Bulletin

Houston Geological Society

HGS JOBS HOTLINE: 713-785-9729

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February 1994

Volume 36
Number 6

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Entering San Vincente Canyon on the Rio Grande River in Big Bend National Park. West dipping beds of the Lower Cretaceous Boquillas Formation tower over the rafts.

– Photo taken by Jeff Skinner

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Bulletin Houston Geological Society

THE MONTHLY BULLETIN OF THE HOUSTON GEOLOGICAL SOCIETY

Houston Geological Society
7171 Harwin, Suite 314.
Houston, TX 77036-2190
Phone (713) 785-6402
FAX (713) 785-0553
Office Hours: 7 a.m. - 4 p.m.

Reservations to the General Meetings

Reservations are made by calling the HGS office (confirmation can be done by FAX and/or mail). 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 $5.00 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.

Prices for February Meetings

HGS / HAPL Dinner Meeting,
Post Oak Doubletree Inn,
February 7, $20.00

Environmental and Engineering Geologists, H.E.S.S. Building
February 9, $2.00

Luncheon Meeting
February 23, $15.00

International Explorationists,
Post Oak Doubletree Inn,
February 28, $21.00

North American Explorationists,
H.E.S.S.,
February 28, $20.00

To Submit Articles and Announcements

Manuscripts, inquiries, or suggestions should be directed to the Editor, c/o HGS Bulletin. Deadline for copy is six weeks prior to publication. **All copy must be prepared on a word-processor and submitted on a disk** along with an identical hard copy output of the text. Most popular software programs will be compatible with our equipment, please call about any particular problems.

To Advertise in the Bulletin

Call John King at 358-8604 for information about advertising in the Bulletin.

Editing

The Editorial staff meets at 5:30 on the first Wednesday evening of the month to discuss the content and improvement of the coming issues.

Layout

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Type

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Bulletin Committee

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HGS DONATION/SPONSOR CONTRIBUTION MENU

The Houston Geological Society has many excellent activities and programs worthy of financial support. Typically, our dedicated program chairpersons must solicit contributions and donations for their activities and programs from the same donor/sponsors who have just been solicited by another HGS committee chairperson. In an effort to simplify this important process, as well as allow potential donor/sponsors to see the full range of deserving HGS programs, we have created this Donation/Sponsor Contribution Menu for your ease and "one-stop shopping". If you take this format to heart and contribute generously all at one time, the HGS committee chairpersons may not have to contact you again near event time, and your designated funds will be provided to them in a more efficient and less time consuming manner. We sincerely hope you can at least maintain your generous event donations at their current levels and perhaps contribute additional funds to our other deserving HGS activities. The HGS Executive Board, the Committee Chairpersons, and all the HGS members "Thank You " for your generous and consistent support.

ENTERTAINMENT	**Dollar Amount**
Golf Tournament	_____
Shrimp Peel	_____
Skeet Shoot	_____
Tennis Tournament	_____
Bass Tournament	_____
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Bulletin (Monthly or one time)	_____
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Calvert Memorial (Graduate)	_____
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General Dinner & Luncheon	_____
International Explorationists	_____
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Environmental/Engineering	_____
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Awards	_____
Computer Applications	_____
Continuing Education	_____
Explorer Scouts	_____
Field Trips	_____
Library	_____
Personnel Placement	_____
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OTHER PROGRAMS	_____
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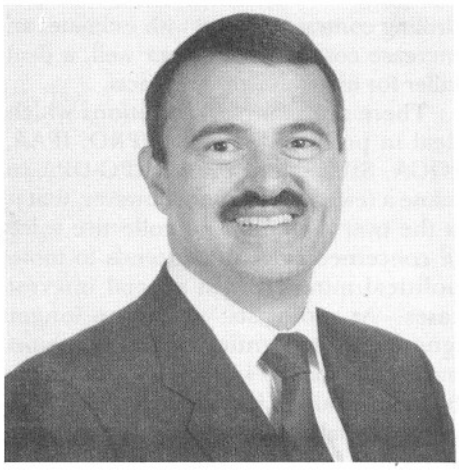
PRESIDENT'S COMMENTS



Since "Valentine's Day" is on the second Monday, which is our usual evening meeting day, and since we would not want to take you away from your Valentine, we have rescheduled the meeting for Monday February 7th. This will be our annual joint meeting with the Houston Association of Petroleum Landmen. The program will feature Mr. Joe Foster, President and CEO of Newfield Exploration Company. Mr. Foster, formerly an executive with Tenneco Oil Company, will discuss his views on the "state of the industry".

One of the most worthwhile things the Society does is to provide support for students of the earth sciences. This is done through two separate entities. The Warren L. Calvert Memorial Scholarship Fund provides scholarships for graduate students and the Houston Geological Society Foundation provides scholarships for undergraduates.

The Warren L. Calvert Memorial Scholarship Fund was established in 1974 by Warren Calvert as an irrevocable trust with an initial deposit of $8,000.00 for the purpose of "assisting worthy and needy geological students to pursue graduate studies in Economic Geology leading to a Master's or Doctor's degree at any accredited university of his or her choice." Through the generous offerings of many contributors and the able management of Dan Smith and Warren Calvert, the Fund now exceeds $230,000.00. The amount available for scholarships, awarded once a year in July, cannot exceed 50% of the interest and contributions for any given year. This year the Fund was able to award four $2,500.00 scholarships. Dan Smith is the Chairman of the Fund.

On June 24, 1993 Warren and Florence Calvert created a living trust which will benefit the HGS and the Memorial Scholarship Fund greatly. The Calverts have set aside substantial assets and have appointed the HGS to act as a future trustee. Ultimately, the HGS will transfer all assets of the trust to the Warren L. Calvert Memorial Scholarship Fund. The Calvert's continued support over the years has helped make the Memorial Scholarship Fund a success and their establishment of the living trust will help guarantee that success into the future. Thank you very much!

HGS supports worthy students through annual scholarships from the Warren L. Calvert Fund and The Houston Geological Society Foundation.

The Houston Geological Society Foundation was organized in 1985 to provide scholarships for the full time undergraduate student carrying a normal academic load of *bono fide* geology major with at least a 3.0/4.0 grade point average and who exhibits scholastic ability, need, and high moral and ethical standards of conduct. The amount of each scholarship is $1,000.00 per academic year, distributed as $500.00 per semester. This scholarship program was established to support worthy students from six area universities. They are: Rice University, The University of Houston, Lamar University, Stephen F. Austin University, Texas A&M University and The University of Texas at Austin. The Foundation has been able to award six $1,000.00 scholarships annually from funds coming from private donations, corporate donations and interest from the Foundation's savings account as well as contributions from the HGS Auxiliary. Selection of candidates for the scholarships are made from responses received from the universities which are provided applications and instructions in August of each year. Completed applications include the completed application form itself plus grade transcripts from all colleges and universities attended and letters of reference from three persons, one of which must be from an instructor or academic advisor during the past year of study. Hugh Hardy is the Chairman of the HGS Foundation.

To everyone who is or has been involved in this great work, either as a committee worker or a contributor, thank you very much!

John Biancardi

John M. Biancardi

COMMENTARY

No Political Vacuum

Formation of the *ad hoc* committee on Government Affairs by the HGS, under the leadership of Jack Howard, was spawned through the realization by many in the Society that geologists and geophysicists do not live in a political vacuum. The recent spate of letters concerning oil price supports and environmental matters in the HGS Bulletin and AAPG Explorer seems to support this. The Government Affairs committee, however, is not an advocacy group nor does it back lobbying efforts, it is merely a tool to disseminate information on important issues affecting geologists to the large number of individuals who are not members of other groups more closely involved in politics.

The Government Affairs committee is useless without a steady diet of information on current issues affecting Society members. Two recent examples of critical issues which have come and gone without much comment on these pages are the MMS hearings on the financial responsibilities of the Oil Pollution Act of 1990 (OPA 90) and a series of restrictive EPA directives governing drilling operations in wetlands.

OPA 90 was enacted by Congress in response to the Exxon Valdez spill. That act requires a $150 million level of financial responsibility for all offshore oil and gas facilities in navigable waters, including lakes, rivers, and possibly other wetlands. The MMS has held public hearings in Houston, and, apparently, a rather raucous affair in New Orleans, to help formulate regulations. Needless to say, with cost of compliance estimated at $3 to $15 million and a daily fine of $25,000 for noncompliance, the effects on the domestic industry would be devastating.

The EPA also has just tightened already restrictive regulations concerning oil and gas operations in wetlands. After public hearings, from which all input was summarily ignored, the EPA issued regulations covering drill cutting disposal. Previously, on-sight disposal was allowed for drill cuttings recovered prior to setting surface pipe. Now, those cuttings must be barged and disposed of off-site. One drilling contractor I deal with estimates an increase cost of $30,000 per well, a deal killer for many shallow prospects.

There are many organizations which deal in political matters, TIPRO, IPAA, IOGA, SIPES, and even AAPG-DPA to name a few. I have found, however, that it is the overwhelming and collective voice of concerned citizens that tends to move political mountains in special interest cases. As geologists, we can no longer ignore the unrelenting offensive against natural resource industries. Pressure from this country is even being felt in the international arena, so there is no longer any safety there. In our favor, we have significant membership numbers as well as means to disseminate information. We must insure rapid communication of information and cooperation on critical issues and events between all organizations so the majority of the 5000 HGS and 35,000 AAPG members have access to knowledge by which they may formulate decisions and take appropriate action.

Steven H. Brachman

Hostile, Harmful: That's Clinton Energy Policy*

Late last October, Energy Secretary Hazel O'Leary set off a firestorm of protest from independent oil and gas producers when she characterized them as "mom and pop" businesses that "might be too feeble to salvage," and asserted the view that the need to maintain a strong domestic oil industry to protect national security may be an "outdated idea." although the Clinton administration quickly moved to exercise damage control, sending O'Leary to New Orleans to recant, and attempting to claim that her remarks were mischaracterized, the truth is that her statements accurately reflected the White House's prevailing attitude toward the domestic petroleum industry: hostility and contempt.

Even if O'Leary had not made her unfortunate comments, the antipathy of the Clinton White House toward the petroleum industry would still be manifest in myriad ways. Indeed, one of President Clinton's first actions on taking office was to propose a Btu tax which penalized oil use. Although the Btu tax failed, the administration did succeed in raising the gasoline tax, and raising the rate on intangible drilling costs, figuring half a loaf is better than none.

Interestingly, while O'Leary has received the most flak, Interior Secretary Bruce Babbitt has probably done even more damage. This is because the Department of the Interior actually has much more to say about the day-to-day operations of the oil industry than the Energy Department. It is the Interior Department, after all, that controls federal leasing, or more accurately, nonleasing.

That federal government, through various moratoria and other restrictions, has managed to place 13 percent of the nation's oil and gas resources off-limits to drilling. Moreover, numerous other promising areas are being withdrawn from consideration at a stop-gap pace, including examples such as the Bridger-Teton Area, Thunder Bay and Shoshone Forest, all in Wyoming, the Bear Tooth Area in Montana, White Run in Colorado and many more on the docket. In other cases, decisions on leasing of tracts are being delayed or deferred for no apparent reason.

Perhaps the most outrageous action taken by the Interior Department, however, is what it is doing with royalty payments. Using an arcane and highly questionable interpretation of the Federal Debt Collection Act. Babbitt has come up with a scam to pick the pockets of the already cash-starved independent oil industry.

The Debt Collection Act permits the federal government to withhold payments owed to individuals such as tax refunds and apply the proceeds to delin-

quent debts those individuals owe the Treasury. Babbitt has interpreted the act as permitting his department to withhold refunds of excess quarterly royalty payments against future potential liabilities. In other words, he is holding the money in case the individual should ever end up owing the federal government money, even though there is no current debt. This means that he is essentially taking the royalty payments and using them as an interest free loan from the producers. His philosophy seems to be: "What's mine is mine, and what's yours is mine, too."

It goes without saying that the Babbitt scam is being challenged in court, and most observers believe it will be overturned in short order. For the time being, however, countless producers are having their money held in Washington at a time when plunging prices make every dollar precious. Babbitt's inability to recognize the damage he is causing is clear evidence of his insensitivity to industry conditions.

And referring to the plunging oil prices, I wonder how much arm-bending is being constantly exerted by the Clinton group on some of the OPEC countries - especially Saudi Arabia and Kuwait (both of which are willing to barter low oil prices for U.S. military protection) - to suppress oil prices and keep them dropping to make his economic package look good.

