January 1993

BULLETIN

HOUSTON GEOLOGICAL SOCIETY

Volume 35
Number 5

★ ★ CAREER CHANGE SEMINAR (See page 34) ★ ★

HGS Jobs Hotline (713) 785-9729

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AND MORE!

See Centerfold for January Calendar and Geoevents.

HOUSTON GEOLOGICAL SOCIETY
7171 Harwin, Suite 314 Houston, Texas 77036-2190
(713) 785-6402

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Parliamentarian	**Mrs. Theresa Baker**	782-2754
GeoWives President	**Ms. Susan McKinley (Mrs. Allan B. Scardina)**	556-1335

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BULLETIN
HOUSTON GEOLOGICAL SOCIETY

Vol. 35, No. 5 January 1993

CONTENTS

DEPARTMENTS

CONTENTS CONTINUED

PRICE SCHEDULE— JANUARY MEETINGS

(Non-members: add $2.00 to the meal price)
See **Meetings** abstracts for times.

HGS Dinner Meeting, Jan. 11
Post Oak Doubletree Inn $20.00

HGS International Explorationists Dinner Meeting, Jan. 18
Post Oak Doubletree Inn $21.00

HGS North American Explorationists Dinner Meeting, Jan. 19
Post Oak Doubletree Inn $20.00

HGS Luncheon, Jan. 27
Houston Club $15.00

RESERVATIONS POLICY

Reservations are made by calling the HGS office (785-6402). At the meeting, names are checked against the reservation list. Those with reservations will be sold tickets immediately. **Those without reservations will be asked to wait for available seats, and a $5 surcharge will be added to the price of the ticket. All who do not honor their reservations will be billed for the price of the meal.** If a reservation cannot be kept, please cancel or send someone in your place.

The Houston Geological Society office is located at **7171 Harwin, Suite 314, Houston, Texas 77036**. The telephone number is **(713) 785-6402; FAX (713) 785-0553**.

Contents Continued

COVER PHOTO:

The picture shows the unique point of convergence of the NE-SW trending Ouachita fold Belt (light colored beds), approximately 300 million years of age, with the NW-SE trending Del Norte-Santiago Range, approximately 50 million years of age, in the Big Bend Country of Brewster County, 10 miles south of Marathon, Texas.

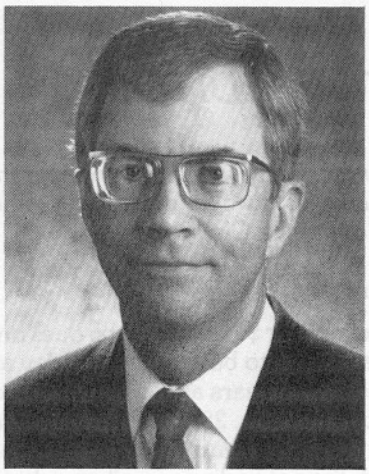
The settlers who gave this wavy formation its name must have imagined a pack of wild horses ("Caballos") galloping across the open fields of West Texas. Little did they realize that some nearby oil wells would one day each yield in excess of 250,000 barrels of oil from this unlikely reservoir rock, a novaculite. Photo courtesy of Bill Kalil.

HAVE YOU EVER MADE A RESERVATION AND NOT SHOWN?

Several years ago the HGS Board adopted a policy of billing those who made reservations for an HGS dinner or luncheon event but did not show. Since the reservation list is used to guarantee the number of attendees to an event, the HGS must pay for that minimum number even if fewer people are served. **Those who make reservations and do not cancel by the published cancellation time will be billed.** For Luncheon and Dinner events, cancellation time is usually noon on the prior business day. **Cancelling after that time yet before the event does not assure that you will not be billed.**

For those who are billed and do not pay, please be aware that the next time you attend an HGS lunch or dinner event, the treasurer (or representative) will ask to discuss the reasons prohibiting payment. **Continued non-payment of billing will result in loss of membership privileges.**

PRESIDENT'S COMMENTS



IT'S TIME FOR A CHANGE! That's what the new administration moving into D.C. this month promised back in the fall. The people have spoken. They are all praying for a positive change in our present economic situation. Even right after the election in November one could see a note of optimism reflected in the news media. No matter which way you voted, or whether or not Clinton really does turn things around in the next four years, the optimism should prevail for most of '93. I believe that will be good for the HGS membership. Optimism brings out the people who want to invest in the oil and gas business. With interest rates so low, many will be looking for higher risk/higher return ventures. And if you had read the Democratic Party energy platform in our October *Bulletin* you know that they are very high on the use of natural gas as a safe, clean-burning fuel. So get out your files and dig up all those old gas prospects. The Gulf Coast shall rise again!

But many in our business have already had to pull out for good. And many of those who've stayed have had a hard time keeping their spirits up about our industry. Now that reminds me of my good friend Frank Millard, an emeritus HGS member who says he'll retire for good this year. This past fall he was doing some petrophysical work on Aqua Dulce field for a client when he came across an old E-log that had his name on it. Yes, it was an old, hand-transcribed one that he had done when he had started with Schlumberger in 1937! Yes, I said '37! Now how many of us can look back at old logs we've witnessed, maps we've initialed, or reports we've signed, and still feel a sense of accomplishment about a job well done?

The HGS Board has unanimously approved the creation of a new committee tentatively called the Registrations Committee. The job entails handling some of the details at dinner and luncheon meetings, short courses, and other programs, to include ticket sales, verifying/accounting for meal and drink invoices, conveying fees to/from the Treasurer/HGS office. The job has been informally handled for years by Claudia Ludwig and a small group of hard-working HGS volunteers. Congratulations are extended to Claudia, the new Chairman, and her staff.

I attended the GCAGS Executive Board meeting in October in Jackson, Mississippi. The annual convention attendance was about 830, nearly 300 lower than expected, resulting in a loss for the year of about $36,000. About one-third of the attendees at the convention were from Houston. Next year's convention will be in Shreveport; Chairman is Roger Berg, Vice Chairman is Johnny Wanger, an HGS member. The GCAGS has also published Vol. 6 of the Bibliography of Gulf Coast Geology, (1985-90), available from Earth Enterprises for $40.

The HGS is in charge of nominating geologists to run for AAPG Delegates in the Houston Area. If you would like to represent us or know of someone who would, please give a call to Cy Strong or Martha Lou Broussard.

Please take a look at pages 2 & 3 of the *Bulletin* concerning our reservations policy. For those coming to a meeting without a reservation, the surcharge will now be $5.00. But you can still make a reservation as late as noon on the last business day prior to the meeting. We encourage you to do so.

In this new year of '93 I plan on having the best year ever for myself and my family. My wish also is for all of you th have the same. Happy New Year!

Pat Gordon

Pat Gordon

CONVERSATION CORNER

YOAKUM CHANNEL - VOLCANIC ORIGIN?

Much speculation has been accorded the origin of this channel but none are known to have associated it with a volcanic eruption.

Hoyt's well-known paper of the channel terminates it with the outcrop of the Wilcox in the vicinity of Red Rock and Rockne in Bastrop County. A projected in-line continuation of Hoyt's channel could easily be drawn toward Pilot Knob, the dormant volcano just south of Austin.

As the depositional sequence of Wilcox sedimentation does not appear to have ceased during the period of channelling, it is presumed there was an underwater eruption at the time, some 800′ prior to the end of Wilcox deposition, that spread lava over an area of approximately 40-50 miles, at least 50′ thick, with a heavier continuing concentration of lava flowing shelfward to gouge a broad chasm which is called the "Yoakum Channel". Displaced Wilcox sediments would have been redeposited by cross-current action, with the lava congealing in place as the flow eased and ceased. There was never an open cut.

Cores of the buried channel material have not been located for analysis; but basaltic-type rocks, collected at the outcrop area, support this concept.

Joseph D. Watzlavick

Reference:
Hoyt, William V., 1959, Erosional channel in the middle Wilcox near Yoakum, Lavaca County, Texas: Gulf Coast Assoc. Geol. Soc. Trans., v. 9, p. 41-50.

THE IMPRACTICAL FRACTAL

We geologists have a reputation for impracticability among management and investors. Current interest in the fractal properties of reservoirs will further erode our credibility. Fractal theory is a mathematical model which embodies the classic principle of science fiction: **what if** the laws of nature are scale-invariant? From this are derived beautiful mathematical consequences and remarkably unnatural pictures. Pretending that this describes the actual world that we live in is foolish. Grains of sand, snowflakes, and fractures are not fractal.

The real world obeys Langevin's Principle, the laws of nature vary with scale. This uniquely robust principle is reliably applicable in all fields of study that deal with natural phenomena and is never misleading (in contrast to a sacred cow known as the Second Law of Thermodynamics).

Atoms are not little planetary systems. Little fleas do not have littler fleas *ad infinitum*. You don't have to apply quantum mechanics to large objects. You can quickly resolve the famous paradox of Schrodinger's cat by following Langevin's Principle. The "laws of nature" are approximations applicable at scales ranging over a few orders of magnitude.

In our business, the sizes of pores and of pore throats are important because the physical properties of reservoir fluids vary with these sizes. Rheology varies with scale. Models do not use correct mechanisms.

Let's save fractal theory for our hobby interests and not inflict it on geology or on reservoir studies.

Thomas C. Williams

LETTER TO THE EDITOR

Editor's Note: This letter was enclosed with a membership renewal and was forwarded to the Bulletin *by Mike Deming, Membership Committee Chairman.*

Dear Officers and Members,

Glad to enclose my check for $9.00 to pay my dues until June 30, 1993. I am just as proud to be a member today as I was when I was accepted **many** years ago. I still have your large certificate awarded to me Feb. 28, 1949, for designing the emblem of the Society. I was 43 years old then. Now I am just double that, 86 years. I'm not finding any oil now, I wish I were. I hope Hankamer and Thompsons Fields are still producing, and many others. I am glad that I joined back in 1936. That was our lucky year. Our older son, Hans, was born on Feb. 29, 1936, Leap Year Day in Houston.

Best wishes,
Walt Osterhoudt

AMENDMENT TO HOUSTON GEOLOGICAL SOCIETY CONSTITUTION CONCERNING MEMBERSHIP

ARTICLE II. Membership

Comment

These changes, which were passed in the last election clarify the membership requirements for active membership status in the society, expecially in regard to applicants working outside the oil and gas area in environmental sciences and/or engineering.

Previous text

Sect. 2. In order to be eligible for active membership, an applicant shall: (1) have a degree in geology or an allied **science** from an accredited college or university; or (2) have a degree in science or engineering from an accredited college or university and **be directly engaged in the application of the earth sciences; or** (3) **have been engaged in earth science work during at least the preceding five (5) years.**

Amended text

Sect. 2. In order to be eligible for active membership, an applicant shall either (1) have a degree in geology or an allied **geoscience** from an accredited college or university, or (2) have a degree in science or engineering from an accredited college or university **and have been engaged in earth science interpretation for at least five (5) years.**

HOUSTON GEOLOGICAL SOCIETY FIELD TRIP

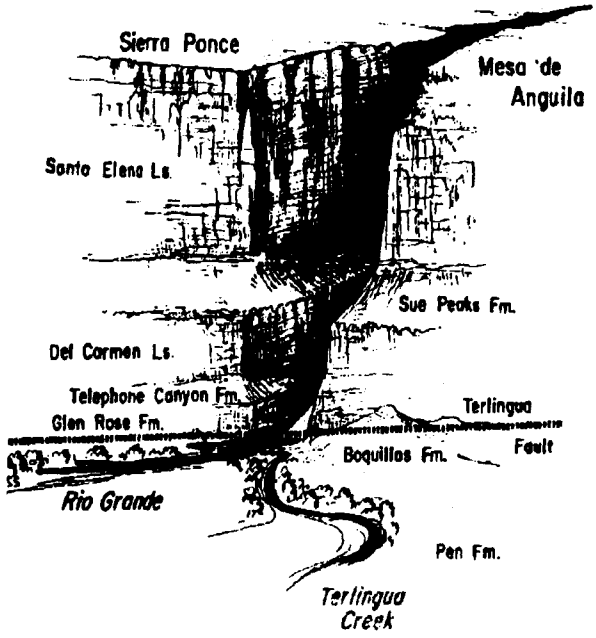
announcing the "First Annual"

HGS GEO-RAFTING EXPEDITION; THE BIG BEND OF THE RIO GRANDE

March 31 - April 4, 1993

This spring, the HGS will offer a unique opportunity to experience West Texas geology while rafting the Rio Grande through Big Bend National Park.

The trip will depart Houston Wednesday evening, March 31, taking Amtrak's westbound "Sunset Limited" to Alpine Texas arriving Thursday morning. The morning train ride offers spectacular scenery, geology, and numerous photo opportunities. Big Bend River Tours will provide transportation to Lajitas, where we will spend Friday night at the resort of Lajitas on the Rio Grande. A backroad tour is planned along the outer edge of the Solitario Uplift to the abandoned mining town of Buena Suerte and the Fresno Mine where dinner will be served around the campfire, complimented by musical entertainment as the West Texas sun sets on the old town.



On Friday morning, our two day fully outfitted rafting adventure will embark at 8:00 a.m. from Lajitas Crossing. The first half of the 19-mile Santa Elena Canyon trip meanders by mesas, beautiful side canyons and desert of Northern Chihuahua with towering Mesa de Anguila off to the left. At this point, the river is incised into the Gulfian Cretaceous Boquillas Formation and the underlying Comanchean Buda and Del Rio Formations. Ample time will be available for exploring the local terrain and hiking on Mesa de Anguila. Saturday evening we will make camp and a memorable meal will be prepared for us by our guide/chef under the incredible night sky of the Chihuahuan desert. All camping supplies are provided by the outfitters.

On Saturday, we will enter the 7-mile-long Santa Elena Canyon. In places the river is confined to 30 yards wide between the cavern-filled canyon walls that tower as much as 1,500 feet overhead. Here, the river has incised into the lower Cretaceous limestones of the Santa Elena, Sue Peaks, Del Carmen, Telephone Canyon, and Glen Rose Formations that comprise the uplifted Sierra Ponce - Mesa de Anguila fault block. A highlight of the trip is navigating the famous Class IV "Rockslide" rapids, as well as Fern Canyon, a spring-fed grotto of sculpted limestone, and Smugglers Cave. Saturday afternoon we will take out near Terlingua Creek, returning to Alpine. Along the way we will stop at "LaKiva" in Terlingua, where hot showers and dinner will be available, before catching the train back to Houston late Saturday evening. We should arrive back in Houston around noon Sunday, April 4.

COST:

$475.00 includes guidebook(s), round trip Amtrak Coach Fare from Houston, 1 night lodging at Lajitas on the Rio Grande (Dbl. Occ.), fully outfitted 2-day rafting expedition and backroad Buena Suerte tour and cookout hosted by Big Bend River Tours, meals (except on train and Saturday evening), and field refreshments.

$375.00 includes above, exclusive of Amtrak fare. Option for those making their own travel arrangements (i.e. Pullman fare, roundtrip from New Orleans, Lafayette or San Antonio, or driving).

FOR MORE INFO AND REGISTRATION FORMS CONTACT:

Martin J. Oldani, Apache Corp. (713) 296-6326 or **Paul Britt,** Texplore, Inc. (713) 341-1800

Early registration is requested, as transportation requires advance ticketing. Limited to 40 participants.

HOUSTON GEOLOGICAL SOCIETY FIELD TRIP
HGS GEO-RAFTING EXPEDITION; THE BIG BEND OF THE RIO GRANDE
March 31 - April 4, 1993

REGISTRATION FORM

_____ **All inclusive $475** _____ **W/O train fare $375**

Name:_____

Address: _____

City, State, Zip:_____

Work Phone:_____ **Home Phone:**_____ **Fax:**_____

Enclose check payable to **HOUSTON GEOLOGICAL SOCIETY,** and return this form to:
Paul Britt, Texplore, Inc., P.O. Box 450, Richmond, Texas 77406

MEETINGS

HGS DINNER MEETING—
JANUARY 11, 1993
Social Period, 5:30 p.m.
Dinner and Meeting, 6:30 p.m.
Post Oak Doubletree Inn

WILLIAM L. BERRY—Biographical Sketch

William L. Berry is Director, Wetlands Management for The Louisiana Land and Exploration Company; a position he has held since he joined the company in June of 1987.

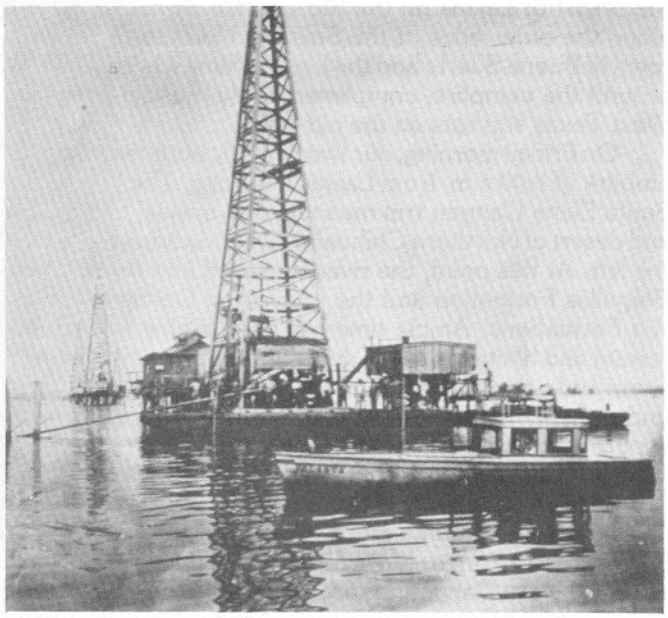
Prior to joining LL&E, Bill worked for Shell Oil Company for over 32 years, in a variety of positions. He has made the environmental field his specialty since the early seventies, first with Shell, and now, with LL&E.

Bill graduated from the University of Missouri in 1955 with a Bachelor of Science in Chemical Engineering.

EXPLORATION AND DEVELOPMENT IN LOUISIANA'S WETLANDS

Hernando DeSoto discovered oil in Louisiana in the 1540's, but Indians had been using it in medicines for centuries. The first commercially successful discovery of oil in the coastal zone occurred in 1926 at Sweet Lake Field, Cameron Parish. Since then oil and gas activities in the wetlands have grown to play a major role in Louisiana's petroleum industry. Fifty-eight percent of the state's total oil and 47 percent of the gas have been produced from this part of the state and adjacent waters.

While not the case in the early days for a number of reasons, exploration and development of these vital energy resources can and have been conducted in an environmentally sensitive manner for decades — from seismic surveys through pipeline installations and subsequent production operations. As a major landowner (lessor) with holdings of over 600,000 acres of coastal wetlands in Louisiana and as a lessee, The Louisiana Land and Exploration Company (LL&E) has been a leader in this regard. Since the 1950's LL&E has actively practiced wetlands conservation and required all contractors and lessees to take measures to preserve Louisiana's precious coastal wetlands when operating on company property. These include oil and gas leases, geophysical permits, canal and pipeline permits, etc. Details of these programs are discussed in the paper.

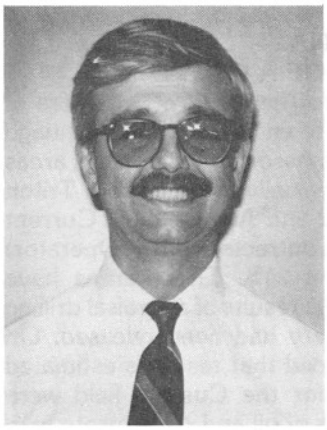


COMPUTER APPLICATIONS POSTER SESSION

The Computer Applications Committee will sponsor a demonstration of several workstation programs during the soical hour of the January 11 dinner meeting. Vendors will be available to demonstrate state-of-the-art products to serve geoscience needs in exploration and production. These UNIX programs typically run on SUN and/or Silicon Graphics workstations, taking advantage of computing power formerly found exclusively on mainframe computers and offering a dazzling array of tools to access, manipulate, interpret and present exploration and production related data. Featured vendors and their products include Stratamodel with SGM, a geological modeling program featuring three-dimensional visualization within a geological framework. Dynamic Graphics Inc. (DGI) will feature ISM, mapping software, and IVM and GMP, geological modeling programs useful for analying a variety of reservoirs. Geoquest will feature their integrated seismic/geological/petrophysical workstation modules. In addition, Simon Petroleum will demonstrate a fully integrated workstation application, TIGRESS, which features petrophysical, mapping, reservoir simulation and economic evaluation capabilities in one package. Landmark will also present an integrated package in STRATWORKS. The demonstrations will last from 5:30 to 6:30.

HGS LUNCHEON MEETING—
JANUARY 27, 1993
Social Period, 11:30 a.m.
Luncheon and Meeting, 12:00 p.m.
The Houston Club

GEORGE CLEMENCEAU—Biographical Sketch



George Clemenceau is Staff Geologist for Amoco Production Company in the New Orleans Region where he has worked a variety of exploration and development assignments in the offshore Gulf of Mexico, since joining them in 1981. Ram/Powell Field has been one of his chief responsibilities for the last 2 1/2 years.

He graduated from George Washington University in 1976, with a B.S. in oceanography. He went on to earn a Masters in geology from Duke University in 1981, upon completion of a thesis in sedimentology.

FANLOBE GEOMETRY AND RESERVOIR SAND CHARACTERISTICS OF RAM/POWELL FIELD, DEEPWATER GULF OF MEXICO

Located 50 miles east of the Mississippi River in 3,200 feet of water, Ram/Powell is one of the largest Deepwater Gulf fields discovered to date. Resources of 300 MMBOE are indicated, not including large unexplored areas. Following Shell's 1985 discovery, eleven wells drilled by Amoco/Exxon and Shell extended the field into a 50-square-mile area. Resource appraisal of this deep-sea fan requires reliance upon predictive geologic models constructed from well, core and 3-D seismic data.

Seismic amplitude associated Miocene pays are stratigraphically trapped between 12,300 and 13,200 feet. Deposition occurred in a passive-margin setting, on an unrestricted slope, overlying Cretaceous source rock. Because they are approximately time equivalent to the 10.5my lowstand event on the Vail eustatic curve, sands may represent basin-floor fans and slope fans of a lowstand systems tract.

Fanlobe reflectors of varying amplitude have continuous, sometimes mounded, configurations. Amplitude outlines are grossly fan-shaped, but individual reservoirs have elongate lens-shaped geometries which pinch-out updip and laterally into lower-slope-zone shales. The lobes trend northwest-southeast. Closely associated lobes exhibit various overlapping and intersecting relationships. Facies geometries were interpreted from variations of lobe thickness and amplitude. Linear or vaguely sinuous thickness trends, sub-parallel to lobe axes are interpreted as mid-fan channel/levee deposits. These sands are massive to fining-upward, 90% sand, highly permeable, 20-120′ thick, moderately to poorly sorted, fine-grained sublitharenites. Thin-bedded levee/overbank deposits are less than 50% sand, but individual laminae are well sorted, very fine-grained sublitharenites with moderate permeability.

INTERNATIONAL EXPLORATIONISTS

Chair's Column

Our moderately updated directory will be distributed at this month's meeting, January 18, 1993. A limited number of copies will be available on a first come, first served basis.

We hope you had a wonderful Holiday Season!

Thom Tucker, Chair

INTERNATIONAL EXPLORATIONISTS COMMITTEE MEMBERS 1992-1993

Chairperson:
Thom Tucker, Marathon Oil 629-6600
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Wynn Gajkowski, Total Minatome 739-3034
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Herb Duey, Consultant 531-0950

Please contact your company representative or call HGS for ticket reservations at 785-6402.

HGS INTERNATIONAL GROUP DINNER MEETING—JANUARY 18, 1993

Post Oak Doubletree Inn
Social hour, 5:30 p.m., Dinner, 6:30 p.m.
Technical Presentation, 7:30 p.m.

GORDON M. SMART—Biographical Sketch

Originally from Nelson, New Zealand, Gordon M. Smart graduated from Canterbury University in 1954 with a Master of Science (Honours) degree in geology. In that same year he joined Shell Canada Ltd. In 1970, he joined New Zealand Petroleum Company Limited (a Triton Energy affiliate) as Exploration Manager. In 1974, he accepted the position of Manager, International Geology, with Triton Energy Corporation in Dallas. He was promoted to his current position as Vice President, Exploration in 1986 and is responsible for the Company's worldwide exploration.

CUSIANA — THE MAKING OF A GIANT

Situated in the foothills to the eastern Cordillera of Colombia and adjacent to the town of Yopal, the Santiago de las Atalayas and Tauramena Association Contract areas in the Cusiana region were originally awarded to a Triton Energy subsidiary in July 1982 and August 1988. Current interests in both Association Contracts are BP (Operator) 38%, TOTAL 38% and Triton 24%. These areas have received world-wide attention as results of appraisal drilling to the 1988 Cusiana-1 discovery had been released. On October 29, 1992, BP announced that reserves estimated from drilling results to date for the Cusiana field were already up to 1.5 billion barrels of oil and condensate with additional large volumes of gas. This estimate is based on three well completions and is expected to increase as wells from a six-rig delineation program are completed. The news release also stated that a new field 15 km north of Cusiana at Cupiagua had been discovered, which is about one third the size of Cusiana. The Cusiana field straddles the Tauramena and Santiago de las Atalayas contract areas with the Cupiagua discovery wholly on the Santiago de las Atalayas block. Areas of the Association Contracts are now 92,455 acres for Santiago and 38,894 acres for Tauramena.

