluation team will be able to fairly well define the expected performance. If the performance of the units varies significantly, then Ryder Scott will determine a broader range of possible performance.

Ryder Scott will apply the range of performance of the analog fields to constrain predictions from the Ivanic pattern-element simulation model. After the evaluation team analyzes the last three analogy units, Wagenhofer will determine the necessary modifications so that Ivanic simulation predictions do not significantly outperform a range of observed analog performance.

Ryder Scott has studied the industry's use of models, both numerical and analytical, and CO_2 flood predictions. The firm compared early simulation predictions with actual performance and found that when operators base their CO_2 flood predictions on simulation models that are not constrained to analogies, they generally over predict actual performance.

"Based on these observations, the use of analog performance data should be very helpful in the work we're doing for INA," said Hambly.

To facilitate maximum cooperation and knowledge transfer between INA and Ryder Scott, two Croatian simulation engineers, Snjezana Sunjerga (left) and Igor Kruljac, spent the month of September working at Ryder Scott offices in Houston.

Reservoir simulation department expands staff with engineers

Petroleum engineers **Raymond Yee**, **Adnan Usmani** and **Paula Wood** have joined the Ryder Scott simulation group, giving the company additional expertise to handle increasing demands for reservoir modeling.

Yee

Yee has been a consultant for about 30 years, conducting integrated reservoir modeling studies used to forecast production and reservoir performance. He also has evaluated gas-storage projects. Yee has appraised property divestitures, constructed economic models for concessions and determined fair market values used in litigation. He has a BS degree in mathematics from Rice University and a master's degree in petroleum engineering from the University of Houston.

With 11 years of reservoir modeling experience, Usmani previously worked for Petroleum Development Oman (Shell) as a senior reservoir engineer. He performed simulation studies for PDO and before that with Avanti Consulting Ltd. He also was a senior reservoir engineer at Shell Exploration and Production during 1994 to 2000. Usmani has a BS degree in physics and an MS degree in petroleum engineering, both from Imperial College.

Usmani

Wood

Wood previously worked at Schlumberger Oilfield Services/Geoquest where she provided simulation support and training for various software programs. Before that, she was a geologist at Svenska Petroleum Exploration UK Ltd. during 1998 to 2001 and a field geologist at Australian Geological and Remote Sensing Services in 1997. Wood has a MSC degree in petroleum engineering from Heriot-Watt University and a BSC degree in geological science from Leeds University.

Geological and engineering challenges in estimating petroleum reserves — Part I: Structure maps

Editor's Note: This is a revised excerpt from "Oil and Gas Reserves Estimates: Recurring Mistakes and Errors," (SPE Paper No. 91069), written by reserves evaluators Ron Harrell, John Hodgin and Thomas Wagenhofer at Ryder Scott. To order a copy of the full paper, go to www.spe.org and access the e-library.

Performing some 800 reserves studies annually for hundreds of oil and gas companies, Ryder Scott personnel see a wide variety of internally produced petroleum reserves estimates. By in large, most estimates are prepared by qualified reservoir engineers and geoscientists.

However, over the years, Ryder Scott has noticed common technical errors in the preparation of reserves estimates aside from any definitional or judgmental issues. This multipart article will offer guidelines to help reduce the chance of errors in geoscientific and engineering analysis.

The geoscience component forms the basis for engineering estimates. Ryder Scott has noticed recurring errors in geological evaluations involving structure and isopachous maps, downdip limits and attic volumes. This first newsletter article focuses on structure maps.

Over the years, Ryder Scott has noticed common technical errors in the preparation of reserves estimates aside from any definitional or judgmental issues.

Common mistakes in structure maps

A geologist selects structure-map surfaces representing the top and base of a contributing reservoir to assist in determining a volumetric estimate. The process involves combining surface-mapping information with lateral limits from structural and stratigraphic barriers and downdip fluid limits to describe a productive reservoir area.

Structure on top surface—A common error is tying structure maps to well-pick or seismic-attribute markers that don't represent the top of the contributing reservoir. This results in overstating the productive area and reserves.

Figure 1 shows an overstatement of reserves caused by picking a marker from well data to represent the structural surface at the top of the reservoir. Note a 50-ft elevation difference between the -7000-ft marker top and the -7050-ft top of the effective pay.

This exaggerates the areal extent, which is based on the projected downdip limit to the top of the reservoir. The magnitude of the error increases as the distance between the mapping points and structural dip increases.