What Clinton doesn't seem to understand is that any short-term benefits that may be gained from artificially low prices will be overwhelmed by the long-term damage this will inflict on our nation's economy. The direct consequences of these low prices have cost American taxpayers tens of billions of dollars in defense outlays to protect the Middle East, destroyed hundreds of thousands of high-paying jobs and substantially undermined U.S. political and economic activity. It is an enigma that all of Washington cannot understand the end results of deliberately destroying the American petroleum industry.

The lack of this understanding of, or sensitivity to, legitimate small independents and business concerns is, however, the signal characteristic of the Clinton White House, so perhaps it should come as no surprise. It comes from the top. Anyone who doubts this need only remember Hillary Rodham Clinton's response to questions concerning the effect the cost of her proposed health-care taxes would have on small business. Her response was that the program could not be held hostage to a few "underfunded entrepreneurs."

It seems that even the administration's much touted forthcoming Domestic Energy Initiative will have little for the domestic petroleum industry to cheer about. In a recent Wall Street Journal interview, an Energy Department spokesman indicated that DOE had already rejected oil import fees, opening the Arctic National Wildlife Refuge and providing tax incentives for drilling out-of-hand as options. The article went on to state that DOE was, however, considering a small tax credit for using advanced computer technology, which is insignificant.

The obvious apathy and lack of concern for the future of the exploration and production segments of the industry accurately reflect the current attitude toward oil in Washington circles.

Among the Clinton crew, oil is viewed as an unmitigated evil that should be eliminated as soon as possible, and independent oil and gas producers are seen as despoilers of the Earth.

Michael T. Halbouty

**Reprinted with permission from the Houston Chronicle, December 8, 1993.*

GCAGS Support

The January, 1994, issue of the *Bulletin* includes a questionnaire on page 24 concerning the annual GCAGS Convention. The questionnaire seems to be an attempt to discern support among the membership of the Houston Geological Society for a change in the traditional rotational system that has been used to select the host society for the annual convention. My point in writing is not to question such discussion but to object to certain statements made in the introductory comments to the questionnaire.

First, the most recent GCAGS Convention was hosted by the Shreveport Geological Society. It was, as always, a large undertaking. I am not aware, however, of any aspect of the convention which suffered due to a lack of volunteers or support from Shreveport, the East Texas Geological Society and our surrounding area. The volunteers to whom I have spoken, have expressed a sense of satisfaction, both in having been involved and in the outcome of the overall effort. As a member of the Short Course Committee, I would echo that satisfaction.

Second, and more important, the final financial analysis of the convention is not complete. However, it continues to appear that 1993 Convention will come very close to breaking even. To state that a large loss was incurred for the convention is not only unfounded, but totally unfair to all those who labored so hard to make the convention a success.

In closing, I must express disappointment that these statements about the level of volunteerism and financial outcome of the 1993 Convention ***might encourage*** responses favorable to a change in scheduling the GCAGS Convention. The GCAGS will, I sure, continue to study and discuss ways to improve the annual convention. If changes are warranted, they should be made, but let's limit discussion to the facts!

William R. Meaney

Original Survey: Author's Reply:

We sincerely regret and apologize for the inference, in the January HGS *Bulletin* version of our GCAGS questionnaire, that the 1993 GCAGS Convention in Shreveport incurred a "large loss." We have amended all future versions to correct this statement. We did not intend to offend anyone, and certainly not misstate any facts, however our facts were supplied by the appropriate GCAGS Committee Chairman that we contacted during the preparation of our questionnaire. We also applaud and commend Shreveport's volunteer effort in filling their committees, and putting on an enjoyable and responsible convention. We sincerely hope that future GCAGS conventions will experience increasing membership participation, and we simply offer our questionaire as a dedicated effort toward that goal. We encourage everyone to participate in this effort for our future, and certainly do not intend to denigrate any society's (or their membership's) efforts of the past.

Clint Moore

JOINT HGS-HAPL DINNER MEETING

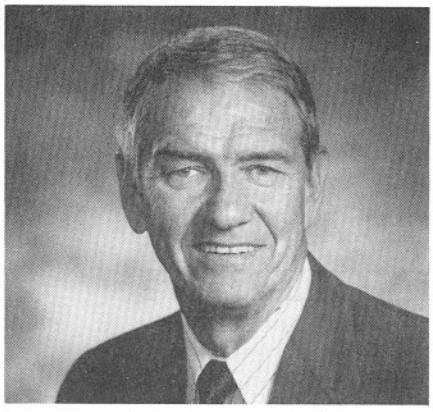
Perspectives On Some Differences Between Major Oil Companies And Independents

Joe B. Foster

February 7, 1994 ***(NOTE DATE CHANGE)***
Social Period, 5:30 p.m. Dinner and Meeting, 6:30 p.m.
Post Oak Doubletree

Our speaker will discuss his opinions of how the oil industry is viewed differently from both the large company and small company perspective. He will discuss the principles used in founding Newfield Exploration Company and how it compares and contrasts to his more than 30 years with a company the size of Tenneco.

JOE B. FOSTER- Biographical Sketch



Joe B. Foster is Chairman and Chief Executive Officer of Newfield Exploration Company, headquartered in Houston.

Newfield was founded by Foster in January 1989, and is an independent oil producer, exploring for and acquiring oil and gas reserves in the central Gulf of Mexico.

Previously, Foster was Chairman of Tenneco Oil and Executive Vice President of its parent, Tenneco Inc. He also served as Chairman of the Tenneco Gas Pipeline Group and was a director of Tenneco Inc. He was with Tenneco for 31 years.

Foster was born in Arp, Texas, on July 25, 1934. He attended Texas A&M University and graduated in 1957 with a Bachelor of Science degree in petroleum engineering and a Bachelor of Business Administration degree in general business.

Foster serves on the National Petroleum Council and is a member of the Executive Committee of the Independent Petroleum Association of America. He is past Chairman of the Greater Houston YMCA and serves on the boards of the Houston Museum of Natural Science and the Houston Hospice.

Foster is a member of the Board of Trustees of the Texas A&M University Development Foundation and has been named a Distinguished Alumnus of the Colleges of Engineering and Geosciences at Texas A&M.

He also serves on the Boards of Baker Hughes Incorporated and Dual Drilling Company.

CALL FOR PAPERS AND FIELD TRIP ANNOUNCEMENT

1994 Permian Basin Section - SEPM
Annual Field Trip and Guidebook
San Andres Mountains, New Mexico April 22 - 24, 1994
In Conjunction with the Roswell Geological Society

Theme: "Paleozoic Stratigraphy of the San Andres Mountains, New Mexico: Emphasizing Upper Pennsylvanian Stratigraphy and the San Andres Formation Type Section."

Manuscript submittals are requested and are to be based upon new research, recent fieldwork, or reservoir studies on the Paleozoic stratigraphy of the San Andres Mountains, regional studies (including adjoining mountain ranges and the Permian Basin), and specific stratigraphic studies on the upper Pennsylvanian and the Permian San Andres Formation.

The 1994 Permian Basin Section - SEPM field trip to the San Andres Mountains will be held Friday evening through Sunday afternoon, April 22 - 24, 1994 prior to and in conjunction with the Southwest Section Meeting of the American Association of Petroleum Geologists at Ruidoso, New Mexico.

For field trip details and manuscript submittals, please contact:
Bob Lindsay, 1st Vice President PBS-SEPM (915) 687-7233 or
call the PBS-SEPM Office (915) 683-1573 Fax (915) 686-7827

HGS LUNCHEON MEETING

Exploration Opportunities For Independents - Case Histories In North And East Texas

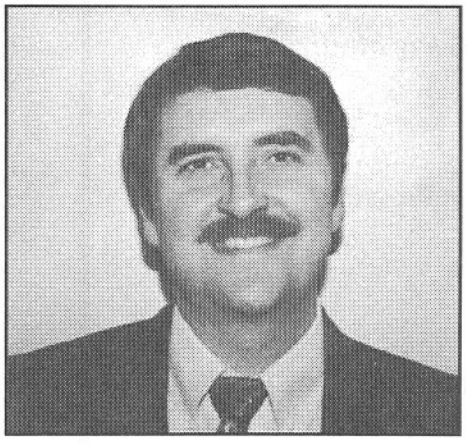
Robert G. Font

HGS LUNCHEON MEETING - February 23, 1994
Social Period, 11:30 a.m., Luncheon and Meeting, 12:00 Noon
The Houston Club

Exploration opportunities throughout the continental USA abound for today's independents. The shift of major oil companies toward the international scene has resulted in chances ranging from purchases of producing properties to singular opportunities in exploration. Well-defined prospects backed by state-of-the-art technical data exist in the archives of most major, domestic oil companies. The fact that reserve levels linked to international and domestic offshore prospects are most attractive to the majors, establishes a window of opportunity for independents interested in domestic, onshore drilling of scientifically-sound, commercial tests.

As a point of illustration, prospects in north and east Texas have been selected for discussion. In north Texas, seismic reveals the potential which still exists within this mature, productive province. Subtle structural and stratigraphic traps involving the regionally productive, Pennsylvanian conglomerates; the fractured, Mississippian Barnett Shale which acts as its own source, reservoir and trap, and where well-established rock mechanics models are applicable in determining optimum fracture development and prospect locations; the productive potential of the Cambro-Ordovician deep Ellenburger carbonates and underlying Cambrian sands; and a fascinating sequence of Pre-Cambrian truncated wedges of unknown hydrocarbon potential mark some of the various opportunities that still exist for the independent explorationist in this region. In east Texas, log analysis of untested sections of the Cretaceous Glen Rose formation, analogous to the prolific production found in the Alabama Ferry field, offer encouragement and affirm the prospective potential that remains for independents in the domestic, onshore scenario.

ROBERT G. FONT - Biographical Sketch



Rob is a native of Havana, Cuba, and has lived in Texas for about 30 years. He has a B.S. degree in Geology and Mathematics and an M.S. in Engineering Geology and Geophysics, both from Baylor University. His Ph.D. degree is from Texas A&M University in Engineering Geology and Structural Geology. He started his post-graduate career teaching at Baylor University for seven years. Following that he was in exploration for ten years with Conoco and two years as Executive Vice President of Strategic Petroleum. He is currently President and owner of Geoscience Data Management in Dallas, Texas, and is the 1993-94 President of the Dallas Geological Society.

BASINS OF THE WORLD

A symposium in memory of Dr. Rudy Schwarzer
Adjunct Professor of Geology, Rice University

Friday, February 25, 1994, 1:00-4:00 p.m.
Rice University Campus

Room 131 - Anderson Biological Laboratories
(next to Keith Wiess Geological Lab)

The Department of Geology and Geophysics of Rice University will present a lecture and poster series - "Basins of the World" - on February 25, 1994. This half-day session, in honor of Dr. Schwarzer, long-time adjunct and friend of the department, will feature three faculty members and be followed by a poster session featuring the worldwide projects of the Rice's Geology and Geophysics graduate students.

Speakers are:

Albert W. Bally
Southeast Mexico, The Regional Setting for the Last Giant Fields of North America

Manik Talwani
Geophysical Methods for Subsalt Exploration in the Gulf of Mexico

Peter R. Vail
Preliminary Results from European Basin Correlation Program

If planning to attend, please make reservations with the department at 713-527-4880.
For more information, contact Martha Lou Broussard at the same number.

INTERNATIONAL EXPLORATIONISTS

The Importance of Cross-Cultural Understanding: China as a Case Study

by Dr. Richard J. Smith

Joint Meeting with AIPN
International Explorationists Dinner Meeting – February 28, 1994
Social Period, 5:30 p.m., Dinner and Meeting, 6:30 p.m.
Post Oak Doubletree Inn

As petroleum explorationists, we often slight the business aspects of exploring outside the United States. This issue is critical to the success of international projects.

As the world "shrinks," cross-cultural understanding becomes ever more important. Modern technology may help to bring countries into closer and more regular contact, but it cannot easily solve fundamental problems of intercultural communication. This slide-illustrated lecture explores the "culture" gap between the United States and China as an example and suggests, at least implicitly, some ways to bridge this formidable divide.

RICHARD J. SMITH
Biographical Sketch

Dr. Richard J. Smith, former Master of Hanszen College (1982-1987), is presently Professor of History and Director of Asian Studies at Rice University, Houston, Texas.

Professor Smith is a specialist in modern Chinese history and traditional Chinese culture, and has travelled extensively in Asia, including India (once), Korea (once), Japan (four times), Taiwan (five times), the People's Republic of China (twenty-two times), and Hong Kong (twenty-five times). He has taught at the University of California, Davis, and at the Chinese University of Hong Kong. He is an Adjunct Professor at the Center for Asian Studies at the University of Texas, Austin, and the former President of both the Texas Foundation for China Studies and the President of both the Texas Foundation for China Studies and the Southwest Conference of the Association for Asian Studies. He is also a member of many other scholarly committees and associations, including the National Committee on U.S. China Relations, the Asia Society, and the Association for Asian Studies. He has lectured widely in the United States, as well as in Europe, Asia, and the (former) Soviet Union.