Following an initial exploratory effort of seismic reprocessing, new seismic acquisition and two wells drilled in the foreland Llanos basin, a further farmout was made to BP Exploration and TOTAL whereby Triton's originally defined thrust play in the foothills would be tested. The initial discovery at Cusiana-1 was made in December 1988 and was confirmed by the Cusiana-2A and 2A sidetrack in July 1991 and by the Buenos Aires-1 in February 1992. There are currently (December 1992) six rigs active with five rigs drilling Cusiana appraisal wells and one rig drilling an exploratory well which is the new Cupiagua field discovery. Appraisal and development drilling will continue. Declaration of Commerciality will be sought from Ecopetrol prior to mid 1993.

The main productive reservoirs for the Cusiana field are sandstones of the Upper Cretaceous Guadalupe formation, the Paleocene Barco formation and the Eocene Mirador formation. In early September 1992, the Buenos Aires-1 well was put on a long-term production test from the Mirador with the Cusiana-2A well 5 km away being an observation well. Flow rates have exceeded 10,000 barrels of oil per day.

Continued on page 16

COMMITTEE MEETINGS

HGS International Explorationists Committee dinner meetings will be on the **third MONDAY** night of each month at **Post Oak Doubletree Inn in the Galleria area** starting with a 5:30 p.m. social hour, 6:30 p.m. dinner and 7:30 p.m. technical presentation.

INTERNATIONAL BRIEF

Spotlight On....SOUTH AUSTRALIA*

by George Tappan

Petroleum exploration is not new to South Australia. The first well in search of oil was drilled just north of the Otway basin in 1866, but it wasn't until 1963 that commercial gas was discovered in the Permian of Cooper Basin well Gidgealpa-2 in the northeast corner of the state. Today, natural gas production from the Cooper Basin averages 390 MMcfd, with 19,800 b/d crude oil, 8,800 b/d condensate, and 7,000 b/d liquefied petroleum gas. A small amount of gas is also produced from the Otway Basin in the southeast.

Apart from Otway Basin gas sold locally, all the state's needs are supplied by production from the Cooper Basin. However, after 1994, industrial and commercial expansion will require additional fuel which, for the near future, has been contracted from the Queensland portion of the Cooper Basin. This trend toward inevitable growth lays open a clear market for the product of continued exploration for natural gas in South Australia.

The Cooper and overlying Eromanga basins, which extend into southwestern Queensland, together comprise Australia's largest petroleum province. (See *International Exploration Newsletter*, 5 February 1990). The intracratonic Cooper Basin consists of two Permo-Carboniferous to Middle Triassic non-marine sequences deposited in three major troughs with as much as 2500m of sedimentary fill. Known source rocks are in the mid-Permian and upper Triassic. Oil is found in the Cambro-Ordovician, Carboniferous, Early Permian, and Triassic. Gas occurs in most reservoirs throughout the section.

The Eromanga Basin, which contains sediments of Early Jurassic to Late Cretaceous age, unconformably overlies the Cooper Basin. The section comprises a lower, non-marine productive sequence, overlain by a middle marine and upper non-marine sequence. It is 3000m thick in the Cooper region. Although potential source rocks occur in the Early and mid-Jurassic, and Early Cretaceous, most of the Eromanga Basin oil and gas, and all of the Cooper Basin oil and gas are thought to be sourced from Cooper Basin sediments.

The Otway Basin is one of a series of Jurassic to Late Cretaceous rift-related basins that parallel the southern coast. An Early Cretaceous fluvial to lacustrine sequence contains proven gas reservoirs, and a Late Cretaceous deltaic wedge is also considered a potential target. Gas production, begun in 1991, supplies local consumers in the southeast. A small amount of oil is produced from Caroline CO_2 Field.

Perhaps its rugged terrain and vast expanses of soil cover have served to deter exploration in South Australia. Only three of its 12 sedimentary basins are productive. The rest have seen some effort over the years, but still remain grossly underexplored. Some have proven mature source rocks and suitable reservoirs, suggesting significant potential for the future explorationist.

As an indication of its support of the minerals and energy sector, South Australia will spend $5 million on new aeromagnetics, and $2 million on a regional and prospect seismic survey, a regional geophysical and geochemical review of the Officer Basin, and development of a state-wide inventory of oil and gas prospects onshore, and offshore in the Bight Basin.

Petroleum in the subsurface of South Australia belongs to the Crown. Upon recovery, ownership transfers to a license, for which the state levies a royalty at the rate of 10% of the value of the petroleum at wellhead. Produced oil, natural gas, condensate, and LPG enjoy a free market in South Australia.

Petroleum exploration and development are administered under the Petroleum Act, 1940, and the Petroleum (Submerged Lands) Act, 1967 of the Commonwealth, and 1982 of South Australia. Unlicensed areas onshore are open for application at any time. Offshore areas are available only by specific offering. The application fee is A$2000 for onshore areas and A$3000 for offshore areas.

The maximum license size is generous. Areas can be as large as 26,000 sq km onshore, and 400 5x5 minute blocks offshore. An annual fee of A$0.24 per sq km applies to onshore areas. For offshore areas, it is A$50 per block. All

SOUTH AUSTRALIA BASINS

*Reprinted with permission from International Exploration Newsletter, October 26, 1992.

applications are considered confidential, and are assessed for the most effective work program.

The initial term is 5 years onshore, 6 years offshore. Relinquishment at the end of the term is 25% of initial area onshore, and 50% of existing area offshore. Terms can be renewed for 5 years. For this, an application fee of A$1000 applies to onshore areas, A$1200 offshore.

A commercial discovery automatically entitles the license holder to a production license issued for 21 years with provisions for renewal. The application fee is A$2000 onshore and A$1200 offshore. State royalty is 10% onshore and 10-12½% offshore. Commonwealth areas are subject to a resource rent tax. An annual fee of A$150 per sq km is due for onshore areas. The fee for offshore areas is A$18,000 per block. A pipeline license may be granted for the same period.

The South Australia Department of Mines and Energy has an extensive database that can be viewed at the Department and is readily available in digital and hard copy format. All basic technical data from onshore licenses are placed in open file two years after acquisition. Offshore well data are released after two years and one month, and survey data three years after completion of acquisition. A five-year retention period applies to onshore production licenses. Offshore basic well data from production licenses are released after 13 months, and survey data after two years.

INTERNATIONAL FEATURE

A NEW LOOK AT THE TERTIARY BASINS OF THE INTRA-CARPATHIAN REGION

by Gabor Tari, Rice University,
Department of Geology and Geophysics
Houston, Texas

Abstract

Based on the structural interpretation of reflection seismic data, some areas of the intra-Carpathian region of eastern Central Europe are characterized by distinct modes of upper crustal extension. Deep (>8 km) subbasins of the Pannonian Basin system such as the Danube Basin, were largely extended during trhe Middle Miocene syn-rift phase. In this area, extension was accommodated by low-angle detachment faults, partly inherited from earlier Alpine overthrust planes. In other areas, however, extension was accommodated only by planar normal faults rotated to different degrees which indicate relatively little extension.

The Neogene (Middle Miocene-Recent) Pannonian Basin proper is superimposed on an earlier Paleogene (Middle Eocene-Early Miocene) basin complex as a result of back-arc extension. Although the stratigraphy of the latter is well known, its formation and structural evolution is much less understood. A transtensional origin was generally proposed for the Paleogene Basin of Hungary, assuming an origin analogous to that of the overlying Pannonian Basin. An alternative geodynamic scenario is suggested here for the development of the Paleogene basin complex, as the observations may be better understood in terms of a retroarc flexural basin model.

Introduction

The Neogene Pannonian Basin proper is one of the Mediterranean back-arc basins (Horvath and Berckhemer, 1981). It was formed as a typical transtensional basin where extension was coeval with compression in the surrounding Carpathian thrust-fold belt (Fig. 1.; for a recent summary, see Royden and Horvath, 1988). In the evolution of this transtensional basin, the initial crustal thinning phase occurred during the Middle Miocene, while the subsequent Late Miocene to Recent period corresponds to the thermal subsidence phase. Crustal extension beneath most parts of the basin is estimated to have been about 50% to 120% (Horvath *et al.*, 1988) based on subsidence analysis.

Systematic mapping of structural elements using reflection seismic data, however, revealed the very heterogeneously distributed nature of Neogene extension in the Pannonian Basin (tari *et al.*, 1992). The aim of this paper is to show two typical seismic examples of contrasting extensional styles. Moreover, one of these seismic lines also shows the underlying Paleogene sedimentary succession. In sharp contrast with previous interpretations, (e.g. Royden and Baldi, 1988) this Paleogene basin is not considered to be a transtensional basin analogous to the overlying Pannonian Basin proper. Instead, the Paleogene Basin of Hungary is better understood in terms of a flexural basin (Tari *et al.*, in press).

Major Tertiary Tectonostratigraphic Units

The Neogene sedimentary succession of the Pannonian Basin clearly reflects its extensional origin. Fig. 2 shows a schematic cross-section from the Pannonian Basin in Northern Hungary that illustrates the relative thickness variations and structural control of the major tectonostratigraphic units. The uppermost unit represents the Late Miocene to Recent (13.8-0 Ma) post-rift sedimentary succession which is the result of regional thermal subsidence. In these young strata the frequently observed strike-slip faults (flower structures) indicate that inversion of the basin has already begun. The locally pronounced Quaternary uplifts, which are responsible for the very few outcrops of pre-Neogene strata (e.g., see the northern end of the section in Fig. 2), are also thought to be the result of neotectonic activity.

The thickness variation and spatial distribution of the underlying Middle Miocene (17.5-13.8 Ma) succession are largely controlled by syn-rift structural features. Dominantly siliciclastic deposition took place in fault-bounded half-grabens and pull-apart basins. The widespread Miocene calc-alcaline volcanism of the syn-rift stage was generated by the subducting European plate below the Carpathian orogenic belt.

Beneath the Neogene Pannonian Basin proper (17.5-0 Ma) in Northern Hungary, another Tertiary basin can be found (Fig. 2). This Middle Eocene-Early Miocene basin fragment is traditionally called the "Paleogene" basin. This flexural basin developed to the south of the backthrusted inner Western Carpathian units (Fig. 1) and since the corresponding thrust system is antithetic to a subducting plate margin, it is considered to be a retorarc flexural basin (Tari *et al.*, in press). It is important to realize that while the Carpathians represented an extensional arc during the Neogene with a corresponding back-arc extensional basin (Pannonian Basin proper), the Paleogene arc of the Carpathians was apparently a compressional arc with a corresponding retroarc flexural basin (Hungarian Paleogene Basin).

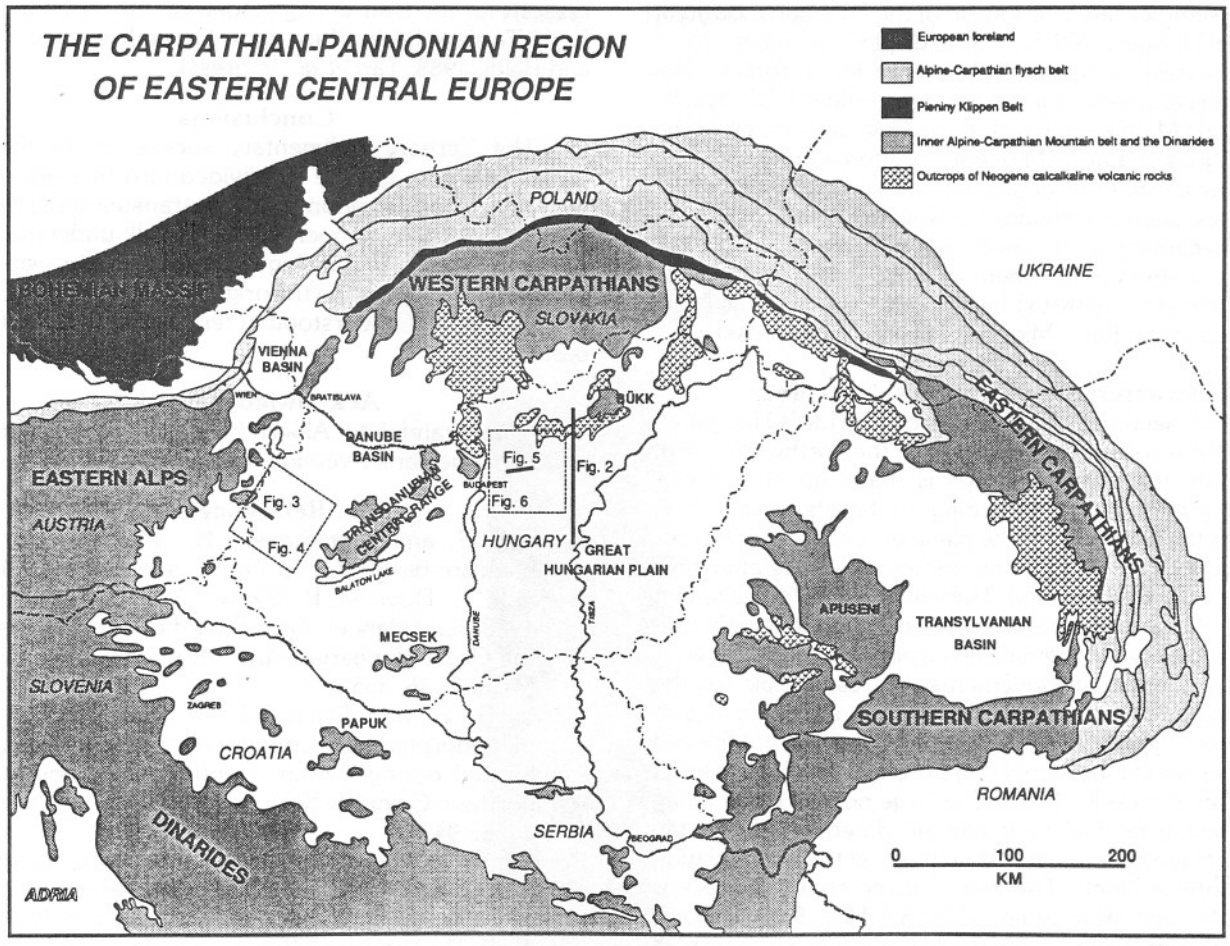

Figure 1. Geologic sketch map of the Carpathians and the Pannonian Basin. Insets shows the location of the schematic cross section (Fig. 2) seismic lines "A" and "B" (Fig. 3, 5) and the block diagrams (Fig. 4, 6).

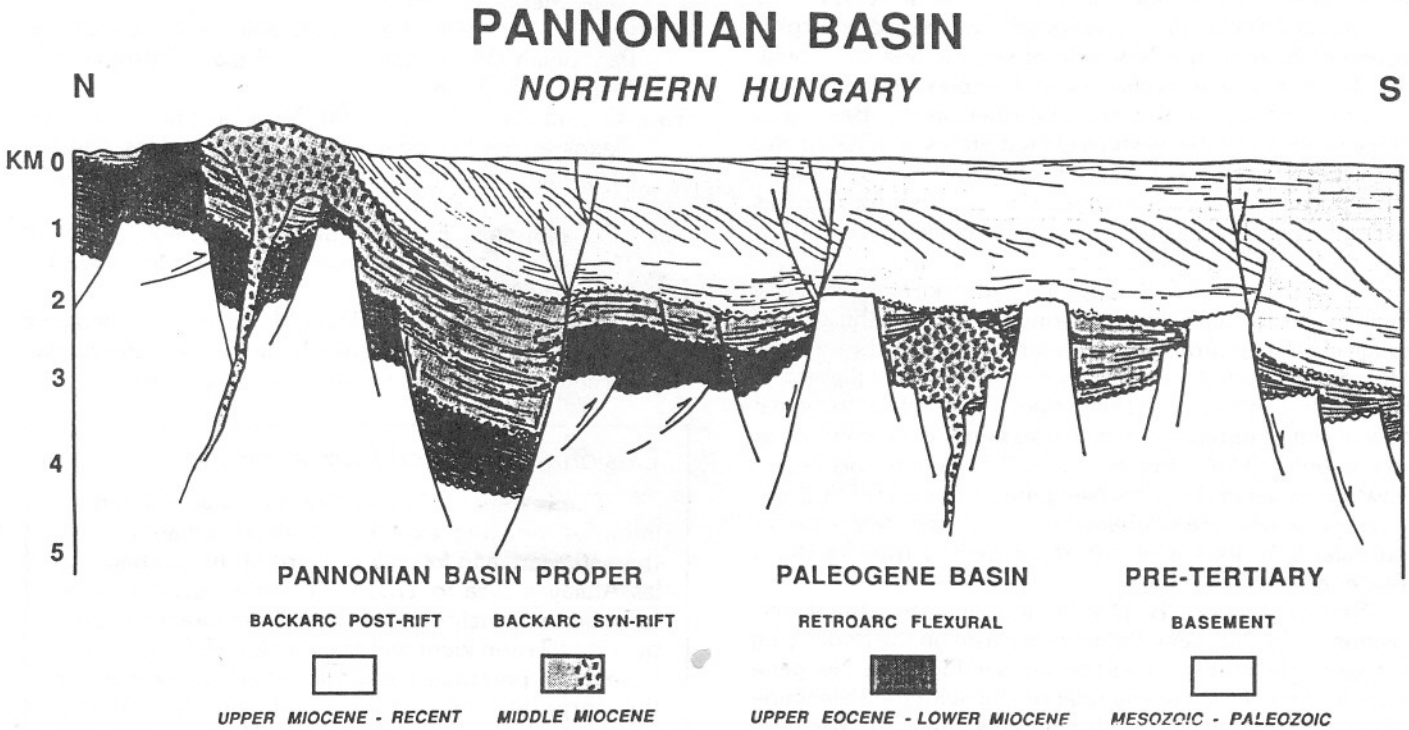

Figure 2. Schematic section across Northern Hungary showing the major Tertiary tectonostratigraphic units of the Pannonian Basin. The vertical exaggeration is about tenfold. For a detailed explanation see text.

The sedimentary succession of the Paleogene Basin of Northern Hungary (49-17.5 Ma) displays a major transgressive-regressive facies cycle driven by tectonics. The thrust load resulted in a generally deep, underfilled "flysch" basin during Middle Eocene to Early Oligocene times. In the Late Oligocene-Early Miocene predominantly shallow marine and continental deposition took place indicating the gradual cessation of thrusting in the adjacent thrust-fold belt and the beginning of "molasse" sedimentation. During this time the abundant sediment supply derived from the uplifting and eroding thrust belt gradually filled up the basin by the end of the Early Miocene (Tari *et al.*, in press).

Characteristic reflection seismic lines

Seismic section "A" (Fig. 3) is from the Little Hungarian Plain of Western Hungary (Fig. 1). On the northwest side of the section, the basement high is made up of epimetamorphic greenschists, according to borehole evidence, located to the northeast of the plane of section. In contrast, on the southeast side of the section anchimetamorphic Paleozoic rocks were drilled. The low-angle tectonic contact between these two different ypes of basement unit corresponds to a two-phase dip-slip displacement. Cretaceous (Eoalpine) overthrust movements are responsible for the older-on-younger relationship, while the sharp change in metamorphic grade is regarded to be the result of Miocene detachment faulting, reactivating a pre-existing Alpine thrust plane (Tari and Bally, 1990). The large normal offset along this low-angle normal fault can be dated by clastic fan deposits which accumulated due to the tectonic denudation of the footwall block. The age of these coarse clastics is middle Miocene (Karpatian; 17.5-16.5 Ma). Furthermore, zircon fission track ages from the outcropping metamorphic core of the footwall close to the NW end of the line range between 18.5 and 15.1 Ma (I. Dunkl, written communication). This is an independent evidence for detachment faulting during the Middle Miocene (Tari *et al.*, 1992).

Tari and Bally (1990) suggested that the metamorphic basement high on the NW side of seismic line "A" corresponds to a metamorphic core complex and finds an analogue in those which are described in the Basin and Range province of the western United States (e.g. Lister and Davis, 1989). The important implication of this interpretation is that the apparent large amount of crustal extension in this part of the Danube Basin (Figs. 1, 4) can locally exceed 200% (Tari *et al.*, 1992).

Seismic section "B" (Fig. 5) is located in northern Hungary (Fig. 1). This is a dip section striking E-W across the Zagyva trough. The structural interpretation shows that the strongly rotated fault blocks are separated by listric faults dipping to the east. In contrast with the previous example in this area, the amount of extension is much less and was estimated as high as only 20-30%. Fig. 6 gives a 3-D view of this region showing the general style of Neogene extension in Northern Hungary, where areas characterized by different amount and polarity of extension are separated by transfer faults (Tari *et al.*, 1992).

Seismic section "B" (Fig. 5) also illustrates the superposition of the Neogene Pannonian Basin on the underlying Paleogene Basin (Fig. 2). all the faults in Fig. 5 are Neogene in age and do not show any relationship with the Paleogene succession. In fact, reflection seismic data in Northern Hungary hardly reveals any structural feature which could be considered to be Paleogene in age. This is one of the main reasons for the contrasting models on the formation of this Early Tertiary basin of the intra-Carpathian area (Royden and Baldi, 1988; Tari *et al.*, in press).

Conclusions

The Tertiary sedimentary succession of the intra-carpathian area can be subdivided into two major basin units. While the development of the transtensional Neogene Pannonian Basin proper is fairly well understood, the formation of the underlying Paleogene Gasin was not so clear. The new model on the origin of the Paleogene Basin in Hungary is best understood in terms of a retroarc flexural basin.

Acknowledgements

I am grateful to Albert Bally and Pinar Yilmaz for reviewing the earlier version of this paper.

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Cusiana, continued from page 10

The results to date at Cusiana have capped an intensive ongoing exploration effort initiated more than 10 years ago following award of the Santiago de las Atalayas area to Triton. All of this has obviously been an extremely successful confirmation of a prospect that Triton identified and had long considered to have major potential. It is also an excellent example of the corporate support provided and the tenacity required to reach this high point. The elephants are out there! Where will the next one be?

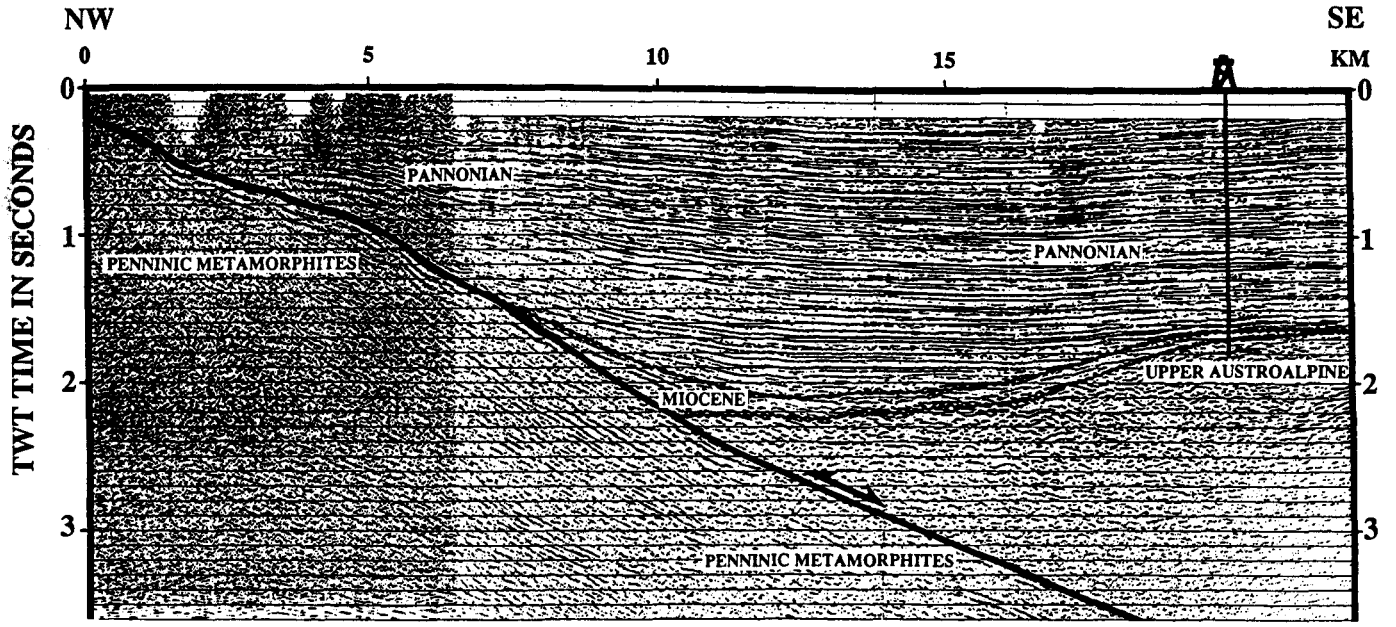

Fig. 3. Migrated reflection seismic line "A" modified from Tari *et al.*, (1992). The basement consists of epimetamorphic greenschists on the northwestern side of the section (Penninic of Rechnitz). The well on the southeastern side of the profile bottomed in anchimetamorphic Paleozoic rocks (Upper Austroalpine). The low-angle tectonic contact between these units corresponds to a major Cretaceous overthrust plane. During the middle Miocene the same fault plane reactivated as an extensional detachment fault.