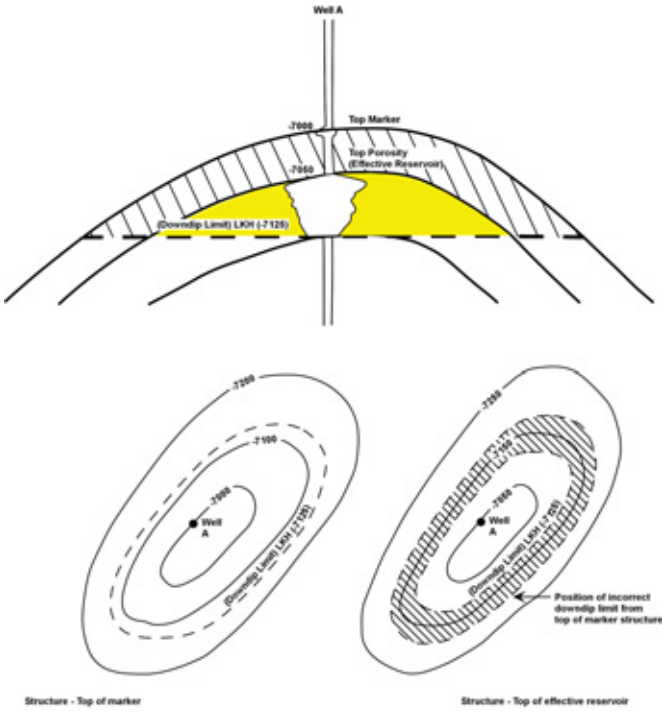


Figure 1. Top-surface mapping error using marker instead of top of effective pay.

Similarly, Figure 2 shows the selection of a map top corresponding to the top of the formation rather than the top of the effective reservoir section. Like the previous example, the selection of a correlative mapping point results in a similar exaggeration of the areal extent and overstates the reserves.

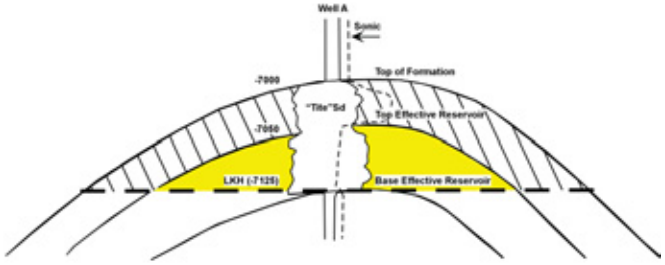


Figure 2. Top surface mapping error using top of formation instead of top of effective pay.

These errors are also replicated when the top of a seismic event is not adjusted to tie with the top of the contributing reservoir unit as determined from well data.

Structure on basal surface—Structure maps tied to markers (well or seismic) on the base of a formation that does not represent the base of the contributing reservoir may result in the following:

- Overstating the gross rock volume.

■ Inaccurately determining the inner limit of the full net thickness used in constructing net pay isopachous maps.

Common mapping practice relies on the calculation of gross rock volume generated by the difference between structural surfaces (or maps) on the top and basal surfaces of the reservoir. The intersection of the fluid contacts on the top and basal surfaces determines the gross rock volume of the reservoir.

Figure 3 shows the overstatement (crosshatched area) of the productive gross rock volume using a marker picked from well data to represent the structural surface at the base of the reservoir. In this illustration, the gross interval thickens in the updip direction. The discrepancy becomes greater as the distance between the mapping points increases.

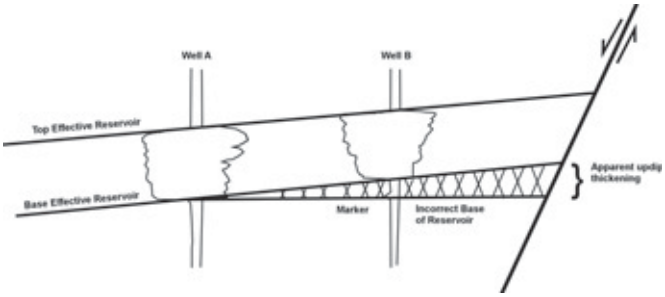


Figure 3. Overstatement caused by selecting marker as base of formation instead of base of effective pay.

Figure 4 illustrates an error in the determination of the inner limit of water. The error is caused by inaccurately selecting the base of the contributing reservoir unit. The volume within the wedge area is overstated and the volume above the inner limit is understated.

This results in an understatement of reserves. The discrepancy increases as the distance between mapping points increases. A decrease in structural dip would further compound this problem.

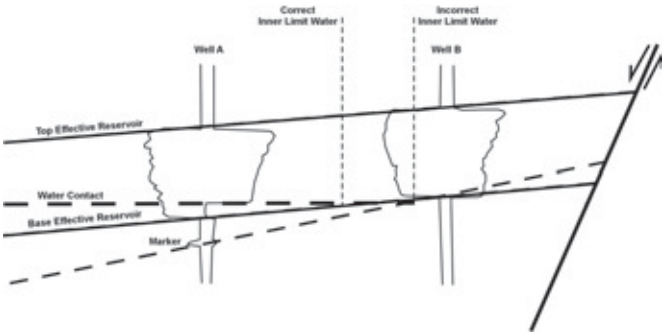


Figure 4. Error of inner water limit caused by incorrectly picking base of effective pay.

These errors are also replicated when the base of a seismic event is not adjusted to tie with the base of the contributing reservoir as determined from well data.

Position of faults relative to the structure on top surface—Faults not tied to the structure map on the top surface of the contributing reservoir may overstate or understate productive area, associated volume and reserves.

Figure 5 demonstrates an error caused by linking the position of the updip trapping fault to the top of structure based on a marker rather than the top of the effective reservoir.