Professor Smith has won nine teaching awards, including the Minnie Stevens Piper Professorship and the George R. Brown Certificate of Highest Merit. He has written numerous articles on China, and several books, including ***Mercenaries and Mandarins,*** (1978); ***Traditional Chinese Culture,*** (1978); ***China's Cultural Heritage,*** (1983); ***Fortune-tellers and Philosophers,*** (1991); and ***Chinese Almanacs,*** (1992). He has also co-authored or co-edited four volumes: ***Chinese Walled Cities,*** (1979); ***Entering China's Service,*** (1986); ***Robert Hart and China's Early Modernization,*** (1991); and ***Cosmology, Ontology, and Human Efficacy.*** A revised and expanded edition of ***China's Cultural Heritage*** will appear in early 1994.

Professor Smith was born in Sacramento, California, in 1944. He had a brief flirtation with professional baseball before coming to his senses.

INTERNATIONAL BRIEFS

Cusiana Progress, Colombia*

In 1993, Cusiana 3, 5 km north of the Cusiana-1 discovery well, tested 2620 BOPD and 3 MMcfd from 3 intervals between 4610 m and 4674 m. Cusiana-4 sidetrack well will be completed as a producer in the Ecocene Mirador formation. The Buenos Aires-2 well, 10 km southwest of Cusiana-1, tested 3590 bopd and 4.4 MMcfd from one interval between 4573 m and 4584 m. Buenos Aires-3 sidetrack was drilling in the Mirador at the end of October, and is expected to be completed as a producer also.

In May of last year, the Cupiagua-1 well, 15 km north of Cusiana-1, tested at a combined rate of 7215 BOPD from the Maastrichtian Guadalupe, Paleocene Barco, and Eocene Mirador formations from intervals between 3813 m and 4435 m. Cupiagua-2, targeted to 5640 m, and Cupiagua-3, targeted to 5030 m, are drilling below 3000 m and should be completed and tested during the first quarter of 1994. Cusiana-4 and Buenos Aires-3 are south west of the Cusiana-1 discovery well. The Cupiagua wells are north of Cusiana.

In June 1993, Ecopetrol, the Colombian national oil company, approved commerciality and exercised its right to acquire 50% of the Santiago de las Atalayas and Tauramena contract areas. The decision obliges Ecopetrol to purchase an interest in certain existing field assets, and contribute to future costs.

The partners have recently approved a preliminary engineering timetable for full field development, which will proceed in stages. Initial production will be limited to available pipeline capacity, currently being expanded. First commercial production is expected in mid - 1994 from one of four production units. Peak gross production in the initial phase is estimated at 150,000 BOPD by the end of 1995. The two fields, Cusiana and Cupiagua, will eventually produce to a central processing facility. Most of the natural gas will be reinjected. Decisions regarding optimum pipeline size hinge on the results of the two Cupiagua wells.

In the meantime, the scenario includes peak production of 500,000 to 800,000 BOPD by 1998.

Participants are:

- BP Exploration (Colombia) Ltd., operator 19.0%
- Ecopetrol 50.0%
- TOTAL Exploration en Produktie Mij.. BV 19.0%
- Triton Columbia, Inc. 12.0%

Triton Quarterly Report, October 27, 1993

**Reprinted with permission from the International Exploration Newsletter, December 1993.*

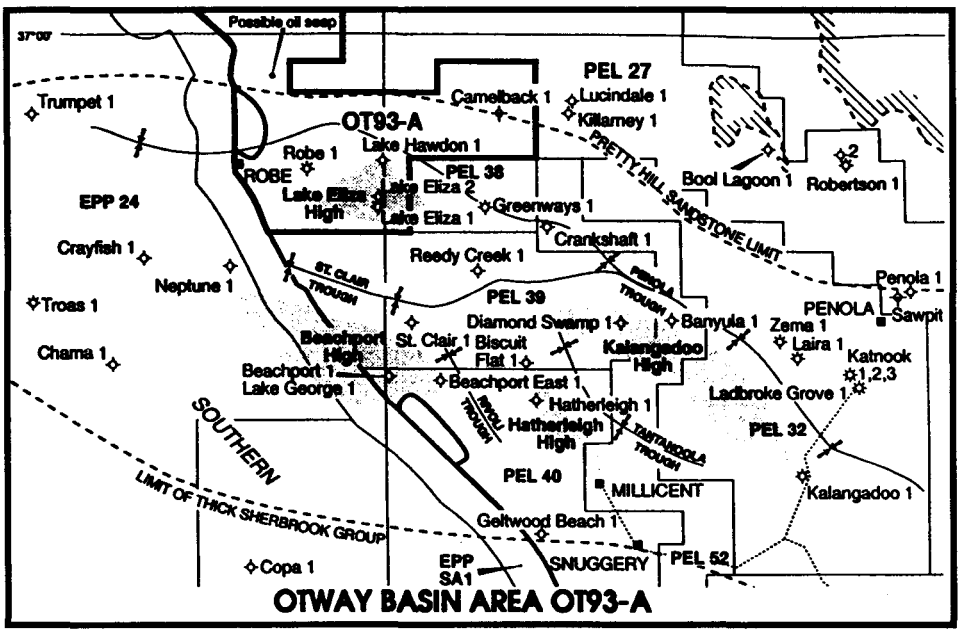
Otway Basin Block Offered For Application In South Australia*

OT93-A covers 1069 sq km in the northwest sector of the onshore portion of the Otway Basin. It is contiguous with OT93, offered earlier this year.

Otway Basin is one of a series of southern continental margin basins formed as a result of rifting and pull-apart between the Australian and Antarctic plates. Rifting, following early uplift during Late Jurassic, probably began in Early Cretaceous, about 125 Ma, forming a system of narrow, east-west trending, north-dipping half grabens in a metamorphosed Paleozoic basement. Early sediment infill was dominated by volcanogenic fluvial sands, and followed by fluvial-lacustrine clastics, coals, channel sands, and non-marine claystones.

Cenomanian crustal breakup, and initiation of sea-floor spreading, about 95±5 Ma, was accompanied by thermal subsidence and a shallow marine transgressive-regressive to non-marine cycle through the remainder of the Cretaceous. Following extensive erosion near the end of the Maastrichtian, marine Tertiary clastics, mudstones, marls, and limestones were deposited on a passive margin. The OT93-A area is estimated to have in excess of 2400 m of Early Cretaceous and 500 m of Late Cretaceous and Tertiary clastic sediments.

Commercial gas was discovered in the onshore portion of the basin at Katnook in 1987. A pipeline to supply local markets has been operating since 1991. Oil was discovered in two wells in the Victoria portion of the basin to the east, and two, Caroline-1, and Sawpit-1, in



South Australia. Negligible amounts are produced from Caroline-1. In July 1992, heavy oil, presumably generated in the Early Cretaceous, was recovered from a 32m interval below 2514m in the Sawpit-1 well. Non-commercial gas was also recovered on RFT from the Troas-1 off the coast south-west of OT93-A.

Five wells have been drilled in the OT93-A block. All were abandoned, but two, Robe-1 (drilled in 1915) and Lake Eliza-1, had shows of gas. Camelback-1 had an oil show. Greenways-1, in OT93, also had a gas show. None of the wells has penetrated the entire Cretaceous section to Paleozoic basement.

Source rocks are mainly gas-prone lacustrine shales, with woody, herbaceous organic matter, but some liquids potential may exist in the deeper unpenetrated sections of the graben. Maturity profiled indicate a gas/oil window between 1800 m and 2600 m. Target depths range between 760 m and 2700 m.

The principal exploration objectives are the Early Cretaceous fluvial-deltaic sandstones. The main proven gas reservoir is the basal Cretaceous Pretty Hill Sandstone, which is Katnook Field has porosities in excess of 25%, permeabilities in excess of 1000 md, and has flowed more than 16 MMcfd on test. Reservoir quality is also excellent in other Cretaceous sandstones.

The area offers possibilities for both structural and stratigraphic objectives. At least four plays or leads with four-way dip or fault controlled closure have been identified, but much of the area, which lacks recent seismic coverage, has yet to be adequately evaluated. The mid-Cretaceous uncomformity play is a likely priority, and meandering fluvial channels or pinch-outs offer good possibilities for stratigraphic traps.

Data Available

All open file data (older than two years), including well logs, completion reports, seismic lines, and recently complied digital datasets are available for viewing or purchase. For more information, contact:

Mr. John Morton
Principal Petroleum Geologist
Oil, Gas, and Coal Division
Department of Mines and Energy
191 Greenhill Road, P.O. Box 151
Eastwood, South Australia 5063
Telephone: 618 274 7565,
Fax: 618 373 3269

Applications

There is no prescribed form for application, but the request should include a map of the area applied for, a proposed 5-year work program, and details of the technical ability and financial resources of the applicant. A $2000 application fee applies. Closing date is 11 March 1994.

Inquiries And Applications Should Be Directed To:

Mr. R. A. Laws, Director
Oil, Gas, and Coal Division,
Department of Mines and Energy
P.O. Box 191, Eastwood
South Australia 5063
Telephone: 618 274 7612,
Fax: 618 373 3269

Reference

Condensed from OT93-A - Otway Basin Invitation for Application, South Australia, Department of Mines and Energy.

NORTH AMERICAN EXPLORATIONISTS

The Greater Natural Buttes Producing Area, Southeastern Uinta Basin, Utah: A Unique Model for a Basin-Centered Gas Accumulation

Logan MacMillan and Dan J. Hartmann

North American Explorationists Dinner Meeting – February 28, 1994
Social Period, 5:30 p.m., Dinner and Meeting, 6:30 p.m.
H.E.S.S., 3121 Buffalo Speedway

The Greater Natural Buttes Producing Area presently encompasses more than 400 square miles (1050 sq. km) in the southeastern Uinta Basin, Utah. Non-associated gas production from the field is from the predominately fluvial sandstone reservoirs in the Paleocene Wasatch and Colton Formations, and the underlying Maastrichtian Mesaverde Group.

Four independently-derived relationships demonstrate a unique Petroleum System. First, regional lithostratigraphic analysis of the Mesaverde Group and Wasatch Formation differentiate source rocks, reservoir rocks and seals. Potential source rocks are coals that are predominately Type III, humic-rich organic material, with high TOC content, These coals are concentrated in the basal Mesaverde Group, as well as disseminated throughout the remaining 2500 feet (800 m) of the Mesaverde. Potential reservoir rocks exist throughout the stratigraphic section of the Mesaverde Group and the 4000 feet (1350 m) of Wasatch Formation. Sandstones deposited in a fluvial and / or braid - plain environment are the predominate reservoir facies. Potential seals to gas migration are seen in a regional sense as lateral and vertical relationships of shales and low permeability sandstones in both the Mesaverde and Wasatch and the overlying Eocene Green River Formation.

Second, gas analysis of the produced gas in the Natural Buttes Producing complex demonstrates two key factors: 1) the source type is from Type III kerogen, and 2) Isotopic ratios differentiate both source-type differences and possible influences of migration. The gas produced from the Greater Natural Buttes Producing area is sourced from the thermally mature, Type III kerogen (coals) of the Mesaverde Group.

Third, the thermal maturity pattern of the deep Mesaverde coal deposits correlates with the higher Estimated Ultimate Recovery (EUR) from the wells completed in both the Mesaverde and Wasatch formation. Detailed true-scale structural cross-sections demonstrate that as the coal rank increases above a vitrinite reflectance of approximately 1.0, the gas column rises 750 feet (250 m) to include a zone in the Wasatch Formation (Chapita Wells zone) that has improved porosity and permeability. In addition, when the deep Mesaverde coal rank is greater than 1.0, over pressuring is demonstrated in the Chapita Wells zone.

Fourth, reservoir characterization and petrophysical modeling indicate characteristics similar to other regional central basin gas accumulations. Standard core analyses indicate that pore-throat characterization, formation water resistivities, and production characterization can provide a significantly better understanding of the mechanical log analysis for determination of pay sandstones.

When viewed in a regional perspective, the Natural Buttes Producing Complex demonstrates a significantly different model for a central-basin gas accumulation than those examples previously described in the literature (Basin Dakota of the San Juan Basin; Wattenburg "J" Sandstone in the Denver Basin, Elmsworth of the Deep Alberta Basin.) In the case of the Wasatch/ Mesaverde petroleum system of the Unita Basin, the gas-prone source rocks have expelled methane from the coals at the coal rank of Medium Volatile Bituminous, and that gas has displaced the free moveable water within the pore-structure over a vertical and stratigraphic thickness of 6500 feet (2170 m).