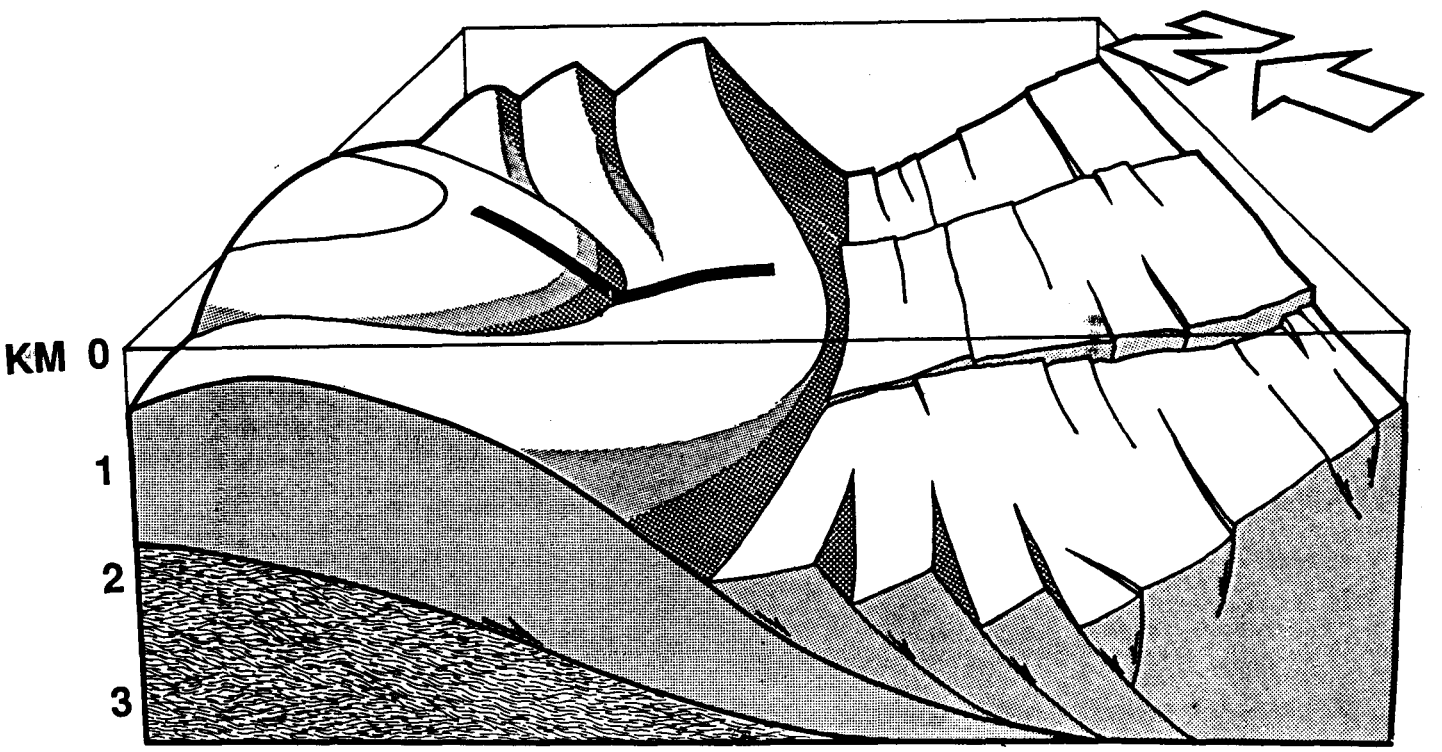

Fig. 4. NE-looking block diagram of the Danube Basin in Western Hungary (see Fig. 1 for location) showing the base of the middle Miocene (base of syn-rift strata). The trace of seismic section "A" (Fib. 3) discussed in text is indicated on this surface.

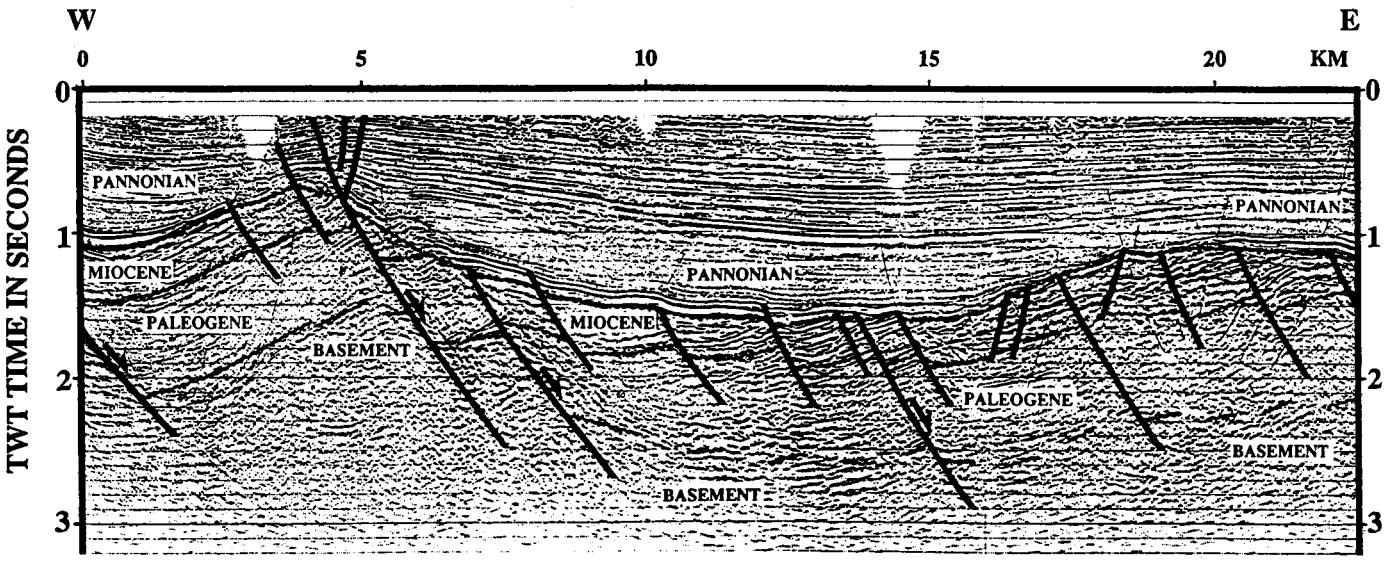

Fig. 5. Migrated reflection seismic line "B" modified from Tari *et al.*, (1992). Note on this dip section the erosional truncation of pre- to syn-rift strata (Miocene) due to the rotation of normal faults.

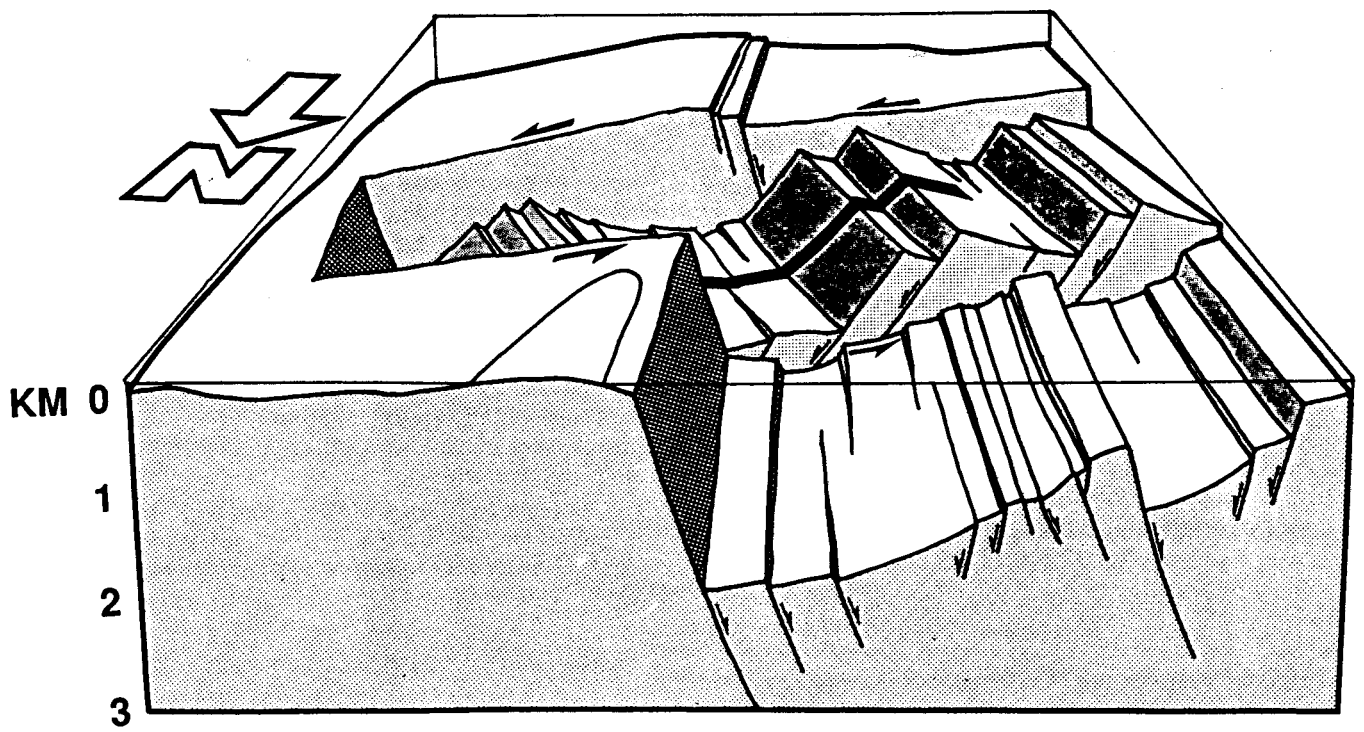

Fig. 6. S-looking block diagram of the Zagyva trough in Northern Hungary (see Fig. 1 for location) showing the base of the middle Miocene (base of syn-rift strata). The trace of seismic section "B" (Fig. 5) discussed in the text is indicated on this surface.

ENVIRONMENTAL/ENGINEERING GEOLOGISTS

HGS ENVIRONMENTAL/ENGINEERING COMMITTEE LUNCH & DINNER MEETINGS—JANUARY 13, 1993

Topic (same at both luncheon and dinner: Environmental Equipment Demonstration

Presented by: Lon McAllister, Techsas, Inc.

LUNCHEON:

Place: Houston Community College
Lecture Room 221, San Jacinto Bldg.
1300 Holman at San Jacinto
(Cafeteria available on 3rd floor)

Time: Social - 11:30 a.m.
Program - 12 Noon

DINNER:

Place: Italian Market and Cafe
2615 Ella Blvd.
(Located behind NW Memorial Hospital just south of 610 North Loop)

Time: Social - 5:45 p.m.
Program - 6:30 p.m.

Note: A $1.00 surcharge will be charged by the restaurant even if you don't order food or drink.

The **Career Change Networking Group** will meet briefly after the dinner meeting, then again at 7:00 on January 25. Joe Murray with Engineering Science will be speaking at the January 25th meeting, which will be held at the Harris County Library (Fairbanks Branch) on N. Gessner (north of Hwy. 290); call Bob Rieser for directions if needed.

ABSTRACT

The equipment demonstration will include both hands-on demonstration and slide presentation of equipment used in the environmental industry. This includes field monitoring devices, pumps, recovery systems, etc.

CONTINUING EDUCATION SHORT COURSE ENVIRONMENTAL/ENGINEERING GEOLOGISTS

Title: Ground Water Sampling Methods and Dense Non-Aqueous Phase Liquids (DNAPLs)

Location: Paul Revere Middle School Auditorium
10502 Briar Forest (just west of Beltway 8)

Date: Tuesday, January 19, 1993

Time: 6:30 - 9:30 p.m.

Speaker: Charles J. Newell, Ph.D., P.E.
Vice President, Groundwater Services, Inc.

Course Description:

The course will be presented in two parts. The first session will be a general overview of groundwater site characterization. Drilling, groundwater sampling strategies and state-of-the-art sampling techniques will be discussed. The topic of the second half of the course is non-aqueous phase liquid (NAPL) groundwater contamination and how it affects site remedial activities. Dr. Newell will also present a case history of the MOTCO Superfund site (LaMarque, Texas) in which he will discuss characterization and remediation of the site.

Biographical Sketch:

Dr. Newell is an Environmental Engineer and Vice President of Groundwater Services, Inc. in Houston, Texas. He has extensive experience in Superfund site remediation and DNAPL and LNAPL recovery. He received his Bachelor of Science and Doctoral degrees in Environmental Engineering from Rice University.

Registration Cost:

$10.00. Free for unemployed and underemployed HGS members. Pre-registration by mailing checks made payable to the Houston Geological Society to the HGS office is requested.

For further information call Nancy Boschetto at 579-8999 (8 a.m. to 12 noon) or Zubair Haq at 495-9828 (12 noon to 12 midnight).

STCL ENVIRONMENTAL LAW SHORT COURSE

South Texas College of Law is sponsoring its annual continuing education course on **Environmental Law Symposium** on January 21-22, 1993. The course is aimed at professionals involved in the environmental areas and environmental lawyers. A well-respected faculty will examine TWC reporting requirements, international environmental laws, wetlands, audit reports, toxic tort suits and criminal and administrative enforcement issues. Tuition for non-legal environmental professionals is $200.00. For more information, call (713) 646-1757.

ON THE MOVE

Samuel G. Reiser has recently joined Nippon Oil Exploration USA, Ltd. as District Geologist. Prior to joining Nippon he was a Geological Consultant, Houston, Texas.

Fairfield Industries Inc., a Houston based firm providing seismic data acquisition and processing services to the oil and gas exploration industry announces the promotion of **Lynn A. Turner** to Vice President of Operations.

Wm. Dock Adams took early retirement from Unocal on December 1, 1992 after twenty eight and one half years with the company. He was Regional Geologist for Unocal's Texas/Southeastern Region in Sugar Land, Texas. Dock will be "consulting" from his NW Harris Co. home in Hockley, Texas.

ENVIRONMENTAL FEATURE

GROUND WATER SAMPLING AT LEAKING PETROLEUM STORAGE TANK SITES IN THE STATE OF TEXAS*

by David DeWitt Harvey, Environmental Geologist
Texas Water Commission District 12 Office
Corpus Christi, Texas

ABSTRACT

Leaking petroleum storage tanks contribute to aquifer contamination in the state of Texas. Chemical analyses of ground water samples collected from monitoring wells located at leaking tank sites will quantify the dissolved phase portion of hydrocarbon contaminants affecting these aquifers. A suggested sequence of events for ground water sampling is as follows: measure the static fluid level in the well, purge the well, collect and preserve the sample, complete the chain of custody form, prepare field blanks, transport the samples to the laboratory, and report the analytical results to the Texas Water Commission.

DISCLAIMER

This paper should not be considered State of Texas law nor official policy of the Texas Water Commission. It is instead a recommendation by the author, using the available references listed at the end of the paper.

INTRODUCTION

A significant threat to Texas aquifers is imposed by leaks and spills from underground petroleum storage tank systems. The Texas Water Commission (TWC) regulates the cleanup of these subsurface releases in accordance with federal Environmental Protection Agency requirements. In order to determine the effects of a leak or spill from an underground storage tank upon the environment, the TWC requires that a contamination assessment study be performed. Such studies will involve collection and analysis of representative soil and ground water samples. The term "representative" used here is very important. The samples collected must mirror conditions encountered in the subsurface.

Most underground storage tank systems contain refined hydrocarbons used for motor vehicle propulsion such as gasoline, diesel, kerosene, jet fuels, etc. These hydrocarbons, when released into the subsurface, migrate in the direction of gravity flow or along the path of least resistance. Man-made pathways can act as conduits for hydrocarbon migration (see Figure 1). When these hydrocarbons encounter the water table they tend to float or mound, creating a "lens" of free-phase product while depressing the water table. The term "light non-aqueous phase liquid" or "LNAPL" describes these immiscible, floating-type hydrocarbons and their hydrologic behavior. A portion of the contaminants will dissolve in ground water as well. A ground water sampling program will help quantify the presence and extent of dissolved phase contaminants.

Ground water samples should be collected from properly designed, constructed, and developed monitor wells. A schematic of a typical ground water monitor well is shown in Figure 2. At most leaking petroleum storage tank sites, the well head is installed below grade, and is protected by a steel manhole and cover (see Figure 3). Only drillers which are licensed by the State of Texas Water Well Drillers Board may install monitor wells. Analyses of ground water samples collected from boreholes, open excavations, or through hollow stem augers while drilling may not be accepted by the TWC as valid (TWC, 1991).

In any sampling event, a strict quality control/quality assurance program should be followed to insure the validity of the sample analyses. Insufficient cleaning of sampling equipment or improper sampling procedures will affect laboratory results. When possible, ground water monitor wells should be sampled in the order from least contaminated to the greatest. This procedure will help minimize cross contamination between wells.

GROUND WATER SAMPLING PROCEDURE

A recommended sequence of events to be followed when sampling ground water monitor wells is as follows:

1. Notify the appropriate TWC District Office via telephone call or fax transmission at least 48 hours prior to the sampling event.
2. Upon arrival at the site, log the facility name, location, the Leaking Petroleum Storage Tank (LPST) ID No., well number, date, time, well casing diameter, and sampling personnel. Other useful observations which may be recorded are the weather conditions (including air temperature), well casing type, sampling equipment used, and the condition of the well (i.e. cracked concrete collar, vandalization, etc.) (UTTU, 1990).
3. Unlock the well. Monitor wells should always be kept locked to prevent vandalism or accidental filling. Copies of keys to the wells should be kept at the facility if possible. Also, the well must be equipped with a watertight cap to prevent the infiltration of surface water

*Reprinted with permission of the Corpus Christi Geological Society.

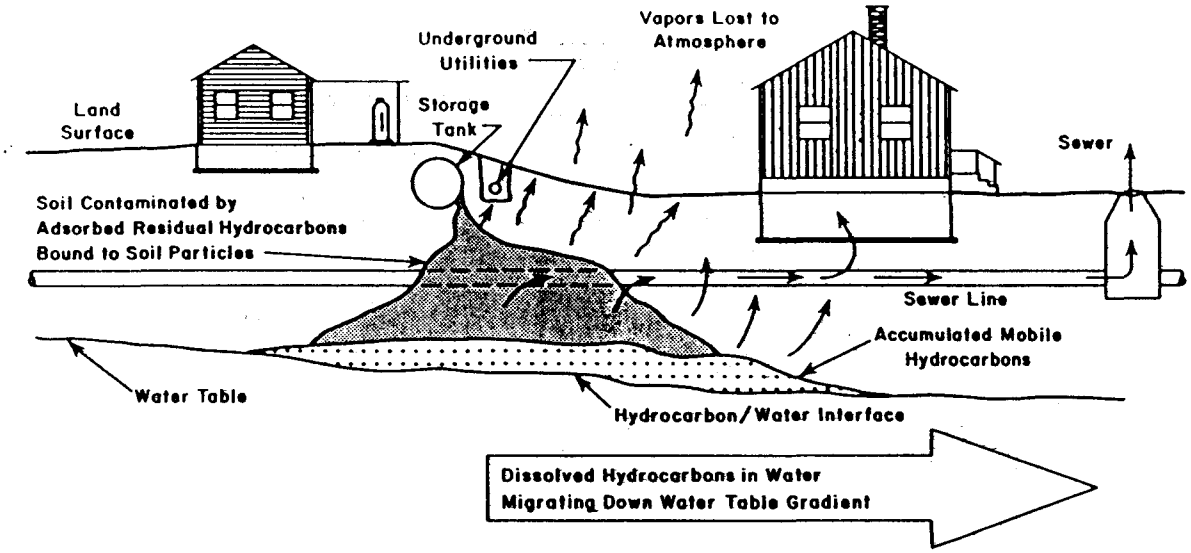

Figure 1 - Common occurrences, avenues of hydrocarbon migration, and reduction, following the leak of an underground storage tank. From Texas Water Commission (1989)

runoff. If water has collected in the manhole it should be completely removed prior to removing the cap.

4. Remove the well cap and sample the air in the well head for organic vapors with a field screening tool such as a photoionization detector (PID) and record the measurement (EPA, 1986).
5. Measure the static fluid level in the well to 0.3 cm (0.01 ft.) and record the value. Fluid level measurements are used to construct water table contour maps which indicate direction of groundwater movement. Each well should have a permanent, easily identified reference point from which its fluid level measurement is taken. The reference points should be established by a licensed surveyor and are typically located and marked at the top of the well casing or on the concrete collar. The reference points should be established in relation to an established National Geodetic Vertical Datum (NGVD) and **not** to an arbitrary daturm (EPA, 1986).
6. Measure the thickness of the free-phase product layer, if applicable, and record the value. A useful tool for making this measurement is an interface probe. These measurements are used to construct a hydrocarbon distribution map which indicates free-phase hydrocarbon thickness across the water table at the facility. Monitor wells which contain layers of free-phase product should not be sampled. Instead, the free-phase product should be removed form the well on a daily basis and records should be kept of the volume of fluid removed as well as its disposition.
7. Measure the total depth of the well and record the value. The measured value should be compared to well completion data to determine if excessive sediment has accumulated in the well.
8. The monitor well must be purged prior to sampling. Water that has remained in the well casing more than two hours has had the opportunity to exchange gases with the atmosphere and to interact with the well casing material (EPA, 1991). Purging the well removes stagnant water and will draw representative ground water from the affected aquifer into the well. Optimally, the well should be purged until certain chemical parameters of the ground water have stablized, namely pH, conductivity, dissolved oxygen, and temperature. Probes and meters used to measure these values several successive readings agree to within 10 percent, the well has been sufficiently purged (UTTU, 1990 and EPA, 1988).

   For many shallow aquifers with low transmissivity, the monitoring of the above noted chemical parameters cannot be accomplished and an alternate purging strategy must be employed. Hardee (1989) recommends that three or more well volumes be removed by hand bailing or pumping. If a hand bailer is used for well purging or sampling, the bailer should never be "dropped" into the well as this may cause agitation of ground water and a loss of volatiles. Also, the rope or cord tied to the bailer should never touch the ground as this may introduce contaminants into the well (Peterson, 1990).

   Low yielding wells may require less purging to obtain representative aquifer water. If water level recovery is extremely slow (i.e. greater than 24 hours to recover), then purging one well volume should be sufficient (Hardee, 1989). The well should then be allowed to recover until a sufficient volume of water is available to sample (Nordstrum and Benyon, 1991 and EPA, 1988). Sampling personnel should never pump a well to dryness if the recharge rate causes the formation water to vigorously cascade down the sides of the screen and cause an accelerated loss of volatiles (EPA, 1986).