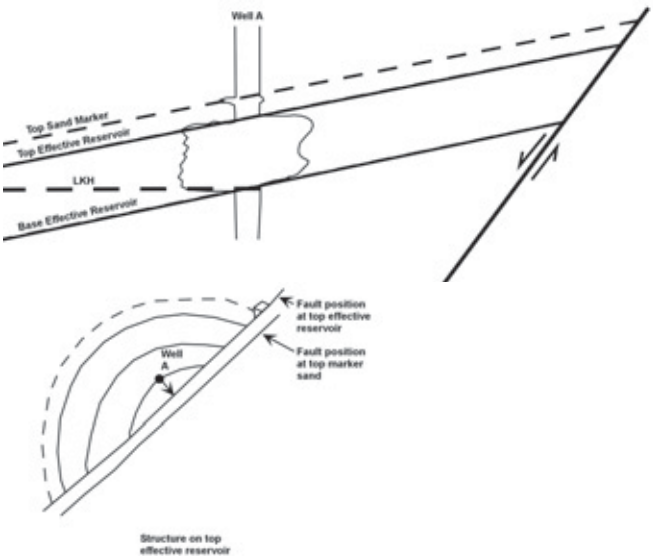


Figure 5. Error in picking fault location caused by incorrectly selecting marker as top of structure.

Once again, factors, such as the distance between mapping points, the structural dip and thickness of the reservoir unit and the dip on the fault plane, determine the magnitude of the error.

Six petroleum engineers, geophysicist join Ryder Scott

To meet increasing demands for reservoir evaluation services, Ryder Scott has added six petroleum engineers and a geophysicist to its Houston staff. This brings the totals for the Houston, Denver and Calgary offices to 46 petroleum engineers and 15 geologists.

John McLaughlin, petroleum engineer, previously worked at Exxon Mobil Corp., where he most recently conducted reserves bookings for deepwater fields in Angola. He also performed integrated field studies of other west Africa deepwater fields that involved pressure transient analysis, production modeling and reservoir simulation. McLaughlin also focused on 4D seismic analysis and

See Staff on Page 8

McLaughlin

Staff—Cont. from Page 7

smart completions. He used techniques from decline-curve analysis to reservoir simulation in a feasibility study for an Equatorial Guinea offshore gas field. McLaughlin has a BS degree in petroleum engineering from the Colorado School of Mines and a master's degree in petroleum engineering from the University of Houston.

Lawson

Elizabeth Lawson, petroleum engineer, previously worked at Exxon Mobil Corp. where she worked as a reservoir engineer for 5 years and as a production engineer for a year. She was a lead reservoir engineer in field-depletion studies of sweet and sour gas fields in the Gulf of Mexico and recommended field-development investments. Lawson has a BS degree in civil engineering from Louisiana Tech University and an MBA degree from Tulane University.

Omar Nur, petroleum engineer, previously worked as a consultant to Osyka Production Co. and Frontera Resources Corp., conducting production and reservoir engineering on properties onshore the U.S. gulf coast, in the Texas panhandle, Bolivia and the Republic of Georgia. Before that, Nur was a petroleum engineer at BP in Alaska for three years. He began his career at Mobil Corp. in 1995 as a petroleum engineer in the U.S. mid-continent region. He has a BS degree in petroleum engineering from Mississippi State University and a MS degree in petroleum engineering from Montana Technical University.

Nur

Walters

Rob Walters, geophysicist, previously worked at Exxon Mobil Corp. for five years where he performed geophysical analysis of properties in Brazil, Canada, west Africa, Chad and the Gulf of Mexico. He combined structural and seismic facies mapping and analysis with volume interpretation on 3D seismic surveys. Walters also conducted research on 3D seismic attributes and volume interpretation for reservoir characterization of deepwater environments. Before that, he worked at Unocal Corp. and Chevron Corp. for four years in geophysical studies of the GOM. Walters has a BA degree in geology and physics from Rice University and MA and PhD degrees in geophysics from the University of Texas.

Petroleum engineers **Raymond Yee**, **Adnan Usmani** and **Paula Wood** have joined Ryder Scott. Please see article on Page 5, "Reservoir simulation department expands staff with engineers."

Roesle—Cont. from Page 7

reserves staff should be free from any undue pressure from management. This includes pressure to maximize proved reserves bookings with inadequate data," he said. Roesle remarked that finding costs (in dollars per barrel) and reserves replacement ratios (a percentage of annual oil production replaced by reserves added during the year) are two metrics favored by analysts.

"Both of these ratios are enhanced by maximizing added reserves," he remarked.

Ryder Scott Co. LP
1100 Louisiana, Suite 3800
Houston, Texas 77002-5218
Phone: 713-651-9191; Fax: 713-651-0849
Denver, Colorado; Phone: 303-623-9147
Calgary, AB, Canada; Phone: 403-262-2799
E-mail: info@ryderscott.com
Web site: www.ryderscott.com

PRSRT STD
US POSTAGE
PAID
HOUSTON TX
PERMIT NO 11296