LOGAN MACMILLAN
Biographical Sketch –

Logan MacMillan is currently an independent petroleum geologist working with Rose Exploration Associates in Denver, Colorado. Logan has worked for companies representing the full spectrum of the upstream sector: majors (Amoco), large and small independents (Apache Corporation, Axem Resources, Bass Enterprises Production Company, and Petroleum Inc.) as well as consulting firms and individuals. His assignments, conducted throughout the Rocky Mountain region, include regional petroleum assessments down to detailed field studies for secondary and tertiary recovery projects.

Mr. MacMillan received a B.S. (1973) in Geological Engineering, an M.S. (1975) in Geology from the Colorado School of Mines, and an M.B.A., (1988) from the University of Colorado, Denver. He is a certified petroleum geologist and has presented and published technical papers on stratigraphy, specific oil and gas fields, generation and migration of hydrocarbons in the Rockies, and field evaluation techniques for regional hydrocarbon accumulation.

ENVIRONMENTAL COMMITTEE

Field Trip To The Houston Ship Channel

The Environmental Committee is currently planning a Saturday morning field trip aboard the Port of Houston MV Sam Houston. The purpose of this trip will be to provide our members with an insight into the environmental workings of a complex industrial area. The trip leader, from the Texas Natural Resources Conservation Commission, will discuss the environmental problems encountered by this high concentration of potentially polluting industries located adjacent to a major body of water. He also will point out and discuss the abatement equipment and procedures that are visible from the Ship Channel. At the conclusion of the 1.5 hour trip, the participants will meet at a local eatery for lunch and further discussion.

We are estimating a March 12th date and a turnout of approximately 20-25 participants. If you have a desire to attend or have comments about this trip, please contact George Vance (713)360-5332 or Ralph Taylor (713)462-5588.

TNRCC RIVER CLEANUP

On Saturday, April 23, 1994, from 9:00 - 11:30 a.m., approximately 5000 volunteers are expected to participate in the San Jacinto River Clean Up Battle and the Galveston Bay Clean Up. These celebrations of Earth Day will include water-based and land-based cleanups, water quality monitoring demonstrations, trash sculpture contests, recycling exhibits, and other environmental and educational activities. To thank volunteers, a "Trash Bash" celebration with free lunch, entertainment, an environmental fair. souvenirs, and door prizes will be held immediately following the cleanups.

Cleanups will be conducted along Buffalo Bayou, the Houston Ship Channel, the San Jacinto River at the San Jacinto State Park, Lake Conroe in the Sam Houston National Forest, the San Jacinto River at Dwight D. Eisenhower Park, and the East Fork of the San Jacinto River, as well as the Texas City Dike, Pierce Marsh, Armand Bayou, and Morgans Point. Celebration activities will take place at the San Jacinto State Park, the Sam Houston National Forest, Alexander Duessen Park, and in Coldspring, Texas, as well as in Texas City and the Armand Bayou Nature Center.

The goals of this Earth Day program are to improve the environment, to educate people about the plight of our public waters and the dangers of pollution, to involve citizens in realworld solutions to pollution problems, to promote recycling and citizens' water quality monitoring, and to have a great day!

We are asking for your help to accomplish these goals. We would appreciate all Texas Watch volunteers taking part in the cleanup at the location of their choice. Also, at the Trash Bash beginning at 11:30 a.m., we plan to have an array of environmental and educational activities. We will need experienced Texas Watch trainers to assist with the monitoring demonstrations at each of the six sites. To volunteer to assist with the demonstrations, please contact Anne Rogers, Texas Watch Volunteer Coordinator, at (512) 463-8206.

We will be contacting you again with additional information, or feel free to call if you have any questions. We thank you for your consideration, and hope we can count on your support of the San Jacinto Clean Up Battle and the Galveston Bay Clean Up on April 23rd.

Dana W. Macomb
TNRCC River Cleanup Coordinator
(512) 475-4835

ENVIRONMENTAL/ ENGINEERING GEOLOGISTS

Active Faults In The Gulf Coastal Zone

Carl E. Norman

HGS Environmental/Engineering Evening Meeting - February 9, 1994
Social Period 7:00 p.m., Program 7:30 p.m
H.E.S.S., 3121 Buffalo Speedway

Several hundred active surface faults are known onshore in the Texas-Louisiana Gulf Coastal Zone, and hundreds have been identified offshore. The vast majority are listric normal growth faults with near-surface dips of 70 to 85 degrees. No strike-slip component of motion has yet been identified on any surface fault.

About 80 percent of the surface faults are associated with diapiric intrusion of salt. They tend to be short, ranging in length from 1 to 5 km, and extend over and radiate outward from salt stocks. The remainder are 5 to 20 km-long regional faults that strike more or less parallel to the coastline. The more active ones are paired with strike-parallel antithetic faults about 2 km from the parent fault on its downthrown side. The antithetics occur in short segments opposite only the more rapidly moving parts of the parent fault.

Rates of dip-slip displacement across the faults vary in both time and space. Currently the highest rates are about 3 cm/yr. In the strike direction, the rates decrease progressively from a maximum near the mid-point of the fault to zero at its *termini*. Unfortunately, the rates of displacement are slow enough to make many of the faults difficult to detect, but fast enough to cause substantial damage to structures built across them. The 16.5 km-long Long Point Fault in west Houston, for example, is in the process of damaging about 240 buildings.

Ground deformation of significance on the human time scale extends only a few tens of feet from the fault trace along the length of the fault. For engineering purposes it is important that the location and width of the zone of deformation be established precisely. The talk will include a discussion of currently used techniques for reaching those goals.

CARL E. NORMAN
Biographical Sketch

Carl Norman is an Associate Professor of Geology at the University of Houston, specializing in structural geology and rock mechanics. He began an intensive study of active faults on the Gulf coastal plain in 1977. Early work centered on identification and mapping of faults. Current work is focused on fault kinematics and dynamics.

GCAGS CONVENTION CITY LOCATION QUESTIONNAIRE

For 42 years, the Gulf Coast Association of Geological Societies, known as the GCAGS, has held its annual convention every October in one of its member society cities. Of the 12 local societies that comprise GCAGS, two have never held an annual convention (East Texas and Alabama) with nine of the other ten member societies hosting the convention every nine years. Since dedicated volunteer members must be found in each city to work on the convention, this nine year schedule has not been burdensome to the memberships, even for the larger three societies who must also host the annual AAPG National convention every six years. However, registrants, exhibitors, and presenters have declined in numbers. In some cases, smaller memberships have left some societies undermanned to barely form committees to hold the GCAGS when it has rotated to their city. Even more importantly, due to the considerable expense guarantees demanded by convention center and hotel facilities in every city, and the recent large loss incurred at Jackson, it seems responsible to at least consider alternative options for future convention years.

HGS has over 5000 of the GCAGS membership of less than 9,000 total members. The Houston membership is consistently represented at over 50% of registrants at all recent GCAGS conventions. Due to the serious financial questions raised by the Jackson GCAGS convention, the HGS Executive Board felt that we should poll the membership about future GCAGS convention options, and offer these results to the GCAGS Board in an advisory capacity when HGS President John Biancardi attends the mid-year GCAGS meeting in March.

Let us know what you think by answering our questionnaire, and be sure to add any additional comments at the end of the page. Thank you for your interest and cooperation.

Please circle the appropriate choice:

Does the host city location affect your decision to:

a) attend as a registrant	yes	no
b) submit a paper or poster	yes	no
c) exhibit your service or product	yes	no

Which of the nine cities should we continue to visit in the traditional nine city rotation, assuming that all of them wish to continue to host the convention?

Houston	Corpus Christi	Baton Rouge
San Antonio	Lafayette	Jackson
New Orleans	Austin	Shreveport

Should GCAGS visit a non-local society Gulf Coast city as a wildcard convention location, much like AAPG National will do in 1996 with our visit to San Diego?

Yes No No Opinion

Would you be more inclined to attend a GCAGS convention located in the following suggested Gulf Coast cities?

Pensacola Biloxi Other _____ No Other _____

Should GCAGS follow the practice of the AAPG Midcontinent section and hold its convention EVERY TWO YEARS, instead of an annual convention?

Yes No No Opinion

If the GCAGS convention continues to be held annually, should the format of every second year be altered to be more streamlined and focused like a research conference?

Yes No No Opinion

Please indicate if you attended the recent GCAGS Conventions?

Shreveport '93 Jackson '92 Houston '91 None

If you did not attend, please write down the principal reason for not attending in the space provided below. Thank you again for taking the time to participate in this fact finding process.

Comments: _____

Mail to : GCAGS Convention Questionaire
Houston Geological Society, 7171 Harwin, Suite 314 • Houston, Texas 77036

Return by March 1st.

GULF COAST FEATURE

Sequence Stratigraphy Of The Upper And Middle Frio, Orange County, Texas*

by Kenneth J. Thies, Bruce E. Bowen, Rashel N. Rosen, Bernard L. Shaffer, and John A. Adamick
TGS - Calibre Geophysical Comapny

Abstract

The middle and upper Frio individually constitute complete depositional sequences, and sand distribution in each is related to stacking patterns associated with the specific systems tracts.

The middle Frio overlies the 30 m.y. unconformity as dated by the nannofossils *Sphenolithus distentus* and *Sphenolithus predistentus* and consists of a slope fan, a lowstand prograding wedge, a transgressive systems tract, and a highstand unit.

The upper Frio overlies the 28.4 m.y. unconformity; in the study area, it consists of two sequences and contains the 26.5 m.y. unconformity. Each of these sequences has a prograding wedge, a transgressive systems tract, and a very thin highstand unit but lack slope fans in this updip position. Its upper boundary is the 25.5 m.y. unconformity based on the occurrence of *Reticulofinestra bisectus*.

Potential new stratigraphic plays are recognized for this highly explored and highly prolific formation.

Introduction

A study of the Paleogene strata in Orange County, Texas (Fig. 1) has been conducted in order to determine the distribution of potential hydrocarbon-bearing sand reservoirs and to construct a model of that distribution which could lead to new plays. Most of the obvious structural traps in these strata have been drilled with varying degrees of success. For successful exploration to continue in this area, new concepts of the depositional models of these sediments need to be developed. We believe that the sequence stratigraphic model developed by Vail et al (1977), best explains the distribution of sands observed in these strata. This paper deals specifically with observations and interpretations of the middle and upper Frio sediments in East Texas.

Methodology

We interpreted a grid of 216 miles of recent vintage, high quality seismic data using a dense network of wire-line logs from 48 wells and detailed biostratigraphic analyses from five wells as control (Fig. 1). A detailed biostratigraphic analysis of the cuttings from each of the wells was conducted, documenting highest occurrences and abundance and species diversity of benthonic and planktonic foraminifera and nannofossils (Fig. 2). Paleobathymetry was determined using the standard Gulf of Mexico foraminiferal biofacies (Tipsword et al, 1966).

The abundance of microfossils varies throughout the strata and significant increases have been interpreted as condensed sections (Shaffer, 1990; Loutit et al, 1988). Some of the condensed sections contain highest occurrence datums of planktonic foraminifera and nannofossils which can be used for dating and correlation. These condensed sections have been shown to be regionally extensive and occur in the transgressive systems tract and on top of the slope fan in each depositional sequence (Pacht et al, 1990). The highest occurrence datums and abundance peaks are correlated to the corresponding well-log and the depths converted to two-way time using check shot surveys. This information is then transferred to the seismic data.

Stacking patterns of the sediments as shown by the SP and resistivity log curves were determined from 48 wells. This data was plotted on the grid of seismic lines, and by incorporating the reflection geometry criteria developed by Vail et al (1977), and the reflection character criteria proposed by Pacht et al (1990), we determined the sequence and systems track boundaries which best fit all the data.