   Record the volume of water removed from the well. All purged fluid should be contained and disposed of in accordance with federal, state, and local laws.
9. Collect the ground water sample using clean, decontaminated sampling equipment. The well should be sampled as soon as possible after the purging

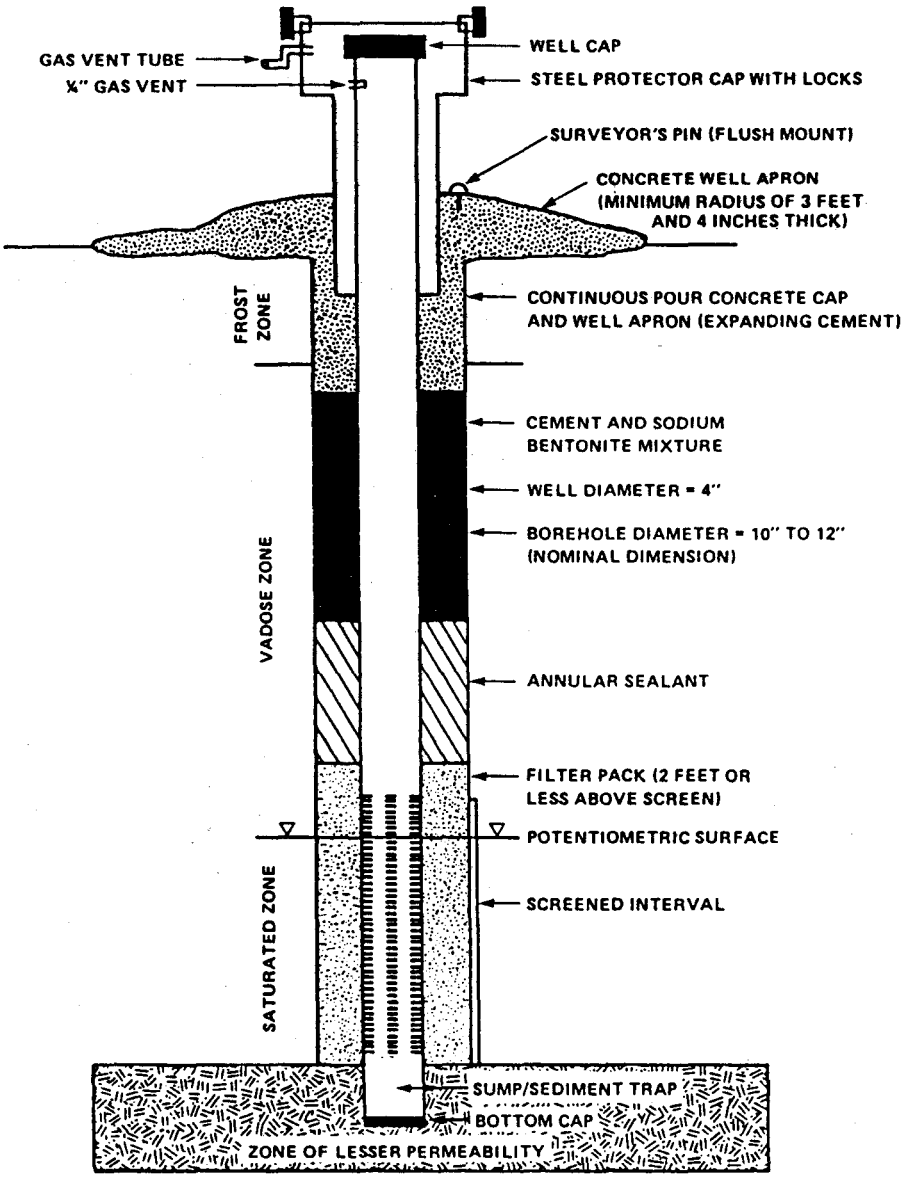

Figure 2 - General ground water monitoring well - Cross Section from EPA (1986)

procedure (API, 1989 and TWC, 1990). Try to minimize agitation of the sample as this may release dissolved volatiles. Once again, if a hand bailer is used to collect the sample, the line or cord tied to the bailer should not touch the ground and should be discarded once the sample is obtained. If the target contaminant is a LNAPL, the sample should be collected from the upper section of the water column in the well. Fill clean, sterile sample containers as completely as possible with no headspace (i.e. no air bubbles inside the sample container). Glass liter bottles with teflon liners should be used for total petroleum hydrocarbons (TPH) analyses. Volatile organic aromatic or "VOA" bottles with 40 ml capacities and teflon septa should be used when analyzing for benzene, toluene, ethylbenzene, and xylenes (BTEX) (TWC, 1991). At least one quart of ground water is required for each TPH analysis and a minimum of two "VOA" bottles is required for each BTEX analysis.

In order to determine background ground water quality at a leaking petroleum storage tank site, the TWC requires that a total dissolved solids (TDS) analysis be performed on a ground water sample obtained from an uncontaminated, upgradient monitor well. If possible, this sample should be obtained during the sampling event.

Record the time of sample collection, along with other observations of the sample (i.e. odor, color, appearance, etc.). Properly label the sample container with the following information: the sample identification

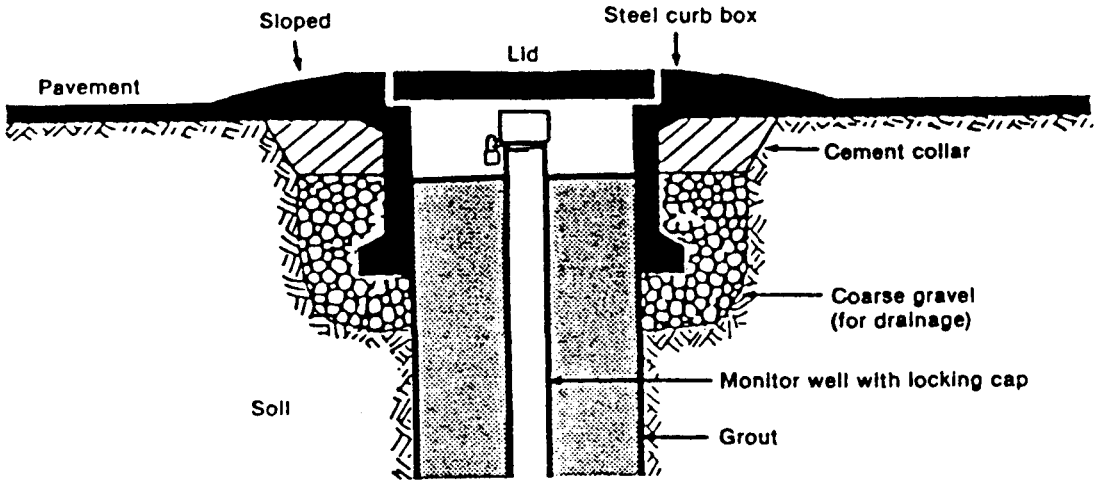

Figure 3 - Typical flush-mounted monitor well with steel curb box; from API (1989)

number, the well number, the name of the collector, and the date and time sampled.

In order to enhance the QA/QC procedure to the sampling event, it may be desirable to use a "dedicated" bailer or pump for each well to be sampled (i.e. a bailer or pump which is used for one well only). This would reduce the possibility of cross contamination between wells.

10. The collected sample must be properly preserved. Preservation requirements for various analyses are specified in EPA 600, SW 846, and **Standard Methods.** To insure sample integrity, the preservation and sample container requirements should be strictly followed (Clesceri, Greenberg, and Trussell, 1989). Record the type of preservation used.

11. Fill out a chain of custody record to accompany each sample or group of samples collected. A chain of custody form documents the possession and handling of the sample from the time of collection through the time of laboratory analysis. A sample is considered to be under a person's custody if it is in the individual's physical possession, in the individual's sight, secured in a tamper-proof way by the person, or is secured in an area restricted to authorized personnel. The chain of custody form is very important in the event of litigation involving the results of sample analysis. When litigation is not involved, the chain of custody records are useful for routine control of sample flow. The form should contain the following information: the sample identification number, the signature of the collector, the date, time, and location of collection, the sample type, the types and sizes of sample containers, preservation mode, analyses requested, and the signatures of persons involved in the chain of possession, including the dates of possession (Clesceri, Greenberg, and Trussell, 1989). An example of a chain of custody form is shown in figure 4.

12. Always properly decontaminate nondedicated sampling equipment between sampling events. This can be done by washing the equipment thoroughly in soapy water with a soft bristled brush, using a mild non-phosphate detergent such as Alconox. Rinse the equipment with tap water, followed by rinsing with methanol. Finally, rinse with distilled water (EPA, 1988). Dispose of the rinse water properly.

13. Prepare field blanks for QA/QC purposes. The primary goal of this procedure is to ensure that sample protocol is being executed in a reliable manner, and that situations which may lead to error are recognized before they seriously affect analytical data. The preparation of field blanks can identify inconsistencies or errors that may occur during sample collection and analysis.

A trip blank (or travel blank) is a sample container filled in the laboratory with Type II reagent grade water and carried unopened during the sampling trip. The container is then transported to the site, handled like a sample, and returned to the laboratory for analysis. This container must be prepared by the laboratory supplying the sample containers and is used to identify contamination introduced from the originating laboratory. One trip blank per sampling event is recommended (Peterson, 1990 and EPA, 1986).

An equipment blank is a sample where Type II reagent grade water is used in the sampling equipment, simulating an actual sampling event. This procedure could indicate proper or improper decontamination of sampling equipment, or changes in the samples due to exposure to airborne contaminants at the site. A minimum of one equipment blank for each day that monitor wells are sampled is recommended (EPA, 1986).

The results of the analyses of the field blanks should not be used to correct ground water analytical data. If contaminants are found in the blanks, the source of the contamination should be identified and corrective action, including resampling, should be initiated (EPA, 1986).

14. The collected samples should be stored and transported to the laboratory in an appropriate manner. The samples should be kept at a temperature of 4 degrees centigrade and the containers should be protected from damage. Also, the samples should be kept in the dark as exposure to light will enhance biological activity (Mazor, 1991). All collected samples should be analyzed as quickly as possible and should not exceed the holding times specified in EPA 600, SW 846, or **Standard Methods.**
15. The samples should be analyzed using the appropriate methods required by the TWC. The analyses performed should be able to detect the specific type of product or compounds which were released into the subsurface. The following analyses reflect compounds associated with a release of unleaded gasoline:

    TPH (total petroleum hydrocarbons) should be quantified using EPA Method 418.1 (IR) or ASTM D3328-78, Method B (GC/FID, capillary column procedure). If the GC/FID capillary column technique described in ASTM D3328-78, Method B is used, then the samples and standard oil should be prepared utilizing the techniques described in Method 418.1.

    BTEX (benzene, toluene, ethylbenzene, and xylene) should be quantified using EPA Method 8020/602 (GC/PID) with EPA Method 5030 (Purge and Trap).

    MTBE (methyl tertiary butyl ether — an octance enhancing additive) should also be quantified using EPA Method 8020/602 (8020/602 (GC/PID) with EPA Method 5030 (Purge and Trap).

    TDS (total dissolved solids) should be quantified using EPA Method 160.1 (TWC, 1990).
16. Once the sample data have been obtained, they should be reported to the TWC according to the May 1991 publication, **Standardization of Report Format.**

CONCLUSION

When developing a ground water monitoring program, emphasis should be placed upon obtaining hydrologic and chemical data that accurately represent *in situ* subsurface conditions. By using proper sampling techniques and appropriate quality assurance procedures, a great many long- and short-term problems can be avoided. The costs of defending poor quality data in the event of litigation or in the presence of regulatory agency compliance can be substantial.

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ACKNOWLEDGMENT

The assistance of Russell Lewis (TWC D-12) and Marilyn Long (TWC D-7) who reviewed and commented on this paper is gratefully acknowledged.

BIOGRAPHICAL SKETCH

David DeWitt Harvey received his B.S. Degree in geology from Trinity University in 1985. From 1986 to 1988 he was employed with Professional Services Industries, Inc., as a geologist. In 1990 he joined the Texas Water Commission District 12 Office and currently works with the Hazardous and Solid Waste program.

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME/SITE NAME					TYPE AND NO. OF SAMPLE CONTAINERS	PRESERVATION TECHNIQUE / REQUESTED ANALYSIS					REMARKS
SAMPLERS: (Signature)		DATE:										
SAMPLE NO.	DATE	TIME	GRAB	COMP	SAMPLE SOURCE AND DESCRIPTION							

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks:	
Carrier Co: Air Bill No:		Carrier Phone No.		Date Results Reported / by: (Signature)	

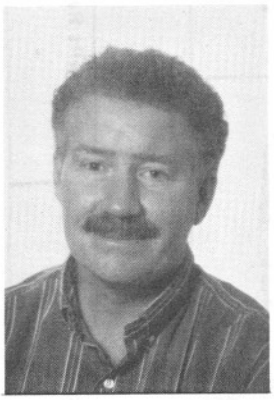
Figure 4 - Sample chain of custody rorm from EPA (1988)

NORTH AMERICAN & GULF COAST EXPLORATIONISTS

HGS NORTH AMERICAN EXPLORATIONISTS GROUP DINNER MEETING—JANUARY 19, 1993

Social Period, 5:30 p.m.,
Dinner and Meeting, 6:30 p.m.
Post Oak Doubletree Inn

ROBERT F. LINDSAY—Biographical Sketch



Robert F. Lindsay currently is a Senior Carbonate Petrographer for Chevron, USA in Midland, Texas. He received his B.S. in geology from Weber State College (1974) and his M.S. from Brigham Young University (1976). He joined Gulf Energy and Minerals in Oklahoma City in 1976 and worked as a development geologist. From 1977-83. Bob was with Gulf Oil Exploration and Production, working with Enhanced Oil Recovery methods. In 1983, Bob moved to Houston to work as a researcher in the Lithostratigraphy group. With the Gulf/Chevron merger, Bob moved to Denver in 1985 and began working for Chevron as a carbonate petrographer and laboratory supervisor. In 1988, he moved to Hobbs, New Mexico and in 1990 moved to Midland, Texas during which time he continued his work as a carbonate petrographer. Bob has published numerous articles including topics such as the Mission Canyon, Arbuckle Group in Southern Oklahoma, Grayburg Formation in the Permian Basin and Enhanced Oil Recovery Techniques.

MISSION CANYON FORMATION RESERVOIR CHARACTERISTICS IN NORTH DAKOTA, WITH EMPHASIS ON LITTLE KNIFE FIELD

Twenty-five oil fields productive from the Mississippian Mission Canyon Formation (middle Madison Group) were studied at four areas in the North Dakota portion of the Williston Basin. These areas are: 1) the Nesson Anticline (North Tioga, Tioga, Beaver Lodge, Capa, Hofflund, Charlson, Hawkeye, Blue Buttes, Antelope and Clear Creek fields); 2) northeast of the Nesson Anticline (Rival, North and South Black Slough, and Foothills fields); 3) the eastern basin margin (Bluell, Sherwood, Mohall, Glenburn, Chola and Haas fields); and 4) the southern basin margin (Lone Bute, Little Knife, Big Stick, Fryburg and Medora fields).

Mission Canyon reservoirs along the eastern basin margin, beneath the State "A" marker are housed in multiple shoaling-upward 4th-order parasequences within the Mission Canyon 3rd order sequence and are composed of intraclast-bearing, oolitic-pisolitic-oncolitic packstone/grainstones that underwent intense subaerial exposure. These barrier island/shoreline buildup complexes are backed by evaporites (shoreward) and grade into offshore marine deposits basinward. Repetitive shoreline progradation further basinward placed lagoonal, tidal flat and supratidal coastal sabkha evaporites over earlier deposited barrier island/shoreline buildup complexes.

Along the southern margin of the basin, beneath the State "A" marker, the 4th-order parasequences are more difficult to recognize and tend to form a single shoaling-upward sequence, with reservoirs housed in dolomitized transitional open/restricted marine skeletal wackestones and restricted marine pelletal wackestone/packstones. Reservoirs along the Nesson Anticline were also deposited in a single overall shoaling-upward sequence. Laterally equivalent evaporites are at a distance east and south of Nesson.

Reservoirs at the Nesson Anticline's northern end are housed in open marine skeletal packstone/grainstones and in buildup complexes of oolitic-pisolitic, intraclast-bearing, skeletal dolostones. Limestones were deposited in a transitional open/restricted marine setting as slightly intraclastic, skeletal wackestone/packstones. At the Nesson's southern end, reservoirs are interbedded limestones and dolostones. Limestones were deposited in a transitional open/restricted marine setting as slightly intraclastic, skeletal wackestone/packstones. Dolostones were deposited in a restricted marine setting as mudstones and skeletal mudstones and pelletal wackestones and packstones.

Immediately above the State "A" marker the Rival ("Nesson") Subinterval is productive northeast of Nesson Anticline. Reservoir rocks are composed of oolitic-pisolitic, intraclast-bearing packstones and grainstones deposited as barrier island/shoreline buildup complexes. The Rival also produces in the northern half of Nesson Anticline. Early deposition was dominated by barrier island/shoreline buildup complexes composed of oolitic-pisolitic packstones and grainstones to the north with evaporites southward.

At the southern margin of the basin Little Knife field produces from the Mission Canyon Formation. This formation is a regressive, shoaling-upward carbonate to anhydrite sequence that was deposited in a slowly shrinking epeiric sea. It is mostly subtidal in origin and consists of: (1) "deeper water" carbonates' (2) parasequences of open, shallow marine mudstone grading up into skeletal packstone-grainstone; (3) parasequences of transitional, open to restricted marine mudstone grading up into skeletal wackestone; (4) restricted marine pelletal wackestone-packstone; and (5) marginal marine skeletal wackestone.

Overlying this subtidal sequence are low-lying barrier island buildups of slightly skeletal, oolitic and pisolitic wackestone-grainstone with storm washover aprons. These beds are interbedded with thin lagoonal limestones or are laterally in contact with the evaporites deposited along the

RMAG CALL FOR FIELD TRIPS FOR 1994 AAPG CONVENTION

In conjunction with the 1994 AAPG annual convention in Denver, the RMAG Field Trip Committee is planning to offer a broad range of field trips to showcase the Rockies. The committee is chaired by Bob Raynolds and includes Sam Johnson and Neil Fishman from the USGS, Bob Lamarre from Texaco and Eric Potter from Marathon. We desire a broad range of trips suitable for technical participants and family members. Some trips will address major technical issues, while others will be designed to highlight geologic controls on the spectacular Rocky Mountain scenery. We hope to have some float trips as well as other adventure trips that will appeal to families making the convention part of their summer plans.

We welcome all trip proposals. We plan to have a firm list of offerings by this winter. Please contact Bob Raynolds at (303) 762-9379 with your suggestions.

North American Explorationists: The *Bulletin* wants your technical articles!

coastline. These in turn are overlain by prograding lagoonal, tidal flat, and sabkha anhydrite beds with local thin interbeds of laminated dolostone.

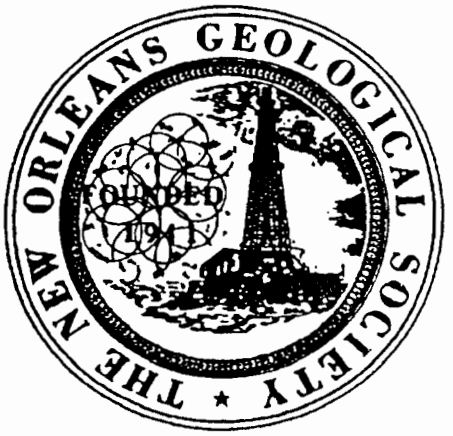
The field is structurally trapped to the north, east, and west within the northward-plunging Little Knife anticline. Closure is less than 100 ft. (30 m). Facies changes entrap the reservoir southward, and the seal is the overlying anhydrite beds. Porous, hydrocarbon-bearing beds are the transitional open-to-restricted marine, restricted marine, and marginal marine facies. These became porous dolomitic reservoir rock by undergoing three diagenetic changes: 1) anhydrite replacement of skeletal fragments, 2) dolomitization of the muddy matrix, and 3) later leaching of the anhydrite to create moldic porosity.

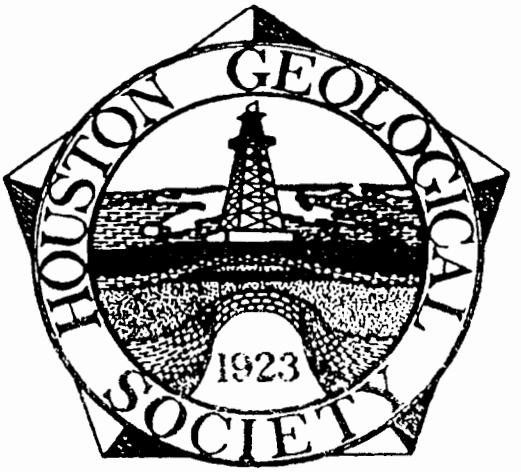
POSTER SESSION PC DATABASE MANAGEMENT SOFTWARE

The North American Explorationist group plans to conduct poster presentations during the Social hour before the January 19, 1993 dinner meeting. We intend to have poster sessions at each monthly meeting that are associated with the dinner meeting presentation or concentrate on a central theme. Our theme for the January poster session is PC database management software. We plan to have several demos that illustrate different application software for database management. The demos will be presented from 5:30 to 6:30, so come early.

COMING OUT SOON

PRODUCTIVE LOW RESISTIVITY WELL LOGS OF THE OFFSHORE GULF OF MEXICO





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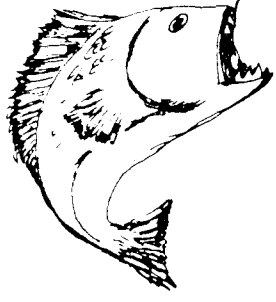

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Contact Joe Alcamo at 353-8341 or Bill Roach at 659-6111 for additional information.

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NAME:_____ **PARTNER'S NAME:**_____

ADDRESS:_____

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Enclose your check of $40.00/contestant payable to Geophysical Society of Houston (GSH) Bass Tournament.
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January CALENDAR of EVENTS 1993

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6 HGA Bridge Briar Club GSH School "Reservior Characteristics" January, 6-7	7	8	9
10	11 **HGS** **DINNER MEETING** **Bill Berry** **Post Oak Doubletree**	12	13 **HGS ENV./ENG.** **Luncheon–Houston** **Comm. College** **&** **Dinner Meeting** **Italian Mkt.**	14 SPWLA Westside Luncheon Radisson Suite Hotel	15	16
17	18 **HGS INTN'L** **DINNER MEETING** **Gordon Smart** **Post Oak Doubletree**	19 **HGS NORTH AMERICAN** **DINNER MEETING** **Wittstrom & Lindsay** **Post Oak Doubletree** **HGS ENVIR. SCHOOL** SPWLA Galleria Luncheon	20 GSH Noon Luncheon H.E.S.S. Geowives Tour & Luncheon Tenneco & Plaza Club	21 SIPES Luncheon Petroleum Club SPWLA G'nspt Luncheon Baroid Cafeteria	22	23 **HGS SCHOOL** **Bob Riser** **Exxon Auditorium**
24 31	25	26 SPWLA Downtown Luncheon	27 **HGS LUNCHEON** **George Clemenceau** **Houston Club** HGA Bridge Briar Club	28	29	30

GEO-EVENTS

HGS JANUARY EVENTS

MEETINGS

JANUARY 11, 1993 (Dinner Meeting)
"Exploration and Development in Louisiana Wetlands"
Bill Berry (see page 8)
Post Oak Doubletree Inn, 2001 Post Oak Blvd.
Social Period 5:30 p.m., Dinner and Meeting 6:30 p.m.
Reservations by name only, telephone **785-6402.** Must be **made** or **cancelled** by **noon Friday, January 8.**

JANUARY 13, 1993 (Luncheon/Dinner Meeting)
HGS ENVIRONMENTAL/ENGINEERING GEOLOGISTS
Environmental Equipment Demonstration
Lon McAllister (see page 20)
Luncheon: Houston Community College, Room 221, 1300 Holman, 12:00 noon.
Dinner: Italian Market & Cafe, 2615 Ella Blvd.
6:30 p.m. (Buy your own dinner)

JANUARY 18, 1993 (Dinner Meeting)
HGS INTERNATIONAL EXPLORATIONISTS
"Cusiana Field, Llanos Basin, Colombia"
Gordon Smart (see page 10)
Post Oak Doubletree Inn, 2001 Post Oak Blvd.
Social Period 5:30 p.m., Dinner and Meeting 6:30 p.m.
Reservations by name only, telephone **785-6402.** Must be **made** or **cancelled** by **noon Friday, January 15.**

JANUARY 19, 1993 (Dinner Meeting)
HGS NORTH AMERICAN EXPLORATIONISTS
"Little Knife Field - U.S. Williston Basin"
M. D. Wittstrom and R. F. Lindsay (see page 28)
Post Oak Doubletree Inn, 2001 Post Oak Blvd.
Social Period 5:30 p.m., Dinner and Meeting 6:30 p.m.
Reservations by name only, telephone **785-6402.** Must be **made** or **cancelled** by **noon Monday, January 18.**

JANUARY 27, 1993 (Luncheon Meeting)
"Fanlobe Geometry and Reservoir Sand Characteristics at Ram/Powell Field, Deepwater Gulf opf Mexico"
George Clemenceau (see page 9)
Houston Club, 811 Rusk
Social Period 5:30 p.m., Dinner and Meeting 6:30 p.m.
Reservations by name only, telephone **785-6402.** Must be **made** or **cancelled** by **noon Tuesday, January 26.**

SEMINARS, COURSES, AND ENTERTAINMENT

JANUARY 19, 1993
HGS ENVIRONMENTAL/ENGINEERING COURSE
"Sampling and Case Story of MOTCO Site"
Charles Newell (see page 20)
Paul Revere Middle School, Briar Forest, 6:30 p.m.

JANUARY 23, 1993
HGS SCHOOL
"Transition for Geoscientists from Petroleum to Environmental"
Bob Rieser (see page 34)
Exxon Auditorium, 800 Bell St.

OTHER EVENTS

HGA Bridge, Briar Club, Timmons & Westheimer, 10:00 a.m. - 2:30 p.m., Jan. 6

SPWLA Westside Luncheon, Radisson Suite Hotel, 10655 Katy Frwy. 11:30 a.m., January 14.

GSH Noon Luncheon, H.E.S.S., 3121 Buffalo Speedway, 11:30 a.m., Jan. 18.

SPWLA Galleria Luncheon, Marriott Galleria, 1750 West Loop South, 11:30 a.m., Jan. 19.

Geowives Tour & Luncheon, "Tour of Bayou Bend Museum" 10:00 a.m., Tenneco Bldg., 1010 Milam, Luncheon 12:00 Noon, Plaza Club, 910 Louisiana, Jan. 20.

SPWLA Greenspoint Luncheon, Baroid Cafeteria, 3000 North Sam Houston Parkway East, 12 Noon, Jan. 21.

SIPES Luncheon, Petroleum Club, 11:30 a.m., Jan. 21.

SPWLA Downtown Luncheon, Metropolitian Racquet Club, One Allen Center, 11:30 a.m., Jan. 26.