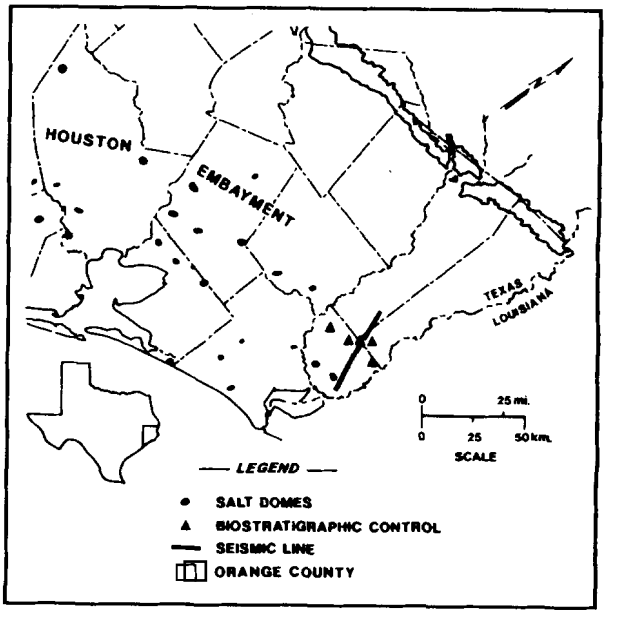


Figure 1 Map showing location of biostratigraphic control and key seismic data used in this study.

Reprinted with permission from GCAGS, Transcripts, 1993.

Regional Setting

Stratigraphy

The Frio Formation represents several episodes of deposition in the northwestern Gulf of Mexico basin. Previous work by Galloway et al (1982 and 1986) has characterized the Frio as systems of broad deltas and intervening barrier island/strandplain deposits prograding the Texas and Louisiana shelf. The deltas are seen as predominantly fluvial dominated depositional systems that have been wave modified. The barrier island/strandplain sediments are interdeltaic deposits interpreted to be strike oriented reworked deltaic material.

Structure

The Frio Formation in the Orange County area represents the latter stages of infilling of a salt withdrawal basin associated with two large piercement salt domes in the southern portion of the county. The lower Frio and older sediments have been displaced by regional, generally down-to-the-south growth faults, which exhibit minor displacement in the middle and upper Frio. One significant exception to this is a proliferation of small-scale local and rotated slump blocks that occur in the basal portion of the middle Frio.

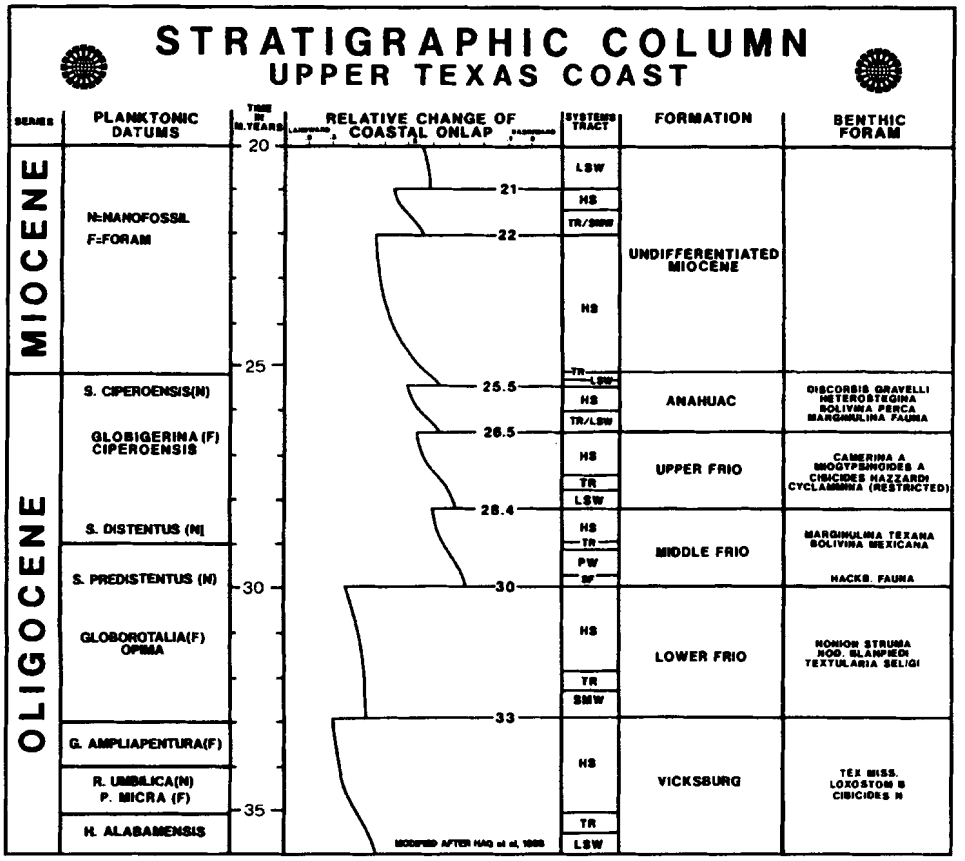


Figure 2 Stratigraphic column for the Oligocene Epoch of the Texas Gulf Coast.

Depositional Units

Galloway et al (1982) recognizes three operational subunits on the basis of correlations of stacking patterns derived from resistivity logs, sand-shale ratios, and benthic foraminifera which they call the lower, middle and upper Frio. Although the relationship between these units is described as lateral and vertical facies, we believe that the three subunits represent depositional sequences bounded by unconformities and their downdip equivalents (Fig. 2).

Middle Frio

The middle Frio in the study area is defined on seismic data by a series of rotated blocks at its base, that are downlapped by a relatively thick package of well-defined clinoforms which prograde southward overlain by set of parallel to slightly oblique reflectors which truncate the clinoforms (Fig. 4). It overlies the shales of the lower Frio on a pronounced erosional unconformity which is evident on seismic data by it's irregular surface and the discordant relationship and internal character differences between the overlying and underlying strata (Fig. 4). Well logs through this irregular surface show a sharp and abrupt contact between the overlying sands and the underlying shales (Fig.3). The unconformity which has a regional extent is interpreted to be the 30 m.y. sequence boundary of Haq et al (1988). Biostratigraphic data has been used to bracket the age between the highest occurrence of *Sphenolithus predistentsus* and the highest occurrence of

the nannofossil *Sphenolithus distentsus*. This points to an age somewhere between 30.5 m.y. and 29 m.y. The strata below the unconformity contains shallow water fauna while the shales in the overlying strata contain the fauna commonly referred to as the deep water Hackberry assemblage.

The upper boundary is placed at the 28.4 sequence boundary of Haq et al, 1988. It is located just above a well developed microfossil abundance peak containing the highest occurrence of *Sphenolithus distentsus* and *Globorotalia opima* at 29 m.y. Although a minor disconformity is expressed on seismic data, the well logs exhibit an abrupt boundary between the underlying interbedded shales and coarsening upward sands and the overlying massive sands (Fig. 3).

Systems tracts (Fig. 5) can be recognized in the middle Frio subunit. The lowest strata which is generally referred to as the basal Hackberry is a slope fan. On seismic data (Fig. 4), it appears to have an irregular upper surface, in some places a mounded geometry containing short discontinuous reflectors. All are characteristics attributed to slope fans by Pacht et al (1990). The upper surface is downlapped by reflectors of overlying strata. SP shapes of sand encountered within this zone are usually blocky with sharp basal and upper boundaries (Fig. 4) or are thin-bedded, fining-upward units indicative of turbidities.

The next overlying stratigraphic zone is interpreted to be the lowstand prograding wedge (Fig. 5). On seismic data (Fig. 4) the zone is characterized by low angle clinoforms which converge updip to below seismic resolution. Chaotic reflections occur occasionally between the clinoforms, suggesting that these sediments are slumped. Well-logs through the prograding wedge show that the clinoforms are sand poor except at the distal end of each clinoform. Here, stacked turbidities have accumulated to thicknesses in excess of 300 feet.

It should be noted that the upper slope shales along the clinoforms have often been referred to as the upper Hackberry (Paine, 1966). A deep water benthonic faunal assemblage, similar to that which occurs in the underlying slope fan strata, occurs in these deep water pro-deltaic sediments as well.

The prograding wedge consists of deltaic and prodeltaic sediments deposited at the shelf edge, on the upper slope and at the base of the slope.

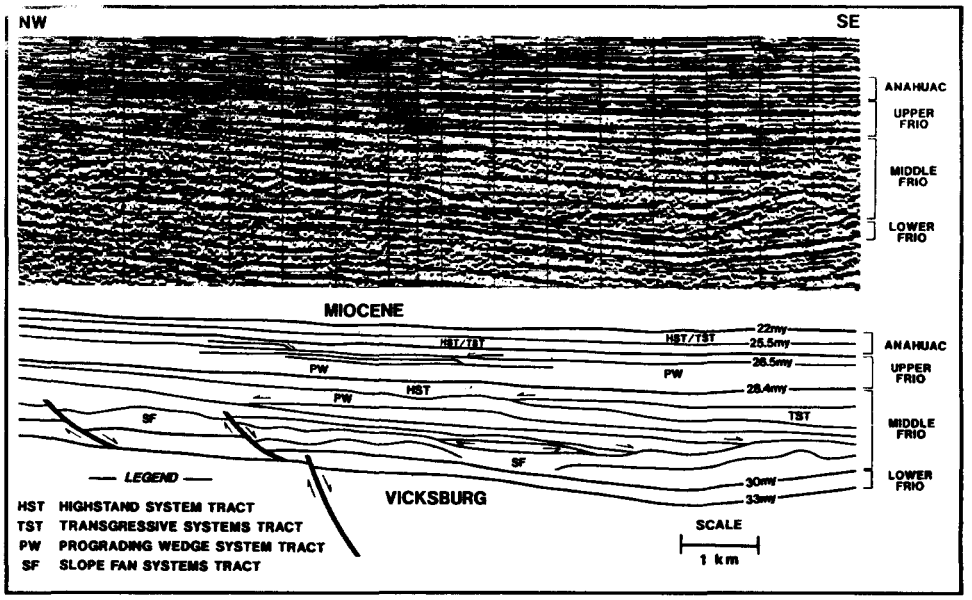


Figure 3 Type log and seismic section for the Oligocene of Orange County, Texas.

Coarsening-upward cycles are the dominant pattern shown by the well logs in the few thin sands encountered through the upper part of this unit, whereas the sands at the base generally exhibit fining-upward cycles. Paleobathymetric interpretations suggests the water depth shallows from upper bathyal to outer neritic.

Above the prograding wedge is a relatively thin shaley zone that contains abundant microfossils (Fig. 3). These strata are the transgressive systems tract (Fig. 5) and represent deposition during the maximum rise of sea level in which there is a limited amount of terrigenous clastic input. On the seismic data this zone appears as an onlapping wedge that thins updip (Fig. 4).

The uppermost member of this sequence is the highstand systems tract (Fig. 5). This is another prograding unit which shows weak clinoforms on the seismic data (Fig. 4). Well penetrations indicate that this section is predominantly shale.

Upper Frio

The upper Frio consists of a series of very thick and generally coarsening-upward and blocky sands with relatively thin shale interbeds. The formation top

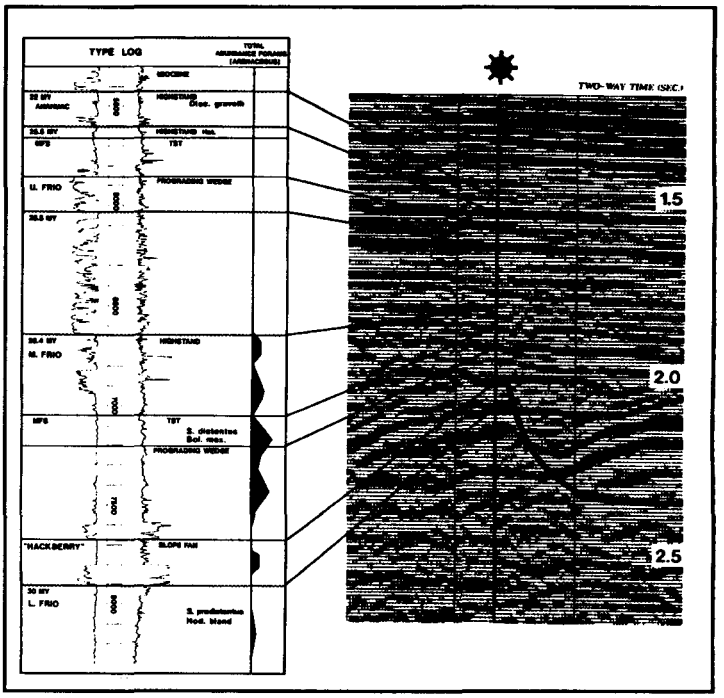


Figure 4 Typical dip-oriented seismic profile and its interpreted section for the lower, middle and upper Frio and Anahuac Formations.

is placed at the top of the uppermost massive sand unit. This upper sand has been transgressed by the shales of the Anahuac Formation and the resulting transgressive surface can be traced regionally on seismic data. We recognize an unconformity within the upper portion of the upper Frio (Fig. 3). This boundary is recognizable from both log and seismic data. In well logs the boundary occurs at the base of a generally massive sand that overlies shaley strata containing thin backstepping sands. On seismic data we see a somewhat irregular surface which is downlaped by low angle clinoforms. This boundary is interpreted to be the 26.5 m.y. unconformity. Within the study area we do not have paleontological information to date this unconformity, however correllation to additional biostratigraphic control in Calcasieu Parish supports this assertion.