HGA Bridge, Briar Club, Timmons & Westheimer, 10:00 a.m. - 2:30 p.m., Jan. 27.

SCHOOLS AND FIELD TRIPS

GSH Course, "Reservoir Characteristics", Jan. 6-7. (see page 37)

FUTURE HGS MEETINGS AND EVENTS (February)

FEBRUARY 8, 1993 (Dinner Meeting)
Post Oak Doubletree Inn

FEBRUARY 16, 1993 (Dinner Meeting)
NORTH AMERICAN EXPLORATIONISTS
Post Oak Doubletree Inn

FEBRUARY 22, 1993 (Dinner Meeting)
INTERNATIONAL EXPLORATIONISTS
Post Oak Doubletree Inn

FEBRUARY 24, 1993 (Luncheon Meeting)
Houston Club, 811 Rusk

COMMITTEE NEWS

CAREER CHANGE SEMINAR

Petroleum Industry to the Environmental Industry
Sponsored by the HGS Environmental and Continuing Education Committees

Since the early 80's the petroleum industry has experienced a slowdown resulting in numerous staff layoffs in exploration and production departments (so tell me something new). This period of decreasing industry activity has taken its toll on the nation's energy reserves and dependence on foreign sources for petroleum.

On a more personal level the slowdown has played havoc with individual lives — lots of them. Where does one turn when laid off from the industry in which one has focused all one's energy? What other career opportunities are open? One option is the environmental industry. But how does one "break into" the industry with no experience? An easy question with a not-so-easy answer.

In January, the HGS Continuing Education Committee is sponsoring a day-long seminar to help those who are interested make the career change from the petroleum industry to the environmental industry. The seminar, taught by Bob Rieser, the Chair of the Environmental/Engineering Geologists Committee, will consist of a quick overview of RCRA and CERCLA regulations, the long-term outlook for the environmental industry, the geologist's role in the industry, how to make the transition (resume writing, skills necessary, sources for retraining, sources for job leads, interviewing), and finally the job search. This course was previously presented to Chevron employees in the Midland office by Mr. Rieser.

This course is oriented toward the former petroleum geologist who wants to enter the environmental industry but is confused or unclear as to where to start. It is based upon Mr. Rieser's experience during his own transition efforts, as well as feedback from those participants of the Environmental Committee's monthly Career Change Networking meetings, which are held every month.

PREREGISTRATION is mandatory.
Preregister by January 15, 1993

Fee: $10.00 to cover course materials.

Location: Exxon Auditorium, 8:15 a.m. to 4:00 p.m.

Date: January 23, 1993

Lunch: On your own.

REGISTRATION

"Career Change Seminar"
January 23, 1993

Name _____

Address _____

_____

_____

Phone _____

Mail this form with check for $10.00 by January 15 to:

Houston Geological Society
7171 Harwin Drive, Suite 314
Houston, Texas 77036-2190

Make checks payable to Houston Geological Society.

AD HOC COMMITTEE re GOVERNMENT AFFAIRS

The *Ad Hoc* Committee on Education regarding Government Affairs has acquired copies of PEP's write-up entitled "The Candidates Respond to the Presidential Questionnaire on a National Energy Policy." PEP is "People for an Energy Policy", a non-profit organization within the U.S. oil and gas industry chartered to promote, support, and educate the American public on the need for rational policies pertaining to energy-related issues. PEP's offices are located here in Houston (783-0480). The responses to these questions by President-elect Bill Clinton are included in this *Bulletin*.

I hope the questions and responses will be of interest to you. In brief, Mr. Clinton is: aware of the energy problem and concerned about the implications of reliance on foreign oil to U.S. national (i.e. military) and economic security; inclined toward conservation; for greater use of natural gas; for research to enhance the use of coal in ways that do not foul the environment; for greater use of alternative energy; against opening ANWR; for changes to remove AMT disincentives; reluctant to support drilling in new areas or environmentally sensitive areas. What presidents say and what presidents do (or are able to do) are different things. This document will provide a checkpoint against which you may compare the performance of the Clinton administration.

I thank PEP for their outstanding effort in formulating the questions asked of the candidates and for sharing the results of their efforts with HGS. They also deserve our thanks, as members of the energy community, for pursuing candidates Bush and Clinton (no easy task) and getting them to answer most of the questions. Next time, perhaps we can help PEP!

J. H. HOWARD,
Chairman

President-Elect Bill Clinton's answers to the P.E.P. PRESIDENTIAL QUESTIONNAIRE ON ENERGY POLICY—September 1992

A. STRATEGIC CONCERNS AND FOREIGN POLICY IMPLICATIONS OF U.S. OIL DEPENDENCE

1. To what extent do you believe that U.S. dependence on foreign oil supplies constitutes a serious threat to the security of the nation?

"Our reliance on foreign oil is a genuine threat to our national and economic security. When George Bush was elected, foreign oil made up a third of our trade deficit, and since then the U.S. has not had an energy policy. Now we import nearly half of our oil, which accounts for two-thirds of our trade deficit. Even James Watkins, the President's Secretary of Energy, has written that the U.S. imports much of its oil 'from potentially unreliable suppliers half a world away.' That kind of dependence makes us vulnerable, and we must change the situation.

We've sent more than 500 BILLION dollars to foreign lands to pay for oil during the Reagan-Bush years. Sending that money overseas undermines our domestic oil and gas industry and makes it less likely that we will seriously

explore conservation and alternative energy sources. Yet the President's top economic advisor calls the idea of energy independence 'economically foolish.'

What's foolish is failing to understand how our dependence on foreign oil and not having a national energy policy has seriously hurt our economy. Under a Clinton Administration, we will commit to changing this situation."

2. *Which, if any, of the following policies would you implement in an effort to reduce U.S. dependence on foreign oil supplies, and what PRECISELY would you propose with regard to each?*

   a) *Develop programs to ensure a significant expansion in U.S. oil and natural gas production.*

"America has huge gas reserves, gas is affordable, and it is clean-burning. As outlined above, the Clinton/Gore national energy policy emphasizes natural gas as an energy source, a policy which will reinvigorate our domestic energy industry.

Our current vulnerability to oil price shocks is due, in large part, to the control of international oil prices by foreign interests. This is a serious economic and national security problem, and it makes it difficult for our domestic industry to secure the capital it needs for expanded production. We will examine appropriate options for tackling our energy dependence problem and for stimulating our domestic energy production.

While we support offshore oil and gas drilling where it now exists, and believe those fields now in production should remain in production, we do not advocate expanding exploration or drilling into new areas or environmentally sensitive areas.

To spur domestic oil and gas production, a Clinton Administration will consider methods which effect both demand and supply. We strongly support a market-based approach to increasing the percentage of domestic energy in the overall U.S. energy mix.

Perhaps the best thing that can be done for domestic production is restarting the American economy and getting capital back into the system. That will be the first priority of a Clinton Administration."

   b) *Set clear ceilings on foreign oil imports.*

"The Clinton/Gore energy policy stresses developing new ways to use the energy sources we already have — including domestic gas and oil — conservation, efficiency, and exploring alternative and renewable sources.

A Clinton Administration will make natural gas a major priority.

We will encourage the use of natural gas for power generation and automobile fuel, and we will convert to natural gas-power the huge Federal vehicle fleet. We will help create new distribution systems for gas, especially to serve new markers.

Continued on page 39

SPECIAL COURSE OFFERING FROM THE GSH CONTINUING EDUCATION COMMITTEE: "RESERVOIR GEOPHYSICS"

Mark your calendars! The Continuing Education Committee of the Geophysical Society of Houston plans to offer a Reservoir Geophysics course on January 6 and 7, 1993. This is a "sneak preview" of the course that will first be offered through the SEG at the Fall 1993 meeting in Washington.

This course explains what geophysicists, geologists, and engineers need to know to develop their models and how geophysical methods can assist in developing and producing hydrocarbon fields more efficiently.

The SEG book, **Reservoir Geophysics,** will be the course textbook and is included in the course price.

The course will be held in the Exxon Auditorium and will have Bob Sheriff, Alistair Brown, Jim Justice, and Bob Hardage as instructors.

Cost for the course will be $200 for those who register before December 1, 1992 and $220 for those who register after the deadline. If you have any additional questions, please contact John Sumner at 297-7017.

REGISTRATION
"Reservoir Geophysics"
January 6-7, 1993
Exxon Auditorium

Name _____

Address _____

_____

_____

Phone _____

Make checks for $220 payable to the Geophysical Society of Houston.

Geophysical Society of Houston
7171 Harwin Drive, Suite 314
Houston, Texas 77036

SEEKING NOMINATIONS FOR AAPG DELEGATES

Local AAPG members interested in serving as a representative from the Houston Geological Society to the AAPG House of Delegates should contact **Cy Strong at 464-5413 or Martha Lou Broussard at 527-4880 or 665-4428.** Members standing for election should be prepared to attend monthly luncheon meetings and the annual House of Delegates meeting held in connection with AAPG's National Meeting. Besides voting as a member of AAPG's governing body, other duties include developing information regarding eligibility of applicants for membership and for certification by AAPG's Division of Professional Affairs.

HUGH W. HARDY ELECTED GSH PRESIDENT

Hugh W. Hardy, President of Interpretation Consultants, Inc. has been elected 1992-93 President of the Geophysical Society of Houston (GSH). The Society is the largest section of the international Society of Exploration Geophysicists, with a membership in Houston of 2,112.

Other newly elected GSH officers are — **President-Elect: Thomas K. Fulton,** Consultant with Seismic Solutions; **First Vice-President: William L. Baker,** Consultant; **Second Vice-President: Robert C. Bunch,** Staff Geophysicist with Mobil Oil; **Secretary: Richard M. McFarland,** with the Marketing Department of Western Geophysical; **Treasurer: Joe Alcamo,** Senior Exploration Advisor with Ashland Exploration, Inc.; and **Editor: David Forel,** Geophysicist with Western Geophysical.

NACSN ANNOUNCES NEW OFFICERS

The North American Commission on Stratigraphic Nomenclature announces that Donald E. Owen, Department of Geology, Lamar University, Beaumont, Texas, was elected Chairman and Donald G. Cook, Institute of Sedimentary and Petroleum Geology, Calgary, Alberta, was elected Vice Chairman for 1992-93 at its annual meeting in Cincinnati, Ohio on October 28, 1992.

KENTUCKY IMPLEMENTS GEOLOGY REGISTRATION LAW

Pursuant to the provisions of KRS 322A.020, Governor Brereton Jones has appointed members to the Kentucky Board of Registration for Professional Geologists. These appointments were received in early August.

The Board is in the process of setting up the necessary State Government accounts, promulgated administrative regulations, and composing the application forms relating to the "Grandfather" period. The "Grandfather" period as set forth in the statute is from January 10, 1993 through January 9, 1994.

Qualifications required of the "Grandfather" applicants are as follows:

(a) Baccalaureate degree in geology, geophysics, geochemistry, or geological/geotechnical engineering from an accredited college or university plus five (5) years of professional geologic work. The board may give one (1) year of credit each for a master's or doctoral degree in the above disciplines in counting years of experience. During the twelve (12) month period January 10, 1993, through January 9, 1994, the Board shall waive the examination requirement for applicants qualified by education and experience.

(b) The Board may waive the education requirements for persons who derive their livelihood from the public practice of geology who do not meet the education requirements, but who can demonstrate to the satisfaction of the Board their competency and who have at least eight (8) years of experience in professional geologic work.

In order to qualify for registration after January 9, 1994, an applicant shall meet all of the requirements in part (a), plus successfully complete an examination designed by the Board to demonstrate the applicant's knowledge and skill required to exercise the responsibilities of the public practice of geology.

Starting January 10, 1994, it shall be unlawful to engage in the public practice of geology or to offer to publicly practice geology in this Commonwealth without being duly registered as a professional geologist.

The nonrefundable application fee is $200. Renewal will not be required prior to January 10, 1995, regardless of registration date. Application forms for registration may be obtained only by writing the address below. Requests will not be taken by phone.

Kentucky Board of Registration for Professional Geologists
228 Mining and Mineral Resources Building
University of Kentucky
Lexington, KY40506-0107

SIPES MEMBERSHIP DRIVE

The Society of Independent Professional Earth Scientists (SIPES) is an association of self-employed earth scientists whose members have been certified by the governing body of the Society as to professional competence and professional ethics. It is the only national organization of self-employed geologists, geophysicists, and engineers primarily involved in domestic energy exploration and development.

If you have twelve years of professional experience and have freedom of choice of clients, you may qualify for membership in SIPES. College degrees may be used as a portion of the experience requirement. Other requirements are similar to those for AAPG Certification. If you are AAPG Certified, there is a reciprocal clause that streamlines admission to SIPES.

SIPES is concerned with the spectrum of technical, economic, and policical factors that affect all of us.

National dues are $60.00/year. Houston Chapter dues are an additional $25/year.

For more information, please contact SIPES Membership Chairman C. David Martin, 496-3488.

FORUM ON MWD EVALUATION/DRILLING APPLICATIONS

The International MWD Society is sponsoring a Forum on MWD Evaluation/Drilling Applications on February 3, 1993 at the Petroleum Club, New Orleans, Louisiana. Topics to be covered are: data acquisition, resistivity measurements, nuclear measurements, pore pressure evaluation, and drilling efficiency. The forum will conclude with a panel discussion. "Should We Run MWD? Yes/No/Maybe". The cost, $40.00, includes a buffet lunch. For advance registration, send fee along with return address and phone number to:

William Hendricks, IMS Treasurer
C/O Sperry-Sun Drilling Services
P.O. Box 60070
Houston, TX 77205
(713) 987-5396

Clinton Policy, continued from page 36

This emphasis on natural gas will have huge economic benefits for the American energy industry, for American consumers, and for the environment.

A primary goal of the Clinton/Gore National Energy Policy will be reducing the amount of foreign oil consumed in America. More than two-thirds of our trade imbalance is attributed to oil imports, and we must establish a policy to substitute domestic oil and gas, conservation, and efficiency for foreign energy sources. Our goal is to make a significant reduction in imports."

c) Add significantly to the Strategic Petroleum Reserve.

"The SPR is America's front-line defense against price and supply shocks that are created by international oil disruptions. A maximized SPR is a good energy and economic policy and we should continue steadily, strengthening the SPR."

d) What OTHER policies would you propose to reduce U.S. dependence on foreign oil?

"A Clinton/Gore Administration will create market-based incentives to encourage the use of domestic fuels, to encourage increased conservation and energy efficiency, and to develop renewable energy resources. Every new use of a cubic foot of domestic natural gas, every compact fluorescent light bulb that replaces an incandescent bulb, every reduction in the cost of solar energy translates to less imported oil and more American money staying at home, putting Americans to work.

One big start toward implementing these programs will be to get the American economy moving again, which will increase markets for domestic natural gas. We also will foster that increase in markets by removing regulatory impediments to gas use. We will restore adequate funding for research, development, and demonstration of renewable energy sources — funding that the Bush and Reagan administrations cut."

3. *How would you assess the U.S. Department of Energy in terms of its effectiveness in implementing policies designed to reduce U.S. dependence on foreign oil supplies?*

"For 12 years DOE has failed to develop a comprehensive national energy strategy and one result of that failure is a 50 percent increase in foreign oil imports since 1986.

We need to realign DOE's budget priorities, stressing research into better methods of exploiting domestic resources, developing alternative and renewable energies, and energy efficiency.

Efforts to reduce imports have been blocked by economic advisors like Michael Boskin, chairman of Mr. Bush's Council of Economic Advisors. Mr. Boskin told the Association of Drilling Contractors that any U.S. policy directed at promoting energy independence would be 'economically foolish,' and 'large-scale substitution of high-cost domestic energy for low-cost imported energy could significantly slow economic growth.'

Tell that to the half-million energy industry workers who have lost their jobs during the 1980's. If DOE had been busy assisting the creation of a domestic energy industry based on domestic resources, efficiency, conservation and alternatives, these workers might still have jobs."

B. STATES RIGHTS.

1. *Do you believe states that are carrying the bulk of the nation's demand for energy are receiving equitable compensation for the depletion of their non-renewable resources?*

"No Comment."

Continued on page 60

AAPG CORNER

HOUSTON HOUSE OF DELEGATES

To aid the members of the Houston Geological Society who are also members of AAPG in contacting their local delegates, we are listing our delegates with their business affiliations and phone numbers. We urge you to contact any of these people if you have a question, suggestion or complaint.

David Advocate/Exxon 591-5206
John F. Allen/Shell 870-2705
Bruce Archinal/Pogo 297-5061
Sandi Barber/Tema 723-1480
Jim L. Barr/Pennzoil 546-4246
Jim L. Becnel/Consultant 353-0359
Bart Birdsall/North Central 974-4600
Paul Britt 341-6200
D. Robert (Bob) Brogdon/Marathon 296-3029
Robert O. (Rob) Brooks/TGS 951-0853
Martha Lou Broussard 665-4428
David C. (Dave) Callaway 589-7923
Paul J. Cernock/Reservoirs, Inc. 932-7183
Marilyn Taggi Cisar/Shell 870-2162
Gerald A. (Jerry) Cooley/Petcons 665-8432
Robert Dawson/Wagner & Brown 951-9200
Jeff Dravis/Dravis Interests, Inc. 667-9844
Marc B. Edwards/Consultant 668-5488
James (Jim) Enyeart/Consultant 497-1936
Bruce Falkenstein/Amoco 556-2038
Wayne Gardiner/Amoco 556-3070
Pat Gordon 556-8170
Samuel C. (Sam) Guy 496-1496
Ron Harlan 782-3274
William F. (Bill) Howell 951-7370
Robert K. (Bob) Johnson 864-3787
Franklin C. Jones/Double J 464-1384
Jim Lantz/Amoco 556-4454
Terry Leyenberger/Exxon 973-3268
Carol M. Lucas 895-9055
Jeffrey W. Lund/Ashland 531-2900
Robin Lyon 650-1051
Jeannie Fisher Mallick/Pohlman 496-6700
David Mason/Chevron 492-6311
Thomas T. (Tom) Mather/Columbia Gas 871-3326
Tom McCarroll/Santa Fe 783-2401
Ray Metter 468-0351
Richard Mills 444-4214
Evelyn W. Moody/Consultant 789-5999
Dwight (Clint) M. Moore/Anadarko 874-8730
Harry W. Mueller/Exxon 965-4161
Richard L. Nagy 251-3208
Ronald E. (Ron) Neal, Houston Energy 445-4791
Charles R. (Chuck) Noll, Jr. 621-2171
Mary Page 367-4061
William K. (Bill) Peebles/Tejas 951-3441
Philip W. (Phil) Porter/Consultant 668-6752
Bill Roberts/Hydrexco 465-2228
James Ruffin 661-1884
Joe Samuels/Independent 939-8791
Steve Shirley/Unocal 491-7600
Jerry M. Sides/Sidesmore 465-0394
Daniel L. (Dan) Smith/Independent 558-8080
Marvin Smith 658-8333
Synthia E. Smith/Exxon 680-6352
John Spaid/Marathon 629-6600
Cyrus (Cy) Strong 464-5413
Richard Tannehill/Pogo 630-4773
Ken Toedter 869-8222
Susan (Sue) van Gelder 466-3348
Jeffrey E. Walter/Samedan 876-6200
Glen Ware 496-5127
Jerry Watson/GECO-PRAKLA 596-1803
Roy Worrell 358-7435

HARRY MUELLER

CALL FOR PAPERS ON GEOTECHNICAL ASPECTS OF RECENT EARTHQUAKES

Third International Conference on Case Histories *in Geotechnical Engineering*
St. Louis, Missouri June 1-6, 1993

Papers are solicited from authors on liquefaction, spreading, failure of dams, landslides and other geotechnical engineering aspects of recent earthquakes. The following deadlines are suggested:

1. 1-page Abstract — January 15, 1993
2. 4-page manuscript — April 15, 1993

Special sheets and instructions for preparation of manuscripts will be sent in February 1993 to authors whose papers are accepted.

The following lectures will be presented on June 2:

1. "Ground Motion Attenuation and Amplification During Recent Earthquakes." Professor I. M. Idriss, University of California-Davis
2. "Geotechnical Studies and Damage During Manjil Earthquake, Iran." Professor Kenji Ishihara, University of Tokyo
3. "Soil Amplification Effects and Liquefaction During the Armenian Earthquake" by M. K. Yegian, Northeastern University, Boston, Massachusetts

There will be short briefings of two or three other recent events.

A preprint volume will be issued during the conference and the final volume III will contain all the accepted papers. For further details, please contact Shamsher Prakash, Conference Chairman, (314) 341-4729.

HOUSTON GEOLOGICAL AUXILIARY

Wow! Those two go-getters, Jeanette Coon and Hjordis Hawkins are planning literally the party of the decade — LUCKY 'N LOVE! What a way to treat your sweetie on Valentine's eve, February 13: dancing to Charlie Prause's renowned band, casino games staged by Casino Parties, Unlimited, continuous hors d'oeuvres, and a big breakfast buffet to climax this fun evening at the Briar Club...a double whammy since all profits to our HGS Scholarship Fund. THIS IS OUR ONLY FUND-RAISER OF THE YEAR. Our thanks in advance to those three "angels": Core Laboratories for the casino games, Schlumberger for funding the band, and Southwest Airlines for donating two round-trip tickets to Las Vegas for some lucky winner.

Listen up, all you oil patch people: Put on your BLACK JACKET, "ROULETTE" (rule out) any other plans for February 13 and don't take a CHANCE on missing the fun. You're simply not operating with a FULL DECK if you miss this one! It's in the CARDS for you to come, and I'm BETTING it will be a FULL HOUSE! It's the best DEAL in town!

* * * * * * * * * * *

Bouquets of roses to Chairmen Terry Pooser and Daisy Wood for our Christmas party in December at Braeburn Country Club. The food, fun and fellowship were truly in the spirit of Christmas. Thanks and well done, Daisy and Terry!

GWINN LEWIS, President

GEO—WIVES

The first 1993 meeting of Geo-Wives is scheduled for January 20 at 10:00 a.m. beginning with a tour of the Bayou Bend Museum in the Tenneco Building (1010 Milam). A luncheon will follow at Noon in the Plaza Club (910 Louisiana).

The February activity will be a luncheon and style show at Two Friends Tea Room in Missouri City. It is set for February 17 at 11:30 a.m.

For more information, contact Linnie Edwards at 785-7115.

Geo-Wives is the newcomers club for the HGA. Monthly activities allow HGA members of ten years or less to become better acquainted. Call membership chairperson Peggy Haueter at 1-251-1769 for details.

SUSAN McKINLEY, President

REMEMBRANCES

Otis B. Coulson, 66, Emeritus member - retired ARCO geologist, died November 13, 1992.

HGA MEMBERSHIP FORM

_____
(Your Name) (Spouse's Name)

Address _____

_____ Zip_____

Home Telephone _____

HGS Member's Company _____

(Dues are $15 per year, check payable to Houston Geological Auxiliary)

Send to: **Mrs. Shirley Gordon**
HGA Membership Chairman
3110 Briar Court
Sugar Land, TX 77478

HOUSTON GEOLOGICAL AUXILIARY

presents

A Casino Dance Benefit for the HGS Scholarship Fund

8:00- Hors d'oeuvres
Dancing, Gaming,
Cash Bar
11:00- Breakfast Buffet
11:30- Auction

RESERVATIONS BY FEB. 5th
Limit 250
$30 Members of HGS and HGA
$32.50 Guests

Black Tie Optional — Valet Parking

Make checks payable to HGA
Return to Janet Peppiatt
14301 River Forest
Houston, Texas 77029

Games Sponsored by:
Core Laboratories
Schlumberger
Southwest Airlines

DETACH AND RETURN BY FEB. 5th

Name_____ Spouse_____

Phone_____

Attending
No. Members ____
No. Guests ____

Amt. Enclosed _____

Guests' Names _____

HOUSTON GEOLOGICAL AUXILIARY
MEXICAN FIESTA

Guest of Honor Deputy Consul of Mexico
Juan Roberto Gonzalez

(L) HGA First Vice President
Lois Matuszak
(R) HGA President
Gwinn Lewis

Janet Peppiatt and Linnie Edwards

(L-R) Susan & Quentin Moore,
HGS President Pat Gordon

HOUSTON GEOLOGICAL AUXILIARY
MEXICAN FIESTA

(L-R) Connie Marmaduke and Terry Pooser

Past President Kathryn Bennett and
HGS Liaison, Bill Dupre'

Ambassadores International Ballet Folklorico

(L-R) HGA Third Vice President
Martha Lou Broussard and Mary Folk

FEATURE

POROSITY CALIBRATION OF MODERN POROSITY LOGS AND OLD NEUTRON LOGS, MABEE FIELD, ANDREWS AND MARTIN COUNTIES, TEXAS*

by Dennis W. Dull
Texaco Exploration and Production Inc.
Midland, Texas

ABSTRACT

The Mabee Field is one of three fields currently targeted for enhanced oil recovery utilizing CO_2 by Texaco in the Permian Basin. The purpose of the individual CO_2 groups was to provide an accurate reservoir description that would not only support the past history of the field, but would predict future reservoir performance and recoveries along with providing for the monitoring of the CO_2 miscible flood after its initiation.