The upper Frio strata below the 26.5 m.y. unconformity consists of a series of very thick coarsening upward sands with relatively thin shale interbeds overlain by a transgressive shale and thin shaley highstand.

The very sandy unit overlying the unconformity shows repetitive coarsening-upward cycles. Some quite massive individual sand bodies, upwards of 100 feet (Fig. 3), occur in the upper portion of this prograding wedge. The paleobathymetry recorded for the upper Frio and overlying shales is middle to inner neritic. We interpret these units as having been deposited in lower delta plain to increasingly updip environments on the delta plain.

The overlying transgressive shales contain several thin calcareous sand lenses which are commonly called the "Marginulina" sands. Resistivity markers within the transgressive shale can be correlated regionally as is expected in this unit. We interpret the shales up to the gamma ray shale maximum as the transgressive systems tract (Fig. 3). Above these shales is another thin shaley zone containing Heterostegina sp., which represents the highstand systems tract. The maximum flooding surface (MFS) which separate these systems tracts is readily identifiable on and can be correlated with log data.

The "Heterostegina" zone has been assigned to both the basal Miocene as well as the uppermost Oligocene by several authors (Curtis et al, 1985; Krutak and Beron, 1990). Our biostratigraphic studies in adjacent Calcasieu Parish indicate a late Oligocene age for the zone, which supports the upper boundary for

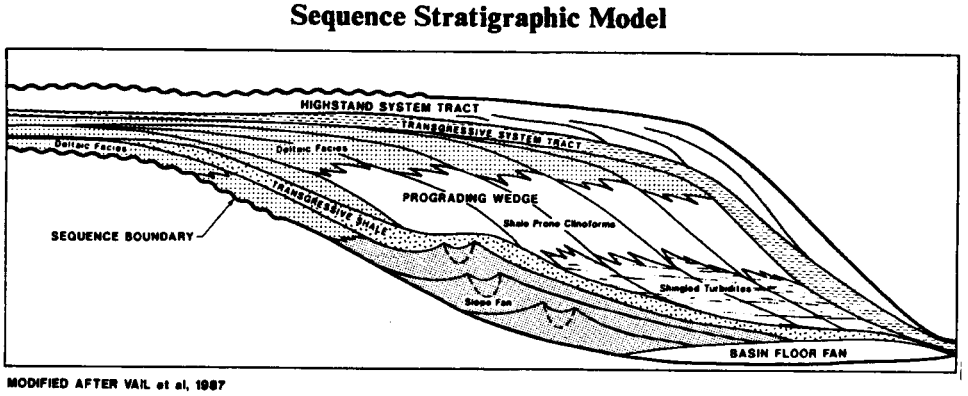


Figure 5 Idealized model for a depositional sequence showing bounding surfaces and systems tracts.

the sequence as being the 25.5 m.y. sequence boundary (Haq et al, 1988) at the top of the Oligocene. We have found these sands to lie above a regional condensed section containing the highest occurrence datum of Sphenolithus ciperoensis, which occurs at 25.5 m.y. (Haq et al, 1988) (Fig. 2). The sequence boundary is expressed on seismic data as a well defined erosion surface of regional extent.

Conclusions

The middle and upper Frio Formation can be subdivided into three depositional sequences bounded by unconformities or sequence boundaries. Each of these sequences has recognizable component systems tracts which contain specific types of sand deposits in specific places. This has several significant effects on our understanding of the depositional history as well as future exploration efforts in the trend. Better correlation techniques are necessary when exploring for subtle traps or when looking for new plays. The use of the sequence boundary as the primary means of correlation provides a better

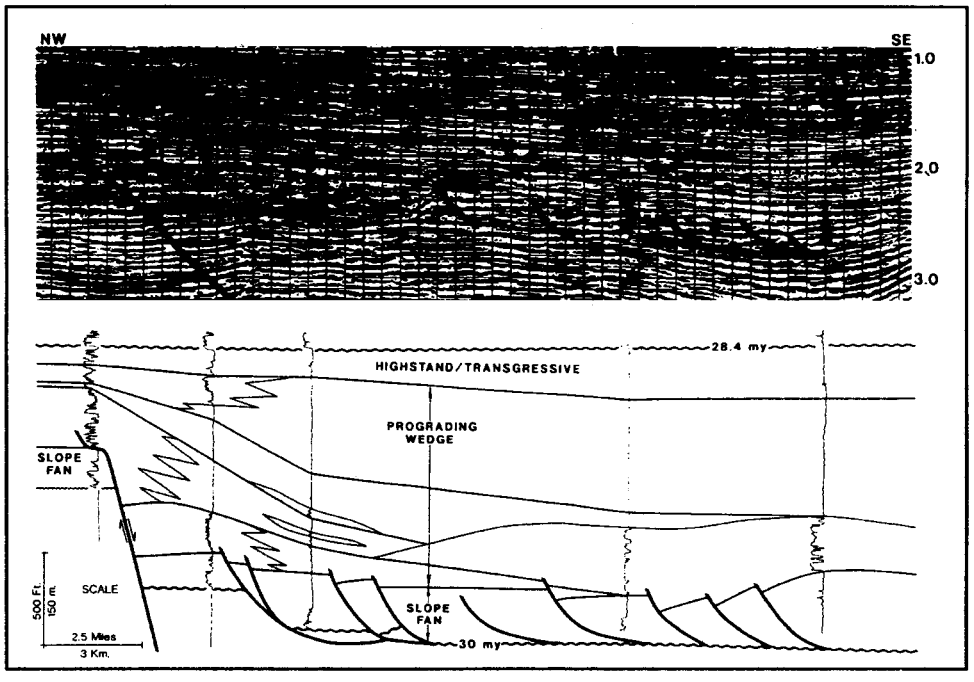


Figure 6 Portion of a dip-oriented seismic section and corresponding well log cross-section for the middle Frio. Log intervals and projected locations are shown on the seismic data. In the slope fan, massive sands and stacked turbidites are concentrated near the base. In the prograding wedge, sands occur in topset bed and at the base of clinoforms.

method of predicting the occurrence and likely location of major unexplored wedges. Correlation by means of time lines within depositional units aides in predicting the occurrence of sands as well as their reservior quality within the systems tracts.

The sands encountered in the Frio tend to be concentrated in three depositional settings (Fig. 6):

1. In the basal slope fan, in the form of channels, levees, and overbank turbidites.

2. In the prograding wedge, at the base of individual clinoforms. These sands tend to be stacked turbidites composed of individual sand lenses that have limited lateral extent. Accumulations of these sands tend to form mounded, low relief depositional pods. These basal prograding wedge sands are commonly correlated for great distances along dip with sands of quite similar character and stratigraphic position, however they are frequently isolated within individual clinoforms as demonstrated in Fig. 6.

3. In the topset beds of the prograding wedge, as prograding and aggrading deltaic sand bodies.

Each of these depositional settings presents different exploration constraints as well as opportunities. Lateral continuity and a strike orientation are characteristic of the deltaic sands in the topset beds of the lowstand prograding wedge. Because these topset beds are generally sandy with few shale breaks the critical exploration factor is a structural and/or stratigraphic seal.

The turbidites in both the prograding wedge and slope fan are very lenticular and are dip directed. While assiciated shales provide good seals questions of porosity, permeability and lateral continuity of reservior are critical factors.

If the stratigraphic model of the upper Frio is like that of the middle Frio, then two unexplored slope fan systems tracts containing sands must occur downdip and could constitute new plays. Additionally each of these sequences should have prograding wedge associated shingled turbidites that will present other exploration targets.

Careful correlation and an attention to detail will pay dividends in the exploration for hydrocarbons in the Frio and in the underlying major clastic wedges.

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RICE UNIVERSITY DEPARTMENT OF GEOLOGY & GEOPHYSICS

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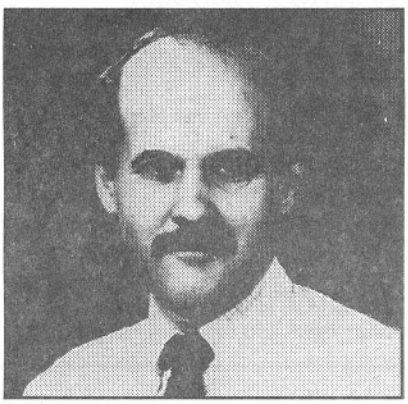

Dr. R. Douglas Elmore, Professor of Geology at The University of Oklahoma, School of Geology and Geophysics, Norman, Oklahoma, and a Distinguished Lecturer sponsored by The American Association of Petroleum Geologists, will address a seminar on Tuesday, February 8, 1994 at 4:00 p.m. The meeting will be held at Rice University in the Keith Wiess Geological Laboratories, Room 106. The title of his paper is "Chemical Remagnetization and Paleomagnetic Dating of Fluid Migration Events: Testing the Orogenic Fluid Hypothesis".

Call 527-4880 for information.

SIMPSON AND VIOLA GROUPS IN THE SOUTHERN MIDCONTINENT—A WORKSHOP
Norman, OK; March 29–30, 1994

Co-Sponsored by

Oklahoma Geological Survey and Bartlesville Project Office of D.O.E.

A 2-day workshop in Norman, OK, at Oklahoma Center for Continuing Education (OCCE).

Tuesday, March 29
Oral Presentations, 8:30 a.m.–4:30 p.m.

Simpson Group Stratigraphy of the Southern Midcontinent, by Raymond W. **SUHM**, Consultant, Oklahoma City

Contrasting Sedimentation Inside and Outside of the Southern Oklahoma Aulacogen during Middle and Late Ordovician Times, by Rodger E. **DENISON**, Univ. of Texas at Dallas

Major Simpson and Viola Oil and Gas Reservoirs in Oklahoma, by Robert A. **NORTHCUTT**, Okla. City, and Kenneth S. **JOHNSON**, Okla. Geol. Survey

Stratigraphy and Petroleum Production of the Simpson, Viola, and Maquoketa in Kansas and Nebraska, by Marvin P. **CARLSON**, Nebraska Geological Survey, and K. David **NEWELL**, Kansas Geological Survey

Tobosa Basin-Related Sediments of West Texas, by David V. **LeMONE**, Univ. of Texas at El Paso

Facies and Karst Development in the Viola Limestone in Southern Oklahoma, by Zuhair **AL-SHAIEB** and Jim **PUCKETTE**, Oklahoma State Univ.

Viola Fractures—Friend or Foe in Hori-zontal-Drilling Programs, by Carlos **GONZALES**, G&G International Consultants, Oklahoma City

The Viola Group as a Petroleum System—Implications for Horizontal-Drilling Prospects, by D. A. **WAVREK**, Univ. of South Carolina, and M. A. **GARCIA**, ARCO, Houston

Geochemical Characteristics of Viola Oils and Source Rocks, by R. Paul **PHILP**, H. **WANG**, J. **ALLEN**, and A. **BISHOP**, Univ. of Oklahoma

Source-Rock Characteristics of the Viola Springs Formation on the South Flank of the Arbuckle Anticline, by Alton **BROWN** and Joe **SENFTLE**, ARCO, Plano

Tuesday, March 29
Poster Session, 4:30–6:30 p.m.