One of the major tasks in the reservoir description was to determine the original oil in place utilizing all available log and core data. The purpose of this paper is to describe the method which was used to calibrate modern porosity logs to core and to normalize old neutron logs in order to obtain reservoir height or PHI*H.

The Mabee Field has 650+ old neutron logs of which about 75 cannot be used at all because they were stimulated with nitroglycerine. The Mabee Field also has about 150 modern porosity logs. In addition, approximately 85 wells have been cored at the Mabee Field, of which only 35 wells have the core report and no actual core for descritpion. All of the logs and core data have been digitized. Before the logs were sent out or digitization, all pertinent information such as logging company, tool model no., hole size, casing point, casing size and weight, source to detector spacing, etc. were recorded and entered on to a spreadsheet to be used in calibrating the logs to core porosity.

The log analysis, mapping and data base management necessary to obtain PHI*H were done on a personal computer. It could not have been accomplished within the incurred time constraints without it.

INTRODUCTION

The Mabee Field discovered in October 1943 coveres an area of 12,800 acres and is located east of the Central Basin Platform in the central portion of the Midland Basin (Figure 1). The Mabee Field produces from the San Andres Formation of Permian Guadalupian age. Although isolated from similar San Andres production, the favorable reservoir facies was draped over paleostructure/topography of early Pennsylvanian age.

The Mabee Field has produced over 90 million barrels of oil and is currently producing about 6,000 BOPD. The San Andres production is from a dolomite reservoir, a time-transgressive sequence that prograded from southeast New Mexico southward across the Midland Basin (Todd, 1976).

The San Andres of the Mabee Field is composed of six distinct facies typical of a sabkha-type environment such as found in the present day Persian Gulf.

The six facies are: supratidal (anhydrite rich, permeability barrier responsible for trapping the oil), oncolites/pisolites, subtidal, ooid, sandstone, and open marine. The productive sequence is almost exclusively confined to the subtidal and ooid facies.

The reservoir at the Mabee Field has been divided into three zones (Figure 2). Zone 1 is capped by a very thin clay-rich stratigraphic marker known as the "B". It is easily identified on the logs by its characteristic high radioactive gamma ray response. Below the "B" marker is the supratidal facies, composed of dolomite, nodular anhydrite, and stromatolitic laminae. Below the supratidal facies is a mixture of subtidal mudstone to wackestone to peloid packstones and subtidal oolite packstone to grainstones. Zone 2 is composed of primarily a sandstone and ooid facies. The sandstone facies, except on rare occasions when porosities reach 15%, is impermeable, non-reservoir rock. The sandstone facies can generally be identified on the logs by its associated high gamma ray response when compared to the clean, low gamma ray of the ooids. Zone 3 is dominated by the ooid facies, vuggy porosity, solutioning, fractures and high porosities and permeabilities. Zone 3 typically produces high volumes of water with significant H_2S.

Zone 3 has produced considerable amounts of oil, but because of the high porosities and permeabilities will not be flooded because of the potential for thiefing of the CO_2. The interval to be flooded, gross pay, as used in this paper averages 115 feet in thickness and consists of Zones 1 and 2 and exludes the sandstones. See Figure 2.

*Reprinted with permission from Transactions, Southwest Section American Associaton of Petroleum Geologists, 1992 Convention (Publication SWS 92-90), David W. Cromwell, Mounir T. Moussa, Louis J. Mazzullo, eds., pp. 137-147.

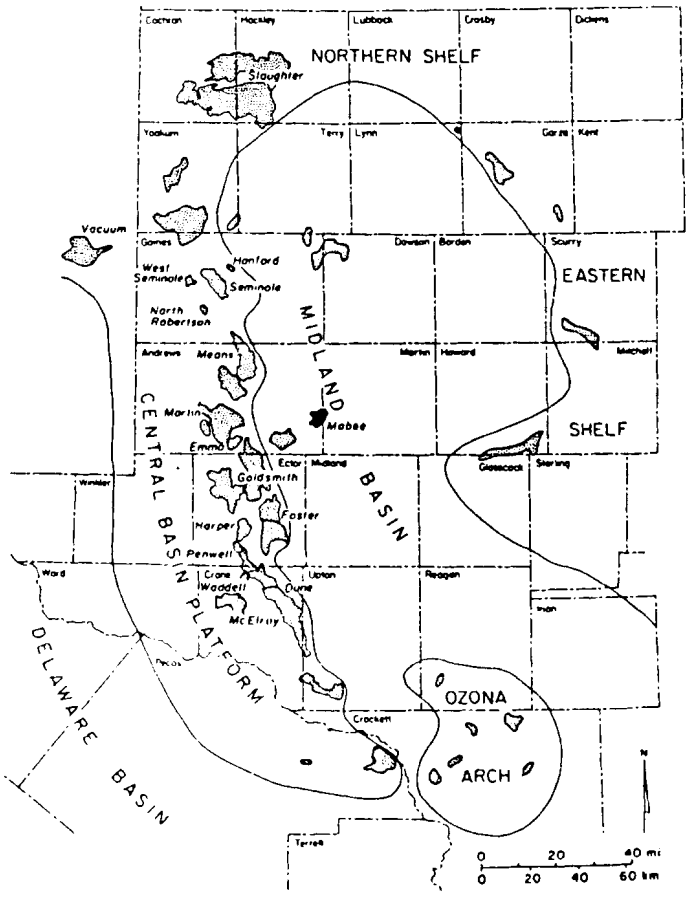

Figure 1. Map of a portion of the Permian Basin showing the location of the Mabee Field in the western-central part of the Midland Basin (from Bebout and Harris, 1990).

LOG ANALYSIS

The log analysis was completed in two steps utilizing those cores and logs over gross pay. The first step was the analysis of the modern porosity log versus core porosity. The second, was to establish a relationship between core porosity and old neutron log deflection.

NEUTRON-DENSITY LOGS

Log analysis software was used to crossplot core porosity (COREPOR) against neutron-density crossplot porosity (PND). (Figure 3). The regression work indicated that a first degree polynomial fit the data best (Figure 4). In other words, there was a linear relationship between neutron-density crossplot porosity and core porosity. Individual plots of COREPOR versus PND were made for 16 wells over gross pay. Equations of the line, slope and y-intercept, along with correlation coefficients were generated using the log analysis software. (NOTE: For statistical purposes, it is extremely important that the interval be large enough to be significant and correlative from well to well.)

The results of the linear regressions are shown in Table 1. All of the wells exhibit a high correlation coefficient (a correlation coefficient of 1.00 would indicate a perfect linear correlation). With the exception of A-1 #483, all wells were used in calibrating the PND curves to core. Well A-1 #483 has an anomalously low slope, but high correlation coefficient. This is believed to be the result of drilling with oil base mud, while all the other wells were drilled with brine.

Logging Company A used the same neutron and density tools, with the exception of A-1 #574 which had a slightly different neutron tool. The linear regression slopes varied from 0.708 to 0.996. The y-intercepts varied from 0.009 to 0.026. Company B also demonstrated similar variability even though using the same logging tools. Despite the variability in slope and y-intercept, the linear regressions had a high correlation coefficient.

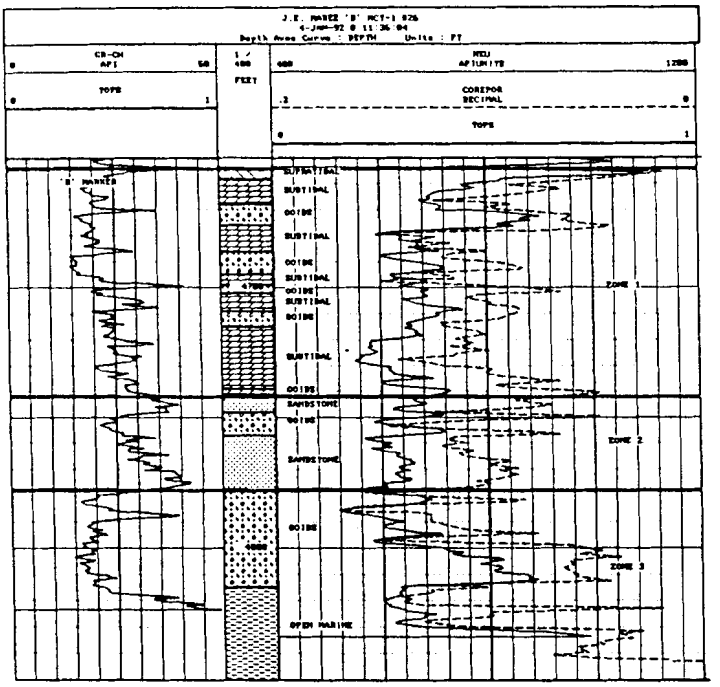

Figure 2. Type log for the San Andres showing the diversity of the facies and Zones 1, 2, and 3.

This variability in slopes and y-intercepts is attributed to the changes in geology (lithology, porosity types and percentages) and changes in salinity due to waterflooding with fresh water. In other words, the slopes and y-intercepts are more of a function of where the wells are drilled than the logging company. An example of this is Well A-4 #69 logged by companies A and B. The linear regressions generated slopes and y-intercepts that are very close. (Table 1).

If geology or location is the controlling factor, then mapping of the slopes and y-intercepts should reflect a gradual change across the field when contoured. In addition, slopes and y-intercepts should be predictable. Figures 5 and 6 are the maps of the slopes and y-intercepts of the linear regression of core porosity versus neutron-density crossplot porosity. Well A-1 #648 was cored and logged after the map was constructed. The map predicted a slope of 0.86 and a y-intercept of 0.014. Table 1 shows the actual slope and y-intercept to be 0.88 and 0.018, respectively.

DENSITY POROSITY VERSUS CORE POROSITY

Linear regression analysis was accomplished using the log analysis software for density porosity on a dolomite

TABLE 1
NEUTRON DENSITY CROSSPLOT POROSITY (PND) VS. CORE POROSITY

Well No.	Y-Intercept	Slope	Correlation Coefficient	No. Samples	Logging Company
A-1 483	.020	.615	.94	170	C
" 538	.025	.915	.90	129	B
" 539	.017	.838	.73	131	B
" 574	.002	.820	.94	170	A
" 597	.033	.803	.84	172	A
" 599	.023	.931	.93	183	A
" 601	.009	.943	.96	154	A
" 603	.021	.996	.95	186	A
" 604	.013	.836	.94	163	A
" 610	.026	.825	.90	69	A
" 616	.014	.848	.94	175	B
" 624	.009	1.007	.97	153	B
" 643	.012	.881	.95	115	A
" 648	.018	.880	.95	158	A
A-4 69	.020	.708	.95	74	A
" 69	.027	.715	.96	68	B
" 71	.006	.909	.93	154	B

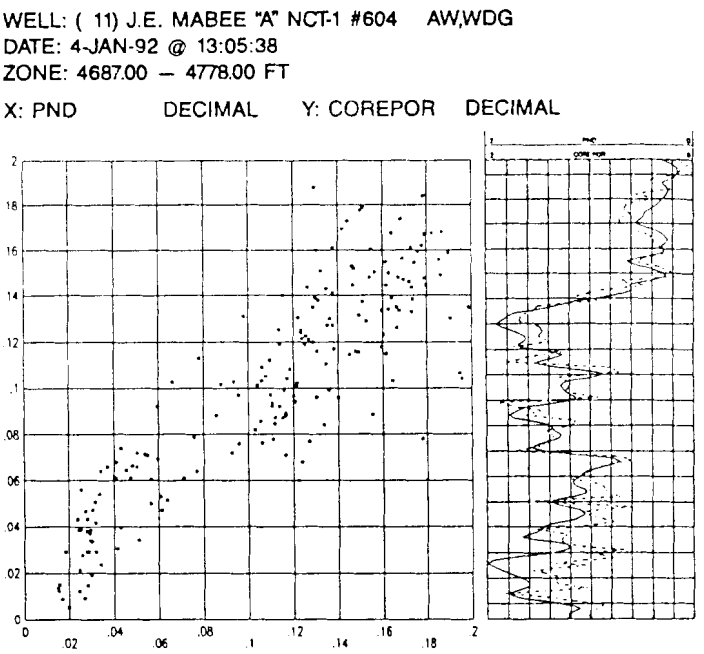

Figure 3. Crossplot of the neutron-density crossplot porosity (PND) vs. the core porosity (COREPOR).

matrix of 2.87 g/cm³ versus the core porosity. This was done for two reasons: first, was to verify that the density porosity had a good correlation with core porosity since the San Andres at the Mabee Field is a known dolomite reservoir. Second, the logging tools were stacked with the neutron tool on top leaving the bottom portion of the pay section with only the density porosity. (Figure 7). No rathole was obtained for logging because of the high water volumes encountered when drilling into Zone 3 and its high H_2S content.

Figure 8 shows the crossplot of the density porosity (PDDOL) against core porosity (COREPOR). Table 2 shows the slopes and y-intercepts of the linear regressions and their associated correlation coefficients for density porosity versus core porosity for 16 wells. The linear regressions showed a good correlation of density porosity when crossplotted with core porosity. Figures 9 and 10 show the gradual change of slope and y-intercept of the linear regressions across the field. As was found with neutron-density crossplot porosity versus core porosity, the slopes and y-intercepts are controlled more by where the well was drilled or geology than logging company. Again, A-4 #69 had similar slopes and y-intercepts for both logging companies A and B. (Table 2). In addition, as with the slopes and y-intercepts of the A-1 #648 of the neutron-density crossplot porosity versus core porosity, the linear regression of density porosity crossplotted against the core porosity had a slope and y-intercept very close to the predicted value from the maps. The predicted values of slope and y-intercept from the contoured values were 0.725 and 0.011 with the actual being 0.765 and 0.012.

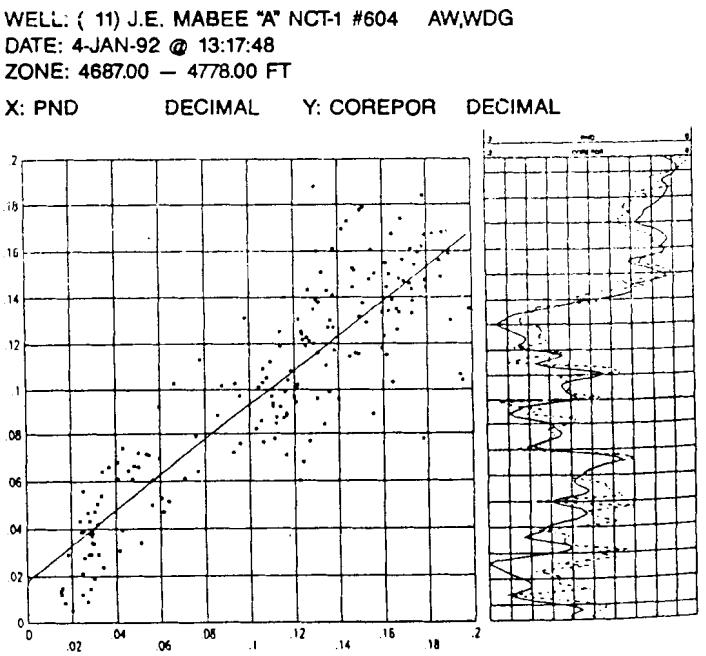

Figure 4. Crossplot, log, and linear regression of the neutron-density crossplot porosity (PND) vs. core porosity (COREPOR) for the J. E. Mabee 'A' NCT-1 #604.

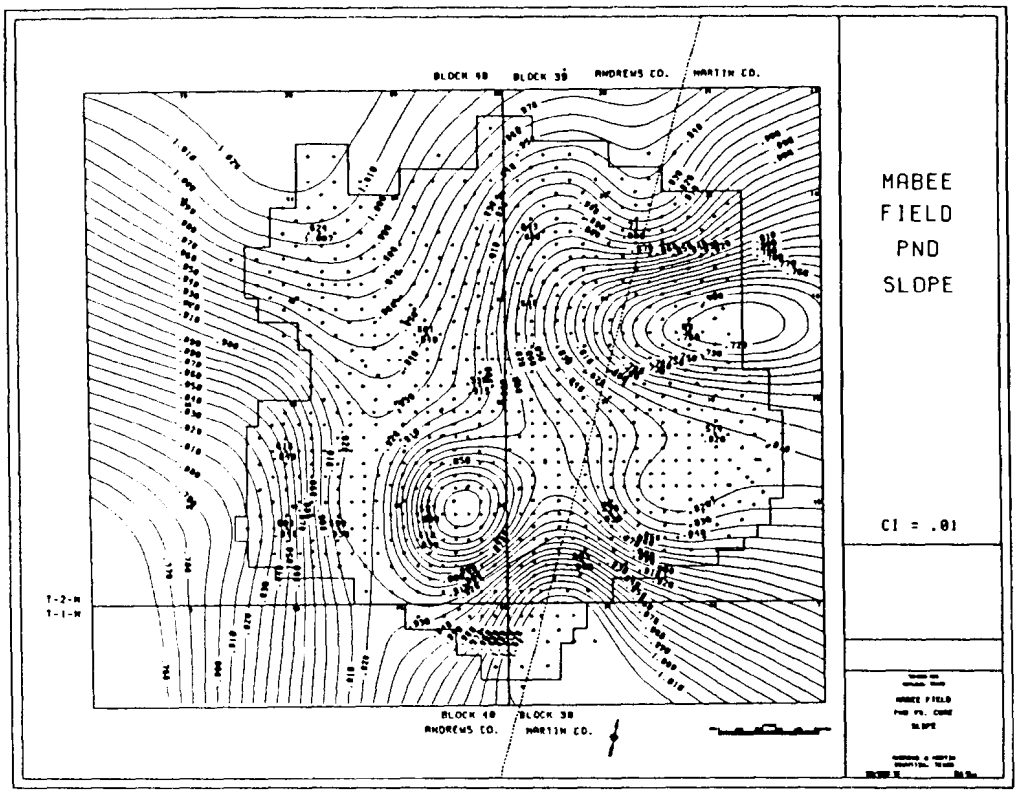

Figure 5. Map of the slope of the linear regression of neutron-density crossplot porosity (PND) vs. core porosity over gross pay.

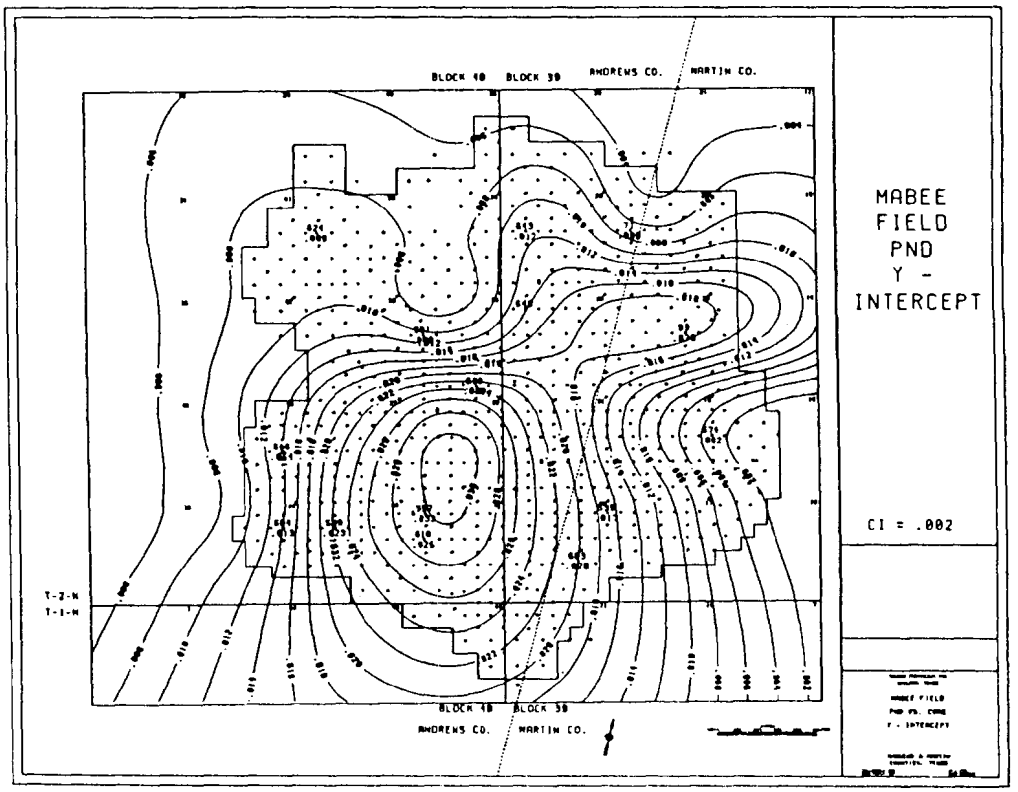

Figure 6. Map of the y-intercept of the linear regression of the neutron-density crossplot porosity (PND) vs. core porosity over the gross pay.

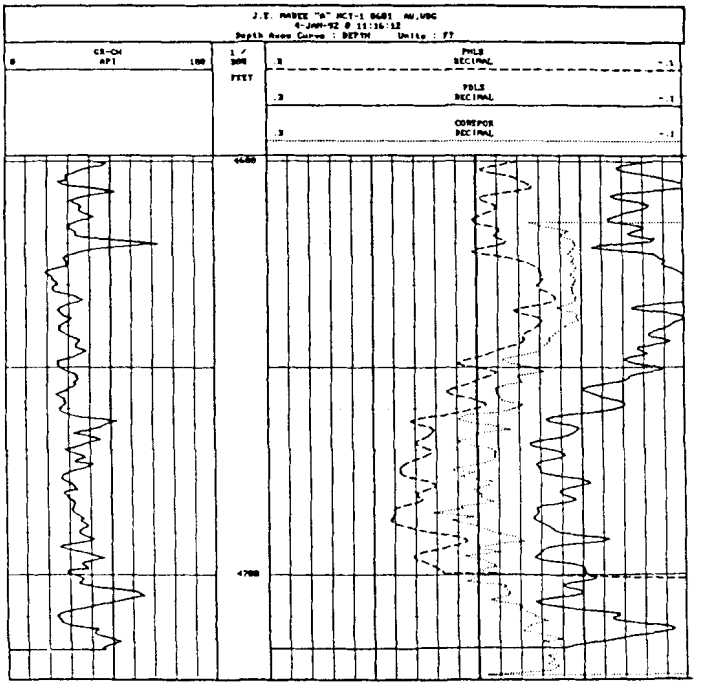

Figure 7. Log showing the neutron porosity not going to TD. (PNLS-neutron porosity limestone matrix, PDLS-density porosity limestone matrix, COREPOR-core porosity).

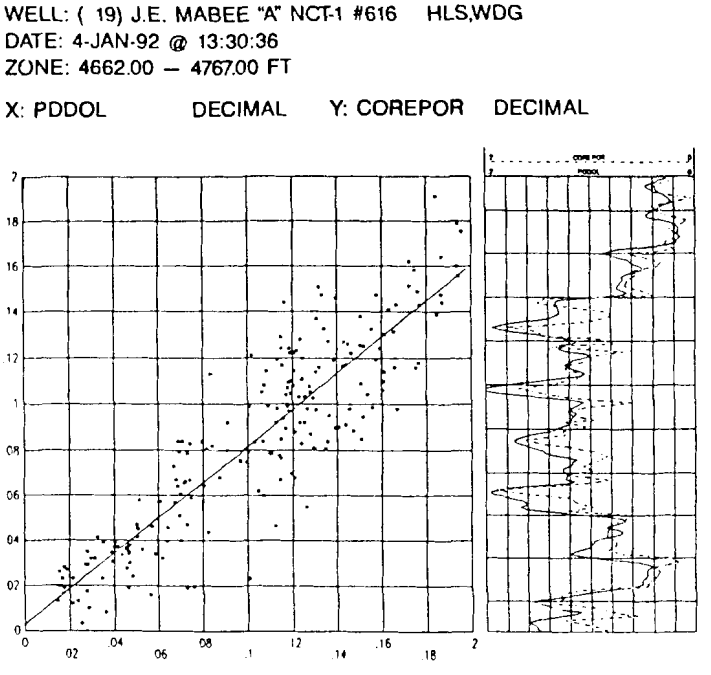

Figure 8. Crossplot, log, and linear regression of the density porosity-dolomite matrix (PDDOL) vs. core porosity (COREPOR) for the J. E. Mabee 'A' NCT-1 #616.

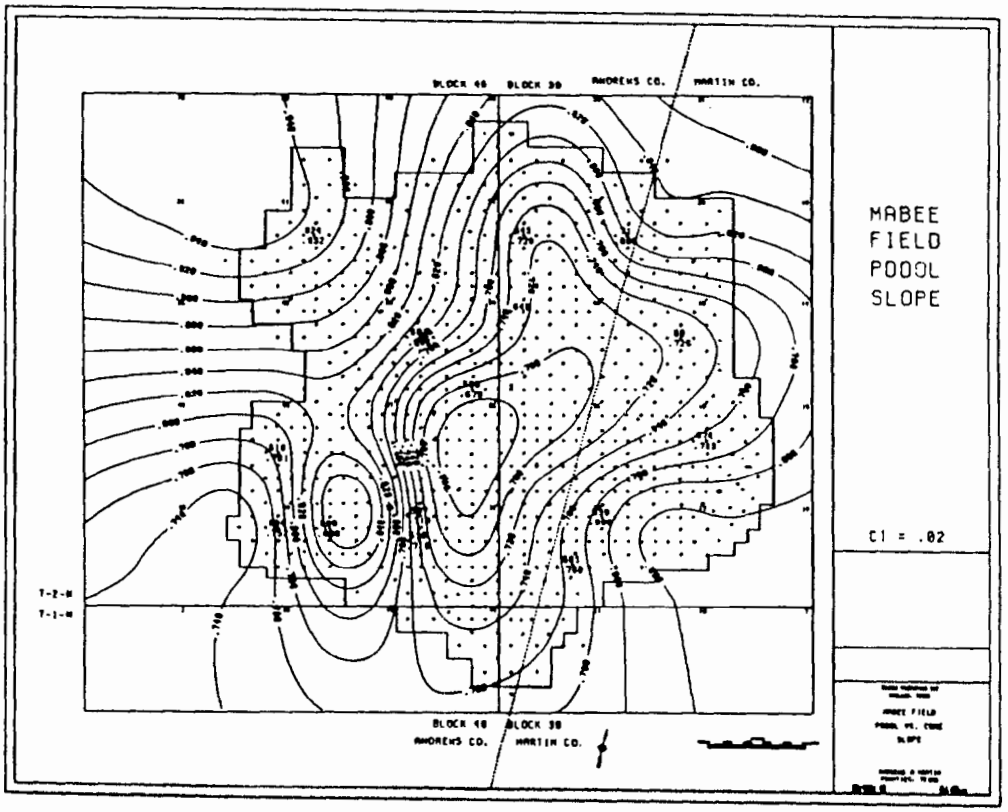

Figure 9. Map of the slope of the linear regression of the density porosity dolomite matrix (PDDOL) vs. core porosity over gross pay.

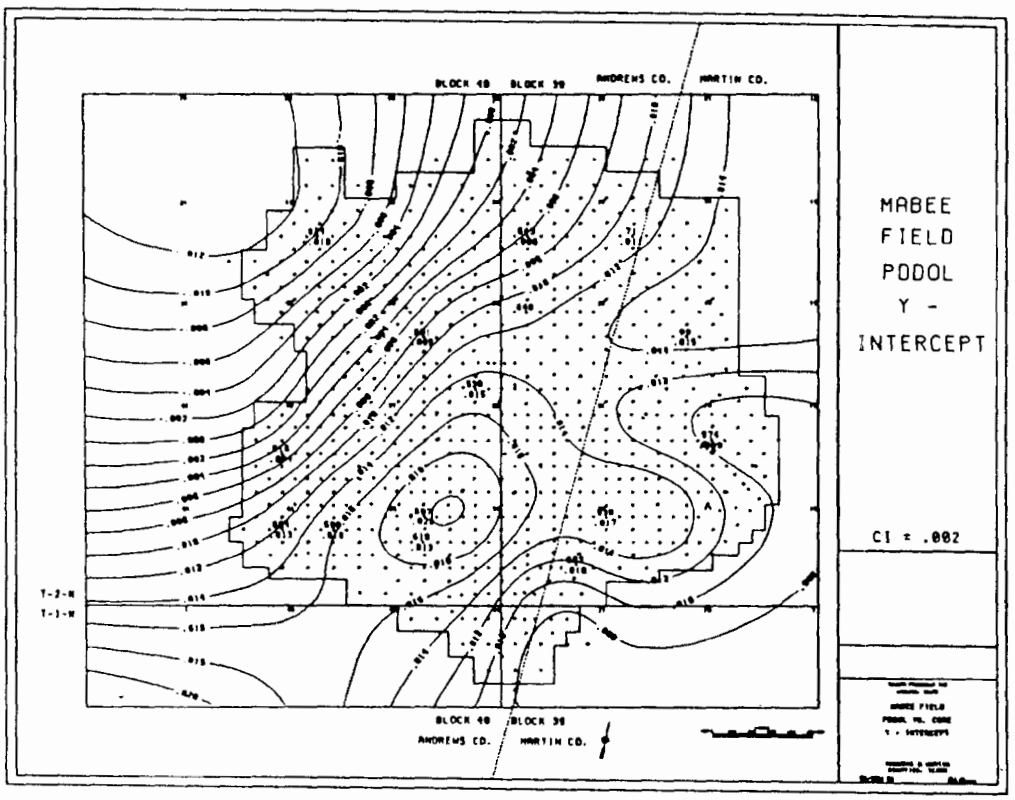

Figure 10. Map of the y-intercept of the linear regression of the density porosity dolomite matrix (PDDOL) vs. core porosity over gross pay.

TABLE 2
DENSITY POROSITY-DOLOMITE MATRIX (PDDOL) VS. CORE POROSITY

Well No.	Y-Intercept	Slope	Correlation Coefficient	No. Samples	Logging Company
A-1 483	.026	.489	.88	141	C
" 538	.015	.678	.92	123	B
" 539	.017	.788	.72	165	B
" 574	.009	.763	.88	155	A
" 597	.026	.710	.80	145	A
" 599	.016	.888	.93	182	A
" 601	.009	.806	.93	151	A
" 603	.010	.760	.92	169	A
" 604	.013	.752	.86	208	A
" 610	.013	.718	.80	145	A
" 616	.004	.781	.92	200	B
" 624	-.010	.932	.96	154	B
" 643	.006	.720	.83	87	A
" 648	.012	.765	.94	152	A
A-4 69	.015	.725	.898	148	A
" 69	.017	.715	.93	130	B
" 71	.011	.808	.89	148	B

TABLE 3
CASED HOLE COMPENSATED NEUTRON POROSITY-DOLOMITE MATRIX (PNDOLCH) VS. CORE POROSITY

Well No.	Y-Intercept	Slope	Correlation Coefficient	No. Samples	Logging Company
A-1 538	.041	.922	.80	121	C
" 539	.058	.600	.69	159	E
" 574	.039	.682	.91	152	D
" 594	-.013	.711	.85	192	B
" 599	.025	.642	.91	182	D
" 601	.028	.775	.91	125	D
" 603	.025	.890	.92	212	A
" 604	.032	.772	.91	205	D
" 610	.036	.819	.91	101	D
" 616	.027	.813	.92	207	D
" 624	.017	.924	.94	158	D
" 643	.028	.706	.92	150	D
" 648	.027	.723	.91	162	D
A-4 69	.035	.924	.94	184	A
" 69	.044	.730	.91	182	B
" 69	.047	.955	.92	170	C
" 69	.031	.517	.94	158	D
" 71	.032	.510	.88	153	D

CASED HOLE NEUTRON POROSITY VS. CORE POROSITY

The cased hole neutron porosity analysis did not exhibit the same relationship as the open hole porosity logs. Well A-4 #69 was logged by four different logging companies. Linear regressions of log porosity on a dolomite matrix (PNDOLCH) versus core porosity (COREPOR) were done. The slopes and y-intercepts show a significant difference (Table 3). Notice that all companies have a high correlation coefficient indicating a good linear response for each company's calculation of porosity. (Figures 11-14). It appears from this that the logging company does make a significant difference in the relationship between core and cased hole neutron log porosity. Therefore, mapping of slopes and y-intercepts regardless of logging company to convert log porosity to core porosity would not be possible. However, mapping slopes and y-intercepts by logging company would be a solution providing there is enough core and wells logged by a specific company. Figures 15 and 16 are the maps of the slopes and y-intercepts of Logging Company D.

TRANSFORMING LOG POROSITY TO CORE POROSITY

The log porosities were transformed to core porosity by using the slope and y-intercept for the contoured values and applying that transform to that specific well. In other words, instead of one transform for all the wells logged by a specific logging company, there would be a different transform, the pseudocore porosity was compared to the actual core porosity for all wells used in the analysis. (Figure 17).

Once this relationship had been established, the transforms were obtained from the maps and used to convert the log porosity to pseudocore porosity of any well in the field.

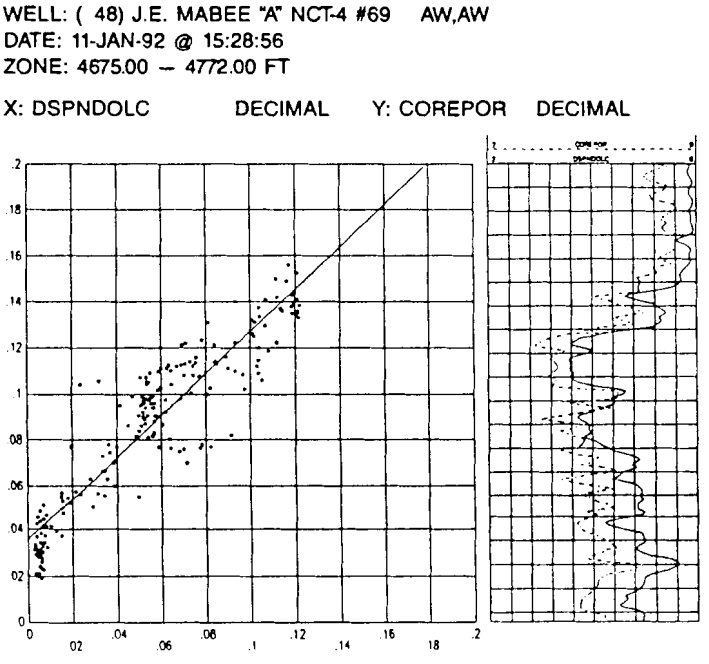

Figure 11. Crossplot, log, and linear regression of the cased hole neutron porosity-dolomite matrix (PNDOLCH) vs. core porosity (COREPOR) for Company A of the J. E. Mabee 'A' NCT-3 #69.

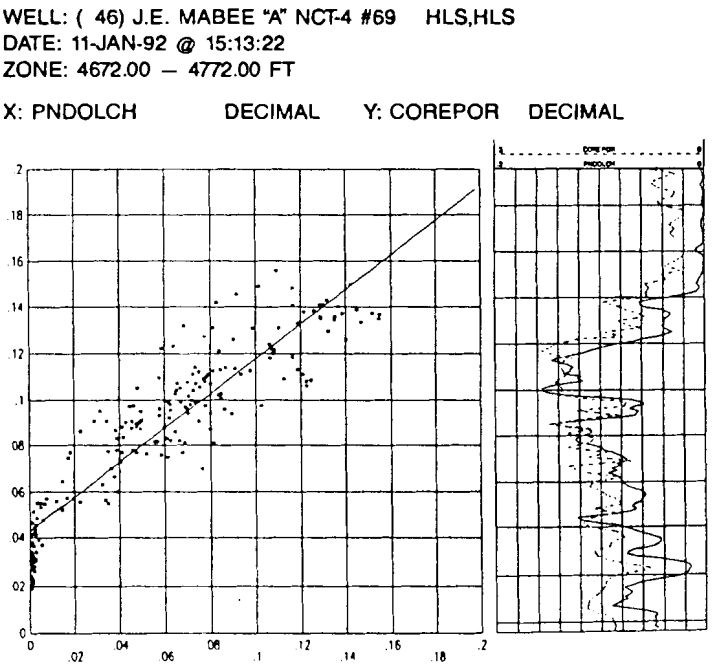

Figure 12. Crossplot, log, and linear regression of the cased hole neutron porosity-dolomite matrix (PNDOLCH) vs. core porosity (COREPOR) for Company B of the J. E. Mabee 'A' NCT-4 #69.

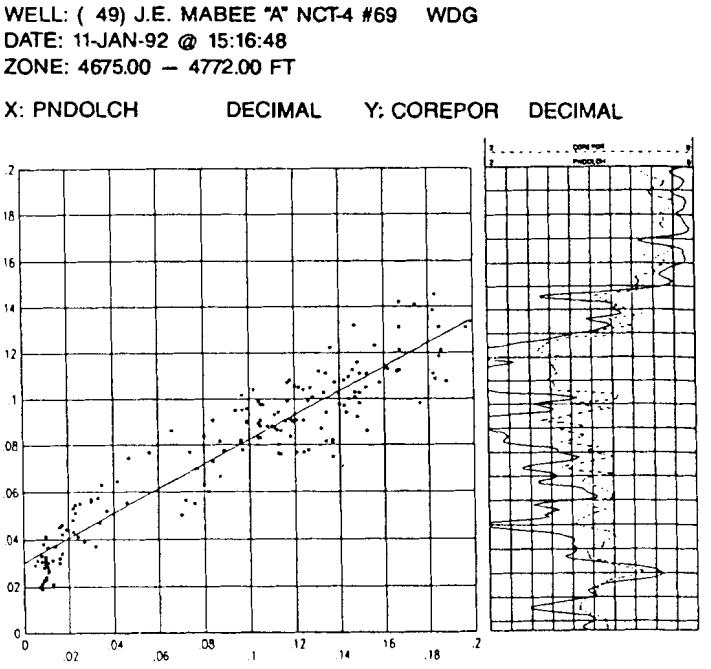

Figure 14. Crossplot, log, and linear regression of the cased hole neutron porosity, dolomite matrix (PNDOLCH) vs. core porosity (COREPOR) for Company D of the J. E. Mabee 'A' - NCT-4 #69.

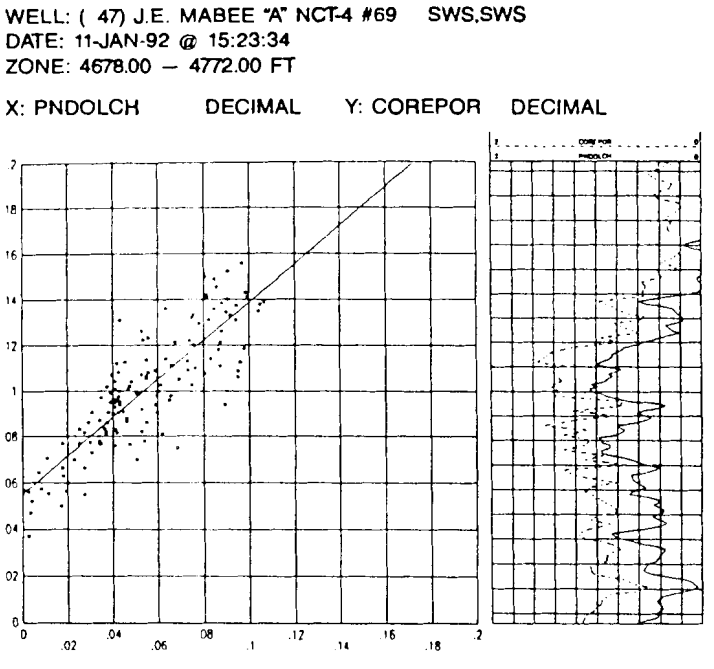

Figure 13. Crossplot, log, and linear regression of the cased hole neutron porosity, dolomite matrix (PNDOLCH) vs. core porosity (COREPOR) for Company C of the J. E. Mabee 'A' NCT-4 #69.

In regards to the cased hole porosity logs, there was only one well, logged by Company D, that went through gross pay. The maps of y-intercept and slope of Company D were the only ones necessary to convert its log porosity to pseudocore porosity. Table 4 shows the PHI*H of the cored wells to their core transforms.

OLD NEUTRON LOGS

The converting of log porosity to pseudocore porosity was necessary if any attempt to accurately convert the old neutron logs to porosity. The more core data, the better the control of porosity that could be applied to the old neutron logs. The ideal way to transform old neutron logs to core porosity is th have a core in every well, obviously that situation usually does not exist. However, there were 13 wells over gross pay with core and logged with old neutron logs.

The relationship between neutron log deflection and porosity was demonstrated by Brown and Bowers (1959). They discovered that there is an inverse linear relationship between porosity and the $\log_{10}$ of the neutron deflection measured from neutron zero. In Figure 18 an example of this relationship is shown.

In calibrating their neutron logs at SACROC (Swulius, 1986) discovered that he could use statistical descriptors in place of the entire core to obtain the same transform. Those statistical descriptors were the maximum, minimum and mean of core porosities vs. $\log_{10}$ deflections. The most unreliable descriptor was the relationship of the $\log_{10}$ of the

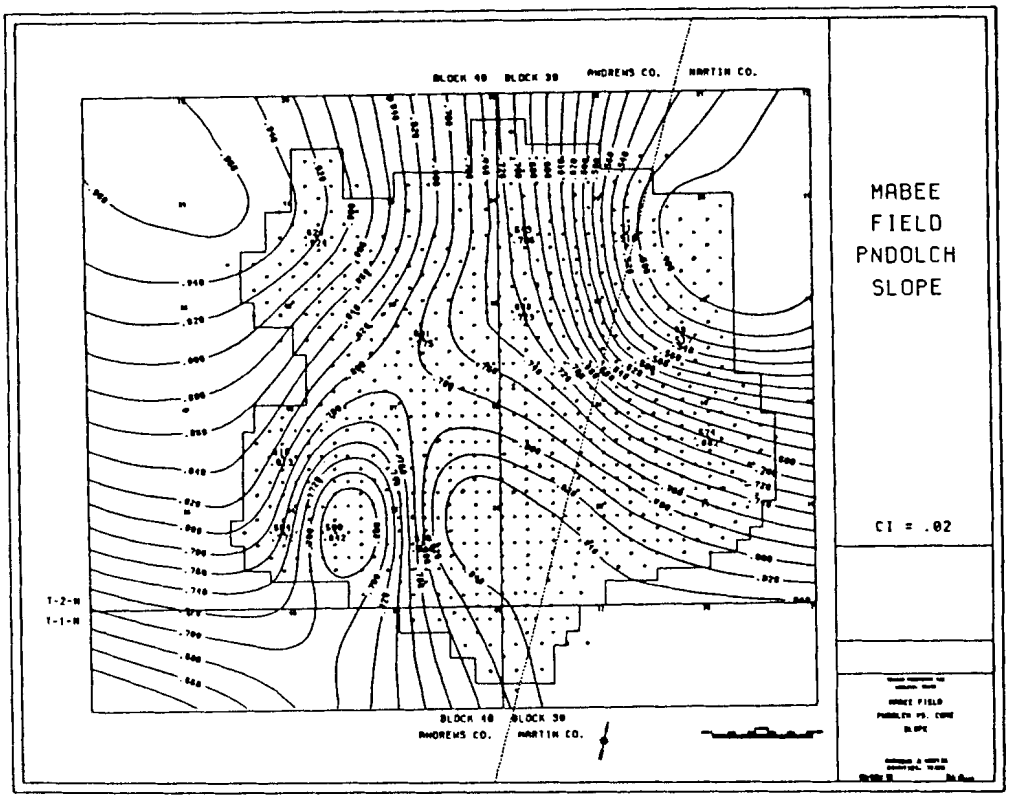

Figure 15. Map of the slope of the linear regression of the cased hole neutron porosity dolomite matrix (PNDOLCH) vs. core porosity over gross pay for Company D.

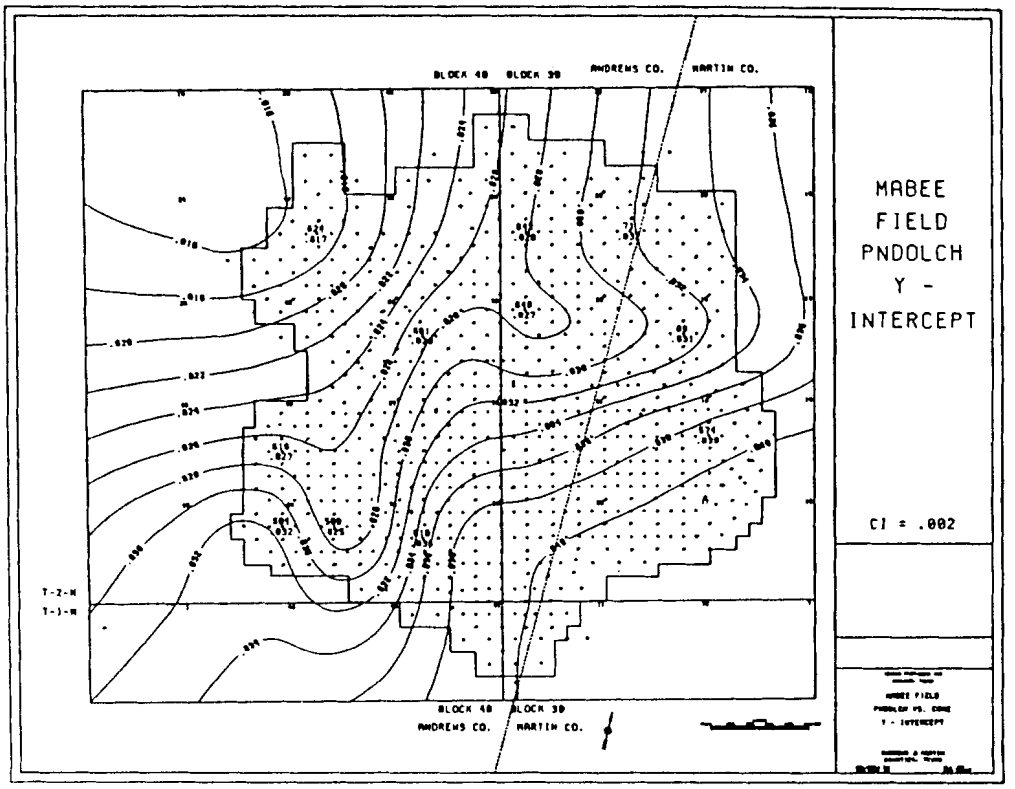

Figure 16. Map of the y-intercept of the linear regression of the cased hole neutron porosity dolomite matrix (PNDOLCH) vs. core porosity over gross pay for Company D.

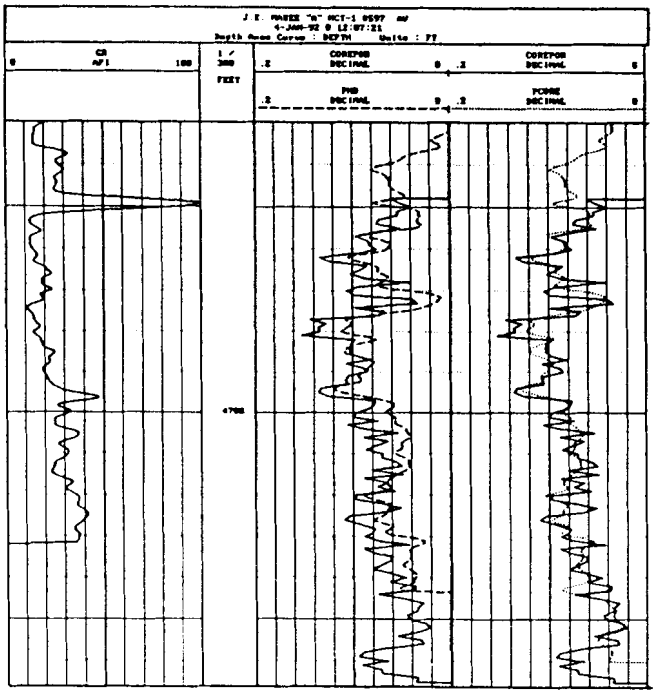

Figure 17. Log illustrating the improvement of the transformed neutron-density crossplot porosity (PCORE, pseudocore porosity) vs. core porosity (COREPOR) over the neutron-density crossplot porosity (PND) for the J. E. Mabee 'A' NCT-1 #597.

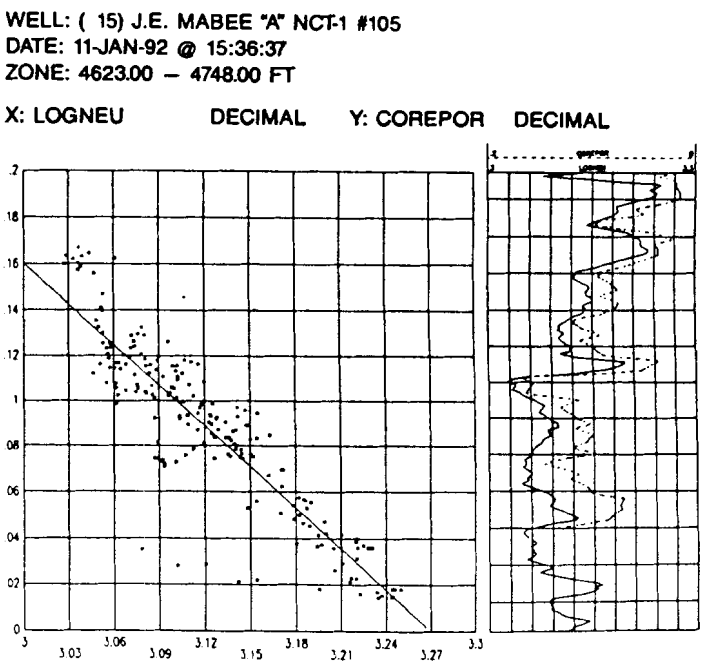

Figure 18. Crossplot, log, and linear regression of the $\log_{10}$ of the neutron deflection (LOGNEU) vs. the core porosity (COREPOR) of the J. E. Mabee 'A' NCT-1 #105 illustrating the inverse linear of relationship.