Sequence Stratigraphic Model for Simpson Group of the Southern Midcontinent: The Key to a New Stratigraphic Play, by Magell P. **CANDELARIA**, ARCO, Midland, C. Robertson **HANDFORD**, ARCO, Plano, and Christy L. **REED**, ARCO, Midland

Correlation and Distribution of Reservoir and Sealing Facies Within the Viola Formation, South-Central Kansas, by K. David **NEWELL**, Kansas Geol. Survey

Controls of Quartzarenite Diagenesis, Simpson Group, Oklahoma: Implications for Reservoir-Quality Prediction, by Mark E. **MATHISEN**, Mobil E&P Technical Center, Dallas

Hydrocarbon Microseepage Signature of the Clarita Prospect, Coal County, Oklahoma, by Daniel C. **HITZMAN**, Geo-Microbial Tech., Inc., Ochelata, OK

Wettability Alteration in Reservoir Rocks Due to Polar Constituents in Crude Oil, by Anuj **GUPTA**, Univ. of Oklahoma

Reservoir Analysis of a Horizontal Well Completion: Viola Ls. "Chocolate Brown Zone," Marietta Basin, Oklahoma, by Brian **ROUX** and Magell P. **CANDELARIA**, ARCO, Midland, TX

Seismic Evidence of the Development of Abrupt Sedimentary Buildups in the Simpson Group of the Marietta Embayment, Oklahoma, by Gary L. **GARNER**, Garner Resources, Inc., Oklahoma City

Shallowing-Upward Events and Their Implications for Internal Correlations and Depositional Environment of the St. Peter Sandstone in the Forest City Basin, NE Kansas, by Lynn **WATNEY**, Kansas Geol. Survey, Bryan **STEPHENS**, Texaco, New Orleans, and David **NEWELL**, Kansas Geological Survey

Tobosa Basin Karsting in West Texas, by David V. **LeMONE**, Univ. of Texas at El Paso

S.O.A.P. Database—Forecasting Trends in Crude-Oil Quality, by S. **NEELEY** and D. A. **WAVREK**, Univ. of South Carolina

Stratigraphy and Depositional Environments of the Middle Ordovician Everton Formation, St. Peter Sandstone, Joachim Dolomite, and Plattin and Kimmswick Limestones (Simpson Group Equivalents), Northern Arkansas, by William W. **CRAIG**, Univ. of New Orleans

Wednesday, March 29
Oral Presentations, 8:00 a.m.–3:30 p.m.

Ordovician Sea-Level Changes as Seen from an Off-Shore, North American Perspective, by Stanley C. **FINNEY**, California State Univ. Long Beach

Structural and Stratigraphic Factors Which Influence Simpson Group Production in Central Oklahoma, by Paul W. **SMITH**, Norman, OK

Stratigraphy, Paleogeomorphology, and Structure of Simpson, Viola, and Mississippian Strata, and Their Integral Relationships to Second Wilcox Production in Lincoln and Logan Counties, Oklahoma, by Kurt **ROTTMANN**, Beard Oil Co., Oklahoma City

Facies, Depositional Environments, and Reservoir Properties of the Simpson Group in Scully Field (Marion County, Kansas), by Jim **MAZZULLO** and Martha **McRAE**, Texas A&M Univ.

Middle Ordovician Ironstones in Kansas: Subsurface Markers of Paleoshorelines for the Midcontinent, Pieter **BERENDSEN** and John D. **DOVETON**, Kansas Geological Survey

Simpson–Arbuckle Contact Revisited in Northwest Oklahoma County, Oklahoma, by Michael D. **ALLISON**, Consultant, Gainesville, TX, and Bob **ALLEN**, Kabodi. Inc., Ardmore, OK

Influence of Vertical Permeability Barriers on the Ultimate Recovery from Oil Creek Reservoirs, by James M. **FORGOTSON** and Roy M. **KNAPP**, Univ. of Oklahoma, Paul W. **SMITH**, Norman, OK, and Huaibo **LIU**, Univ. of Okla.

Characterization of High-Molecular-Weight Paraffins in Simpson Group Reservoirs—Implications for Advanced-Recovery Techniques, by N. F. **DAHDAH** and D. A. **WAVREK**, Univ. of South Carolina

Diagenetic Banding as a Sealing Mechanism in Bromide Sandstone Reservoirs in Central Oklahoma, by James **PUCKETTE**, Azhari **ABDALLA**, and Zuhair **AL-SHAIEB**, Oklahoma State Univ.

Optimized Recovery from Simpson Sandstones in the Noble Townsite Field, by James M. **FORGOTSON** and Roy M. **KNAPP**, Univ. of Oklahoma, Paul W. **SMITH**, Norman, OK, and Jorge Luis **CARMONA**, Univ. of Oklahoma

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SIMPSON–VIOLA WORKSHOP, PREREGISTRATION FORM — Make checks out to "**OGS Conferences**."

Please fill out form, detach it and return it to: **Oklahoma Geological Survey, 100 E. Boyd, Room N-131, Norman, Oklahoma 73019.**

NAME: (Last) _____ (First) _____ (Initial) _____

(Nickname, for badge) _____

AFFILIATION: _____

MAILING ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____ PHONE: (_____) _____

Check, payable to "**OGS Conferences**," must accompany preregistration form. Use separate form for each registrant. For **CEU** credit(s), please check here ____.

Regular Registration

	Received by *March 4*	Received after *March 4*	
Workshop	$50	$65	$_____
Banquet	$15	$18	$_____
		TOTAL	$_____

(FOR HOUSING AT OCCE, SEE FORM ON OTHER SIDE) ***Payable to "OGS Conferences"***

Student Registration

	Received by *March 4*	Received after *March 4*	
Workshop	$25	$35	$_____
Special regist. (no lunch/proceedings)	$ 0	$ 0	$_____
Banquet	$15	$18	$_____
		TOTAL	$_____

Payable to "OGS Conferences"

If you have a disability which requires special services, please check here ☐

SIMPSON AND VIOLA GROUPS IN THE SOUTHERN MIDCONTINENT—A WORKSHOP

Additional Information

(*see previous page*)

PURPOSE AND SCOPE OF WORKSHOP—This workshop is designed to transfer technical information that will aid in the search for, and production of, oil and gas resources. It will focus on reservoirs in the Middle and Late Ordovician Simpson and Viola Groups of the southern Midcontinent. These reservoirs already have yielded large volumes of oil and gas, and they have great potential for additional recovery using advanced technologies. This is the seventh workshop/symposium in as many years, each program covering a topic of major concern to geologists and others involved in exploration and petroleum-resource development in Oklahoma and adjacent states.

LOCATION—Oklahoma Center for Continuing Education (OCCE) is a conference facility that provides meeting rooms, housing, restaurant, and parking at 1704 Asp Avenue, Norman, Oklahoma (405/325-5631).

REGISTRATION FEE—Advance registration (prior to March 4) is $50 ($25 for students) for the entire technical conference, or any part of it. Late registration will be $65 ($35 for students). Registration covers technical sessions, lunches, and the workshop proceedings, which will be published in early 1995. The fee does not include the Tuesday evening banquet. Students may choose a special registration, at no charge, that does not include luncheons or workshop proceedings.

REGISTRATION DESK—Main lobby of the Forum Building at OCCE on Monday, from 4:00–8:00 p.m.; on Tuesday, 7:30 a.m. until 5:00 p.m.; and on Wednesday, 7:30 a.m. until 3:00 p.m. Pick up badges, tickets, and other materials at the desk upon arrival. Admission to workshop activities will be by badge or ticket only.

EARLY-BIRD PARTY—A no-charge cocktail party will be held for early-arriving registrants in the Commons Restaurant from 5:00–8:00 p.m. on Monday.

TRANSPORTATION—Will Rogers World Airport, Oklahoma City, is about 20 miles north of Norman. Rental cars or taxi/limousine service (about $30 for one to four persons) are available at the airport. If driving: exit from Interstate 35 in Norman on Lindsey Street; travel 2 miles east to Asp Avenue; turn south (right) on Asp and travel 0.4 mile; parking lots of OCCE are on your right (see map of OCCE facilities).

BANQUET—Will be in the Commons Restaurant (OCCE) at 7:00 p.m. on Tuesday, following a no-charge cocktail hour at 6:30 p.m. Cost is $15 per person. Reserve tickets on the registration form. The banquet will have a speaker and entertainment.

HOUSING—Rooms are available in Sooner Hotel and Cottages at OCCE. Sooner Hotel rooms have two beds, phone, color TV, and private bath. Cottages have two bedrooms (each with one queen-sized bed), living room, kitchenette, phone, color TV, and one private bath (available only for parties of 2, 3, or 4). Complimentary breakfast is available for guests in Sooner Hotel or Cottages. Send the attached housing-reservation form to OGS and we will forward it to OCCE. Call Sooner Hotel direct (405/329-2270) to cancel or change housing plans. You may arrange for your own rooms at Norman's Marriott Residence Inn (405/366-0900), Quality Inn (405/329-1624), Ramada Inn (405/321-0110), or Sheraton Hotel (405/364-2882), all located on Interstate 35, about 3 miles from OCCE.

POSTER SESSION—A poster session will be held on Tuesday, March 29, in Conference Room B. Persons doing work on appropriate subjects may display their work. Posters can be work sheets, work maps, or rough copies of cross sections and other data. Posters already offered are listed elsewhere in this announcement. Others planning to bring materials for the poster session should contact LeRoy Hemish, Poster Chair, at the Oklahoma Geological Survey (405/325-3031) by March 4.

Posters will be up by early afternoon, on Tuesday, and authors will be at their poster display from 4:30–6:30 p.m. on Tuesday. Poster authors may submit an extended abstract (or short paper) on their work for publication in the Proceedings Circular which will be released early in 1994.

CONTINUING EDUCATION UNITS—1.5 CEUs are available for the two-day workshop.

FURTHER INFORMATION—Contact the Oklahoma Geological Survey (405/325-3031): Kenneth S. Johnson, General Chair; LeRoy Hemish, Poster Chair.

SIMPSON–VIOLA WORKSHOP, HOUSING-RESERVATION FORM

Please fill out this side of the form if you want to reserve a room at OCCE. See description of accommodations under "**HOUSING.**"
Do not prepay for your room.

Sooner House: 1 person, $32 ❑ 2 persons, $40 ❑ (per night) *(no tax will be charged)*

Cottages (only for 2 or more): 2 persons, $60 ❑ 3 persons, $66 ❑ 4 persons, $72 ❑ (per night) *(no tax will be charged)*

Complimentary breakfast for residents of Sooner Hotel and Cottages: juice, cereal, pastry, coffee, milk.

Arrival date_____, approximate time_____. Departure date_____ (Check-out time is noon)

Name _____

Mailing address _____

City, State, Zip _____ Phone (_____) _____

Names of other persons who will be sharing room _____

Preregistration Form on other side. Return this with Preregistration Form to the Oklahoma Geological Survey. But then call Sooner Hotel direct (405/329-2270) if you must cancel or change your housing plans.

MID-CONTINENT FEATURE

Sequence Stratigraphy of the Hunton Group as Defined by Core, Outcrop, and Log Data

Richard D. Fritz and Patrick L. Medlock

INTRODUCTION

The Hunton Group represents a prolific oil and gas producing horizon in both the Midcontinent and the Midland Basin. Equivalent strata in the Black Warrior Basin and other interior basins also show potential for production. Most of the Hunton accumulations are structural/ stratigraphic traps, often produced by truncation of porous carbonate across structural noses. Some of the greatest potential for Hunton production is now found in the deepest parts of the Anadarko Basin; some of the deepest gas fields in the world are located in the Hunton Group at depths below 20,000 ft along the Oklahoma/ Texas border.

From 1982 to 1989, the Hunton Group was studied by employees and consultants of Masera Corp. as part of a commercial project. The project area included the Anadarko Basin, central and southern Oklahoma, and the Arkoma Basin (Fig. 1). More than 10,000 wells were correlated and evaluated for reservoir potential. Regional and detailed cross sections were built and used to construct detailed maps that show thickness and net porosity of individual zones within the Hunton. Although most of the results of this project are still proprietary, some of the basic findings are discussed in this paper.

REGIONAL SETTING

The Silurian-Devonian was a time of widespread marine-carbonate deposition. Marine waters covered the Trans-Continental arch and most of the Canadian shield. In fact, the transgression responsible for this expansive sea was fully as extensive as that of the Ordovician. Considering the great thickness of Cambrian-Ordovician carbonates, the Silurian-Devonian strata were deposited as a relatively thin veneer of limestones and dolomites, with locally significant deposits of sandstone and shale.

In the Midcontinent, the Latest Ordovician-Silurian-Early Devonian is represented by the Hunton Group, which was deposited primarily as subtidal/intertidal facies in a ramp-type environment. Outside the Midcontinent, extensive reefs are present in equivalent strata along the cratonic edges in Nevada, Canada, Franklin trough of Baffin Island, and Greenland. Off-shelf, dark graptolitic shales are typical basinal sediments.

Silurian strata are more extensive than the Devonian and are preserved in diatremes in northern Colorado and southeastern Wyoming on the crest of the Trans-Continental arch (Fig. 2; Wilson, 1975). Silurian and Lower Devonian carbonates are also found in karstic deposits within underlying Ordovician strata in the Llano uplift.

STRATIGRAPHY

The Hunton Group is a readily recognizable distinctive unit because it is stratigraphically sandwiched between the Woodford Shale, above, and the Sylvan Shale, below (Fig. 3). The Hunton is composed of sequences of dolomite, limestone, and calcareous shale. Based primarily on outcrop surveys, the Hunton is divided into a number of formations. The Chimneyhill Subgroup, at the base, is comprised of the Ordovician Keel Formation and the overlying Silurian Cochrane and Clarita Formations (Amsden, 1961, 1975,1980). The Chimneyhill is overlain successively by the Silurian Henryhouse and the Devonian Haragan and Bois d'Arc Formations (Fig. 4). In central and southern Oklahoma, the Bois d'Arc is overlain by the Frisco Formation, and in the Arkoma basin the uppermost Hunton is composed of the Sallisaw Formation (Penters Chert). Some workers do not include the Sallisaw Formation within the Hunton Group.