TABLE 4
COMPARISON OF PHI*H FROM CORE AND TRANSFORMED LOGS

Well No.	Log	Core	Logging Company
A-1 483	7.407	7.465	C
538	6.660	6.553	B
539	9.248	9.118	B
574	6.242	6.221	A
597	8.229	8.216	A
599	10.403	10.004	A
601	6.184	6.138	A
603	8.071	8.345	A
604	11.142	10.613	A
610	9.061	9.217	A
616	9.002	8.929	B
624	7.283	7.225	B
643	3.716	3.697	A
648	6.740	6.629	A
A-4 69	10.003	9.478	A
69	9.897	9.478	B
71	4.900	5.125	B

minimum neutron deflection to maximum porosity, probably in part due to the low count rates in the porosities.

Figures 19 and 20 show the linear regressions of two wells: using (1) core porosity vs. $\log_{10}$ deflection, (2) maximum, minimum, and mean values of core vs. $\log_{10}$ deflection, (3) mean and minimum of the log porosity vs. mean and maximum of $\log_{10}$ deflection, (4) mean and 0.015 (field minimum) porosity vs. mean and maximum of $\log_{10}$ deflection.

The two examples demonstrate that using field minimum porosity or minimum porosity and mean porosity vs. the mean and maximum of the $\log_{10}$ neutron deflection nets nearly the same result as using all the core data vs. the log data. In other words, the statistical descriptors worked as well as if all the data had been used. The significance of this, providing there is ample core data, is that the mapping of the mean porosity across the field would allow the calibration of any old neutron log to core regardless of logging company, tool model no., hole size, cased or open hole, etc. providing the neutron log is over gross pay. Table 5 presents the results of the regression of the 13 wells of core porosity vs. $\log_{10}$ deflection.

Table 5 demonstrates as Figures 19 and 20 illustrate that using the statistical descriptors of core (mean and minimum) is sufficient for obtaining the slope of the line, therefore, the transform for converting $\log_{10}$ deflection to porosity providing logs are over gross pay. Figure 21 is the map of mean porosity over gross pay (Zones 1 and 2) utilizing all core and pseudocore porosities.

There were 29 cores and 28 porosity logs employed in generating the mean porosity map. Of the 29 cores, 16 wells had both core and modern open hole porosity logs and 15 had cased hole neutron porosity logs. Thirteen wells had core porosity over gross pay with old neutron deflection curves.

All neutron logs over gross pay were transformed to porosity by crossplotting mean and maximum of $\log_{10}$

TABLE 5
LINEAR REGRESSION CORE POROSITY VS. LOG_{10} NEUTRON DEFLECTION

		All Core and Log Data					Mean and Field Minimum of Porosity		Mean and Minimum Core Porosity	
Well No.		Y-Intercept	Slope	Correlation Coefficient	Logging Company	Number Samples	Y-Intercept	Slope	Y-Intersept	Slope
A-1	105	1.947	-.595	.90	G	194	1.786	-.545	1.809	-.552
	305	1.792	-.530	.86	F	180	1.707	-.504	1.707	-.504
	356	1.245	-.354	.75	F	226	1.375	-.396	1.375	-.396
	361	1.570	-.464	.88	F	221	1.419	-.419	1.419	-.416
	380	1.726	-.507	.75	G	249	1.945	-.574	1.739	-.511
	481	1.528	-.449	.89	F	229	1.629	-.480	1.455	-.426
	488	0.747	-.243	.71	F	222	0.574	-.183	0.590	-.189
	494	1.143	-.347	.89	F	220	1.206	-.368	1.206	-.368
	495	1.185	-.368	.90	F	226	1.114	-.344	1.114	-.344
	503	0.911	-.298	.87	F	253	0.745	-.240	0.745	-.240
A-3	18	1.136	-.328	.93	F	229	0.899	-.257	1.017	-.292
B-1	26	1.127	-.365	.73	F	249	1.180	-.383	1.167	-.379
MFC	12	1.047	-.277	.84	F	181	0.869	-.288	0.869	-.228

neutron deflection against the mean (obtained from contoured value on the map Figure 21) and field minimum porosity (0.015). This generated a regression equation which then was applied to the log_{10} of the neutron deflection curve to transform it to porosity. Figure 22 shows well #105, which compares core porosity, core transform porosity, and pseudocore transform porosity (using maximum and mean log_{10} neutron deflection vs. 0.015 and mean porosity of the core data to generate an algorithm for neutron log transformation to porosity). Well #105 shows excellent agreement between the core transform porosity (TPNEU1) and transform porosity (TPNEU2).

SUMMARY AND CONCLUSIONS

1. The neutron-density and density porosity demonstrated an excellent linear correlation to core porosity that depended more on where the well was drilled than the logging company.
2. The relationship of neutron-density and density porosity to core porosity for any one logging company varies in the Mabee Field, reflecting changes in geology.
3. The cased hole neutron porosity log response displayed a good linear response to core porosity, but indicated a dependence on logging company.
4. The linear correlation of the cased hole neutron porosity log to core porosity for any one logging company varied across field as did the neutron density logs mirroring changes in lithology.
5. The neutron-density, density, and cased hole neutron porosity logs were transformed to pseudocore porosity utilizing the maps of the slopes and y-intercepts of the linear regressions of log porosity crossplotted against core porosity.
6. The old neutron logs exhibited an inverse linear response of the log_{10} neutron deflection when crossplotted against core porosity.
7. The statistical descriptions of mean and field minimum porosity (0.015) crossplotted versus the mean and maximum log_{10} neutron deflection generated nearly the same slope and y-intercept of the linear regression as applying all the core and log data.
8. The mapping of the mean porosity from the cores and the transformed porosity logs would enable the generation of a transform to convert log_{10} neutron deflection over gross pay to porosity.

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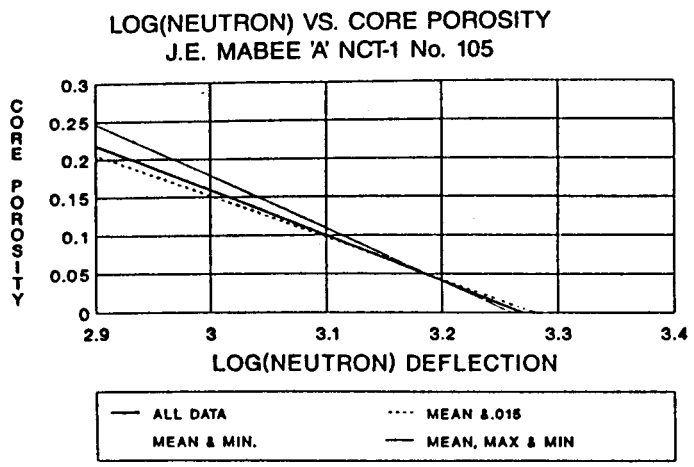

Figure 19. Linear regressions of the core porosity vs. $\log_{10}$ of the neutron for J. E. Mabee 'A; NCT-1 #105 comparing the use of all the data versus the statistical descriptors.

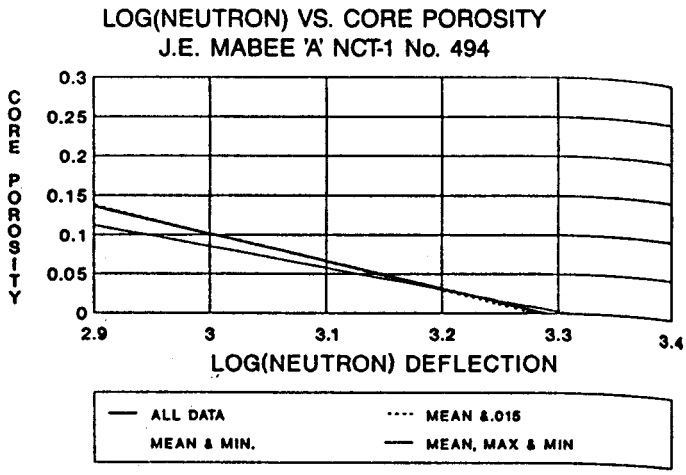

Figure 20. Linear regressions of the core porosity vs. $\log_{10}$ of the neutron for J. E. Mabee 'A' NCT-1 #494 comparing the use of all the data versus the statistical descriptors.

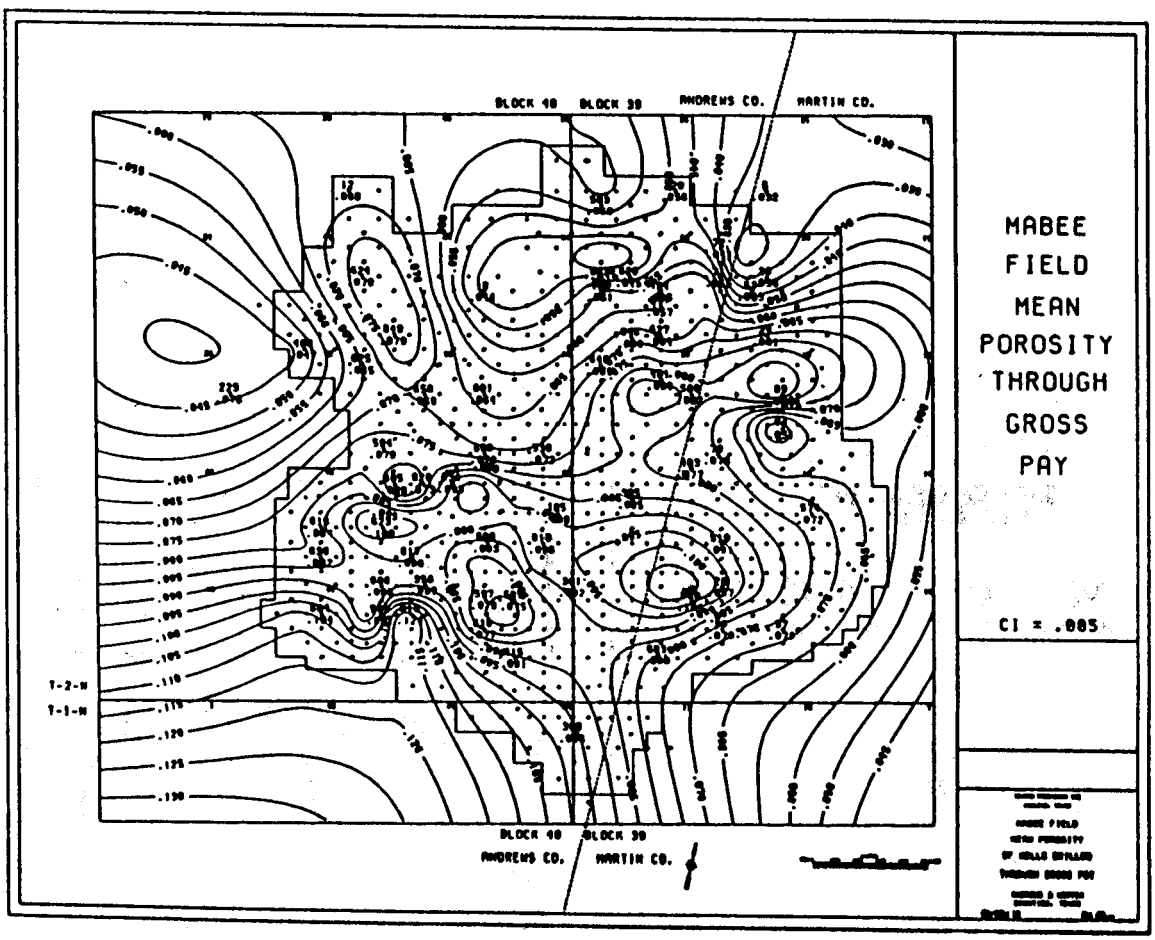

Figure 21. Map of the mean porosity of wells drilled through gross pay using all the core and calibrated porosity logs.

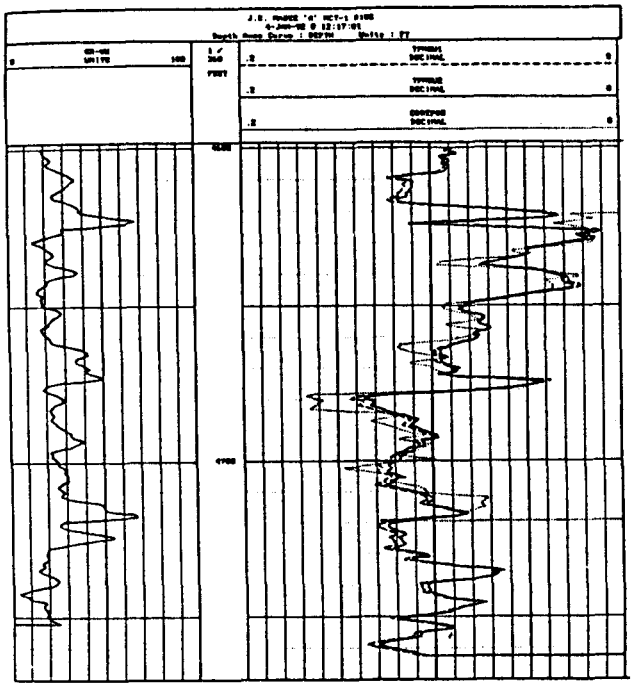

Figure 22. Log illustrating the difference between the two log transforms using all the core and log data (TPNEU1) and the mean and field minimum porosity of 0.015 (TPNEU2). NOTE: Both transforms closely follow the core porosity (COREPOR).

EXPLORATION ACTIVITY REVIEW

By Bill Eisenhardt
Consultant, Geol. Representative—Geomap Co.

National Rig Count: November 21—890; Year Ago—828
Gulf of Mexico Rig Count: 107

(Domestic activity is reviewed quarterly and will next appear in March.)

INTERNATIONAL HIGHLIGHTS

Provided by PETROCONSULTANTS, Foreign Scouting Division, Geneva, Switzerland

LATIN AMERICA

Brazil (Onshore)

In August, Petrobras made an oil discovery at wildcat 1-CER-3-BA (Cidade Entre Rios 3), 45 km (28 miles) ENE of Alagoinhas in the state of Bahia. Drilled to TD 1470 m (4823′) in the northeastern compartment of the **Reconcavo Basin,** the new find recovered an average of 2,200 BOPD (33.8° API) in tests of two zones, at 933-981 m (3061-3219′) and at 999-1014 m (3278-3327′). The reservoir is assumed to be in the **Lower Cretaceous.**

Brazil (Offshore)

In October, Petrobras announced its fifth oil discovery in the **Santos Basin.** Wildcat 1-BSS-64, located 10 miles SSE of the Coral Field discovery well, was drilled to TD 5394 m (17,698′) and tested 2,500 BOPD (43° API) from an undisclosed interval around 4900 m (16,077′), probably in the **Albian Guaruja** limestones. A second zone remains to be tested.

Chile

In September, state company Enap's technical operator Anderman Smith spudded Laguna Ema 1, its second wildcat in the Lago Mercedes permit. Objectives include not only the oiland gas-bearing **Springhill** Formation, but also the fractured **Permo-Triassic granites,** expected at a depth of about 4000 m (13,124′). Drillsite is about 3.7 miles northwest of the Marazzi gas/condensate field, and about 45 km (28 miles) northwest of the Lagos Mercedes 1 discovery, drilled earlier this year, which confirmed theories that an important gas/condensate play may be found in the fractured granites.

EUROPE

Netherlands

In the **Northwest German Basin,** NAM's Munnekezijl 1 was suspended as a major Slochteren gas discovery. The 4225 m (13,862′) wildcat was directionally drilled under the Lauwersmeer Estuary from the Noord Friesland permit into the northwestern part of the Groningen concession. The reservoir, in the **Rotliegendes** Formation, is approximately 6 ¼ miles north of the 1990 Grijpskerk gas discovery with recoverable reserves in the order of 500 BCF in the same formation.

Norway (Offshore)

Mobil's 35/11-7 wildcat north of Troll tested up to 7,875 BOPD and 13,770 MCFGPD from the Jurassic. Norsk Hydro's Barents Sea wildcat 7316/5-1, 130 km (81 miles) southwest of Bear Island, tested 19,880 MCFD dry gas from a shallow Tertiary pay.

AFRICA

Kenya

After a drilling hiatus of more than two years, exploratory drilling was resumed in September when the Shell/Amoco group spudded wildcat Eliye Springs 1 in Turkana Graben Block 10. Latest reports indicate that the test reached TD at 3000 m (9843′) and was D&A. A second drillsite is being prepared.

Morocco

In September, the SCP-Onarep partnership spudded wildcat Oulad Brih 1 (OLB-1) in the Sidi Slimane convention area, marking the first drilling onshore Morocco in nine months. The well reached a total depth of 990 m (3248′) and was completed after testing gas in **Miocene** sands.

NEAR EAST

Oman

PDO suspended wildcat Nawal 1st as an oil discovery in southern Oman. The new find, drilled in the **Eastern Flank Sub-basin,** bottomed at TD 1800 m (5906′), and probably found oil in sandstones of the **Permian-Carboniferous Haushi** Group. Location is 9.3 miles southeast of the Mukhaizna North Field and 1 ¼ miles SSE of the Ghanimah 1 oil discovery (1989).

Syria

Elf Aquitaine made a fourth oil discovery in its Deir ez Zor exploration permit in the **Euphrates Graben.** Substantial flows are reported from wildcat Qahar 101, drilled to TD 3373 m (11,067′) in the eastern part of the permit, halfway between the Saban and Tayyani East fields. The **Cretaceous Rutbah** Formation constitutes the main play in the area.

FAR EAST

Malaysia (Offshore)

Off Sarawak, Occidental Petroleum confirmed the Jintan 1 gas discovery, located in license SK-8. Outpost Jintan 2 yielded 64,400 MCFGPD and 620 BCPD from 164′ of perforations below 1610 m (5282′). The appraisal confirms in place reserve estimates of 4 TCF gas and 75 MMB condensate from a large **Upper Miocene** carbonate reef.

Vietnam (Offshore)

The first well drilled in Vietnam by Malaysian state company Petronas is understood to be an oil discovery. Jade 1 (2-C-1X) penetrated a significant oil column in an undisclosed **Tertiary** sandy interval. Drillsite is in Block 2, about 70 km (43 miles) northeast of the Bach Ho oil field

(Miocene) and 80 km (50 miles) off the coast. Further testing is planned.

AUSTRALIA

South Australia

Santos suspended two gas discoveries in PEL-5&6 Murta. Wildcat Farina 1 (TD 2327 m/7635') tested an aggregate of 13.2 MMCFGPD and 44 BCPD with 3 DST's in the **Permian Patchawarra** Formation, while Wirrarie North 1 (TD 2148 m/7048') flowed 8.1 MMCFGPD with traces of condensate from the **Patchawarra.**

Western Australia (Offshore)

WMC's wildcat Maitland 1 in WA-149-P **(Barrow Dampier Sub-basin)** is a gas/condensate discovery. The new find, aimed at a **Tertiary** objective, reached TD at 1502 m (4928') and tested 12.12 MMCFGPD and 96 BCPD in an aggregate of two drill stem tests.

Clinton Policy, continued from page 39

C. ENHANCING DOMESTIC OIL AND NATURAL GAS PRODUCTION.

1. *Which, if any, of the following policies would you implement in an effort to stimulate the domestic production of oil and gas, and what PRECISELY would you propose with regard to each:*

a) Reduce or eliminate the oil and natural gas section of the Alternative Minimum Tax.

"The energy legislation now in Congressional conference committee contains beneficial changes for oil and gas producers who have to pay the Alternative Minimum Tax. I favor these changes for an industry that lost nearly 500,000 jobs over the last decade. The changes are needed both to promote economic growth and tax fairness. Current AMT law penalizes investment in domestic oil and gas exploration and development and is basically unfair to drillers. The proposed changes will help correct some of these inefficiencies and the unfairness in the current law."

b) Develop new tax incentives to spur increased domestic oil and natural gas exploration.

"A Clinton Administration will develop new tax incentives to increase domestic oil and natural gas exploration and production and to increase markets, particularly for domestic natural gas. The best thing we can do, however, is to bring back a healthy economy, which will help increase demand."

c) Create a special set of incentives to prevent the premature abandonment of marginal oil wells.

"No Comment."

d) Develop mechanisms to guarantee a price floor for domestic oil and natural gas, in order to prevent severe price fluctuations.

"All options, including floor-price mechanisms, should be investigated in determining how best to tackle our energy dependence problem."

e) What other policies would you propose to stimulate domestic oil and natural gas production?

"No Comment."

D. FINDING THE APPROPRIATE BALANCE BETWEEN ENERGY PRODUCTION AND ENVIRONMENTAL PROTECTION.

1. *Would you favor or oppose the development of a special set of tax incentives that would support the environmental remediation efforts of oil and gas companies, by allowing them to apply some of the costs of that remediation to the taxes that are tied to future exploration and development?*

"No Comment."

2. *Would you favor or oppose opening the Arctic National Wildlife Refuge to limited exploratory drilling, in order to determine the amounts of oil and gas that could be produced in that area?*

"A Clinton Administration would not support opening the Arctic National Wildlife Refuge to oil drilling operations. Even under the most optimistic scenarios, all of the recoverable oil in ANWR would supply our nation with but a few months worth of our oil needs. That potential gain is not worth the risk to the unique ANWR environment.

Moreover, opening ANWR or other fragile areas is not necessarily the answer to rebuilding the American oil and gas industry or securing American energy independence. We should first explore increased recovery of oil and gas in existing fields, offer sufficient incentives for the development of new domestic fields, increase our efficiency and conservation, and renew efforts to develop alternative sources that will form a foundation for the next generation of the American energy industry."

3. *If commercial quantities of oil and natural gas were found in ANWR, would you allow production to proceed, if the industry can guarantee that the land will be fully restored to its original condition after commercial production ceases?*

"Modern oil and gas production techniques can make exploration and production relatively clean. But as stated before, ANWR is a precious resource and should be preserved. While one should never say never, I still believe the way to America's energy independence is through increased use of domestic natural gas, incentives to spur oil and gas production in the Lower 48 states, increased energy efficiency and conservation, and research, development and demonstration of renewable energy sources."

4. *Would you favor or oppose the imposition of so-called "green taxes," such as a carbon tax on fossil fuels?*

"The Clinton energy plan does not advocate carbon taxes at this time. Carbon taxes are often proposed as a way to reduce polluting emissions, which they might do. But unilateral imposition of a carbon tax by the U.S. would put our industries at an economic disadvantage without guaranteeing the desired environmental benefits."

E. THE DEVELOPMENT OF DOMESTIC NATURAL GAS AND COAL PRODUCTION.

1. *What specific role do you foresee for NATURAL GAS for the next ten years?*

"As detailed in previous answeres, the Clinton/Gore national energy policy will greatly increase natural gas usage in the U.S. for energy generation and transportation. This policy will create jobs, enhance national security, and reinvigorate our domestic energy industry."

2. *What specific role do you foresee for COAL for the next ten years?*

"Coal is an abundant fuel, with over 200 billion tons of coal resources in the United States. We must find ways to make high-sulfur coal less polluting when its burned. That's why the Clinton/Gore plan calls for increased investment in research aimed at developing clean coal technologies. Like co-firing gas and coal, fluidized coal bed methane, and gasifying coal."

3. *Since natural gas and coal are the most abundant domestic energy resources, what incentives and research support, if any, would you provide to stimulate the development of new methods of combining these fuels in order to produce energy in environmentally responsible ways?*

"Energy independence is our goal. While natural gas has many environmental benefits, we cannot afford to ignore our tremendous reserves of coal. Additional and better research must be targeted at methods for burning coal of all types more cleanly."

4. *Under what circumstances, if any, would you favor the burning of coal if natural gas is available as an alternative fuel?*

"No Comment."

5. *What specific plans would you develop in order to ensure that, if the U.S. experiences a colder than normal winter, deliveries of natural gas to residential and commercial customers will not be interrupted due to the lack of available supplies?*

"A Clinton Administration will speed development and certification of natural gas pipelines.

The U.S. has plenty of natural gas. The problem is getting it to market though what is now an insufficient pipeline capacity. Over the long term, more pipeline capacity must be constructed to ensure adequate supply of gas to the Northeast. The consensus is that the FERC certification process needs improvement, particularly in the area of interagency cooperation.

The Reagan and Bush administrations have failed to authorize needed gas pipeline expansion in a timely manner. We need to improve the pipeline network and part of the solution is regulatory (state and federal) and part is to encourage demand.

FERC recently implemented a new order which completely restructures the manner in which natural gas has been supplied from the wellhead to the consumer. Under the new restructuring, more extensive storage of natural gas has been made necessary. Significant increases in the storage of natural gas in the proximity of the end user will smooth out any supply fluctuations."

6. *What new federal programs (tax incentives, regulatory relief) would you propose, if any, in order to encourage the expanded use of natural gas nationwide and to boost the development of natural gas reserves?*

"The answers above detail the steps a Clinton Administration would take to expand our reliance on domestic energy sources, natural gas in particular.

But the best thing we can do to spur expanded use of domestic energy sources like natural gas is to get our economy going again and to decrease our reliance on foreign energy sources. These will be the priorities of a Clinton Administration."

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