The overlying Woodford Shale and equivalent strata are part of an extensive sequence of hydrocarbon source beds that provided oil and gas for many of the Paleozoic petroleum reservoirs. The Woodford underlies most of Oklahoma, ranging in thickness from a feather edge in northern Oklahoma to >700 ft in southern Oklahoma. It contains conodont fauna of Late Devonian to Early Mississippian age.

The Woodford is easily distinguished on outcrop by its dark-gray to black color and its cherty composition, and in the subsurface it is an excellent "marker bed" because of its distinctive "high" gamma-ray response (Fig. 3).

The underlying Sylvan Shale is typically a greenish-gray to greenish-brown marine shale. On average the Sylvan is <50 ft thick, although it attains a thickness of >300 ft in the Arbuckle Mountains.

PETROGRAPHY

More than 100 cores from Texas, Oklahoma, and Arkansas were described and evaluated during the course of this study. Recognition of lithofacies in these cores is based on texture, sedimentary structures, constituents, and geometry.

Reprinted and excerpted with permission from: Johnson, K. S. (ed.), Hunton Group Core Workshop and Field Trip: Oklahoma Geological Survey Special Publication 93-4, p. 161-180.

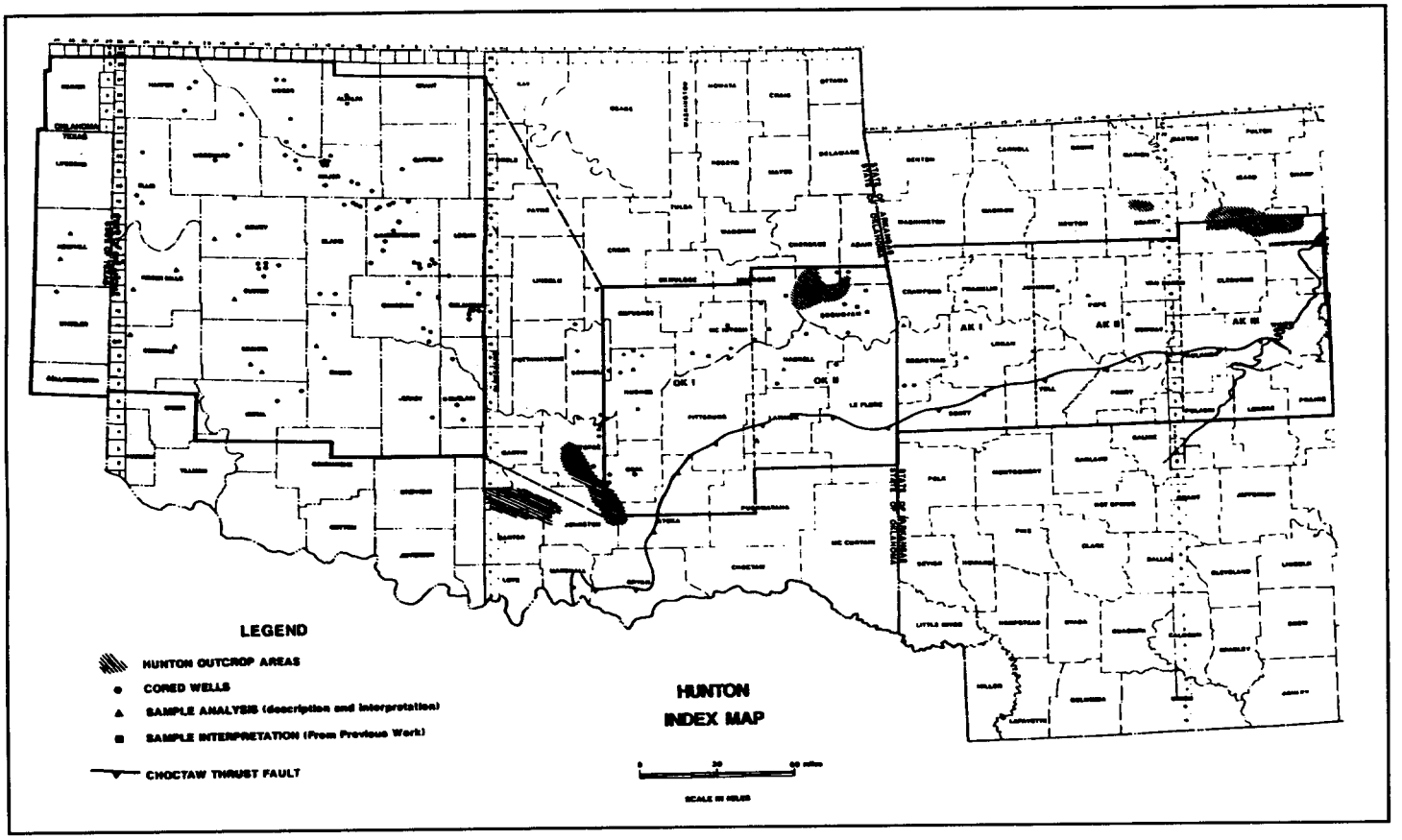


Figure 1. Index map showing area of the Hunton Group study.

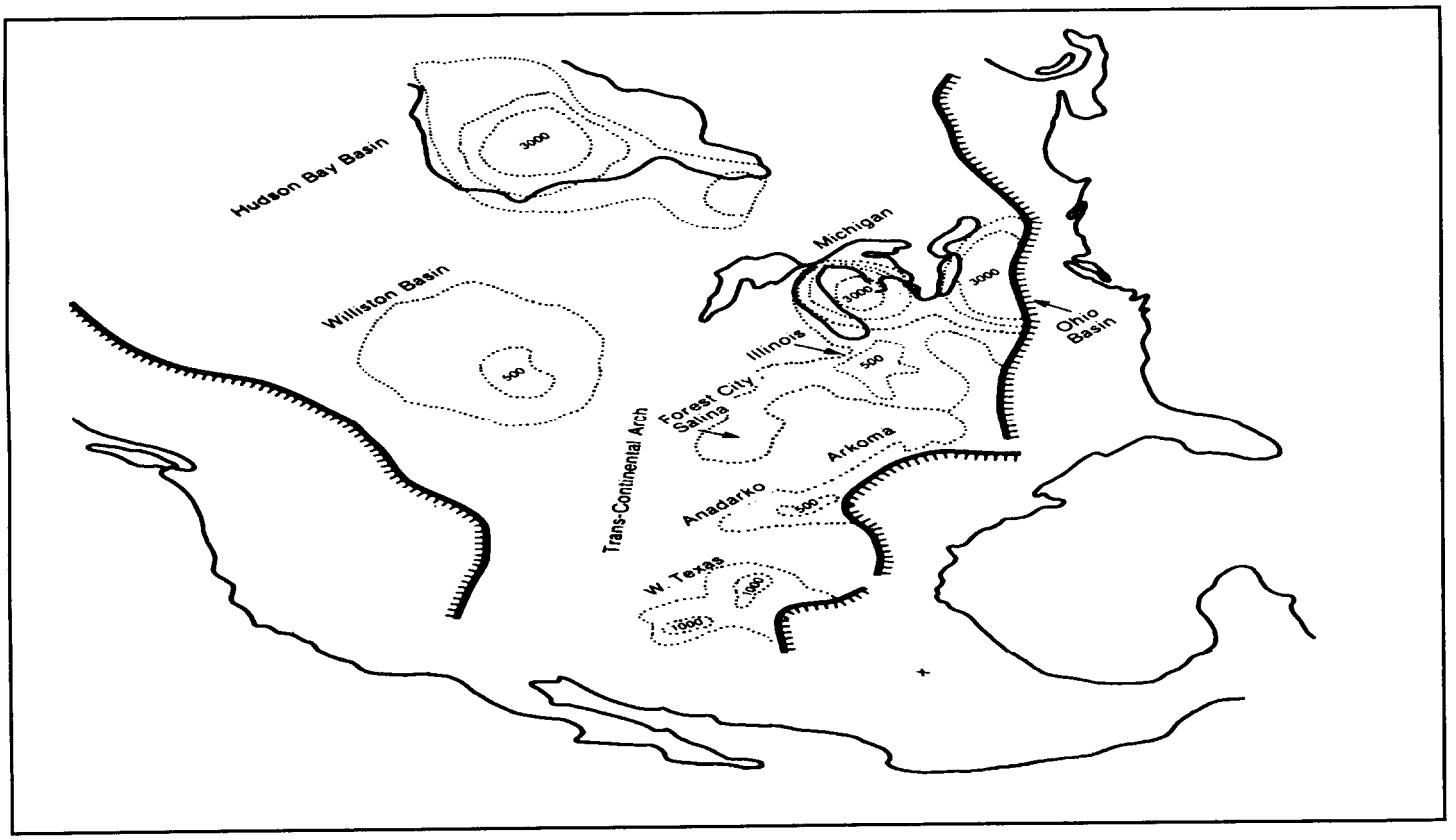


Figure 2. Map showing distribution and thickness (in feet) of Silurian strata in North American.

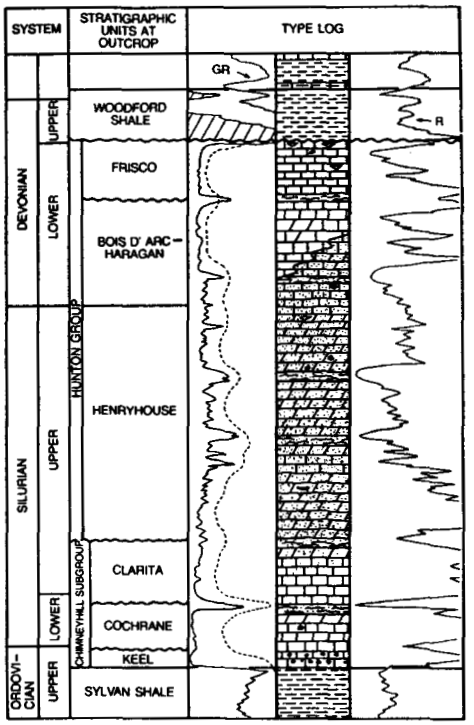


Figure 3. Type log of the Hunton Group in central Oklahoma (excluding the Sallisaw Formation).

Lithofacies are classified according to Dunham's organization of inferred depositional textures (Fig. 5). Mudsupported rocks are much more abundant than grain-supported rocks, although a gradation exists between the two types. The Chimneyhill Subgroup and the Frisco tend to have more grain-supported textures, whereas the Henryhouse to Bois d'Arc section is typically mud-supported. The precursor to the Penters Chert was most likely mud-supported, but it is difficult to determine the original fabric due to the amount of alteration and brecciation.

Burrows and bioturbation are the most common types of depositional structures. Ripple bedding and cross bedding are typical of pelmatozoan and oolitic grainstones and packstones. Algal laminations are common and are often associated with fenestral fabric. Thin- to medium-bedded strata are present on outcrop and in core.

The most common constituents are skeletal fragments and lime mud (micrite). Peloids and ooids are common in high-energy facies. Skeletal fragments consist mostly of pelmatozoan material (dominantly crinoids). Certain portions of the Hunton contain abundant brachiopods (such as the Henryhouse) and abundant bryozoans (such as the Frisco). Other skeletal grains include algae, trilobites, corals, mollusks, and ostracods.

Terrigenous constituents are typically clay, with some quartz silt and sand. Penecontemporaneous constituents include dolomite, anhydrite, and glauconite.

DEPOSITIONAL ENVIRONMENT

Based on core and outcrop descriptions, the Hunton was deposited on a broad ramp in a shallow epicontinental sea (Fig. 6). Overall slope was generally toward the south, with the deepest water in the region of the Oklahoma aulacogen; the off-shelf basin was probably located south and southeast of the aulacogen.

Carbonate ramps have been described by Roehl (1967) and Laporte (1968) for ancient carbonate environments. Unfortunately, few, if any, modern analogues exist, although some areas such as the Persian Gulf have similar geometry. It is thought that the local slopes associated with the shoaling areas on the ramp were generally steeper than the very gentle slope of the sea floor.

DEPOSITIONAL MODEL

Based on the petrographic examination and evaluation of outcrops, cores, and samples, several distinct environments and related lithofacies can be identified. The basic depositional environments are supratidal, which occurred above high tide; intertidal, which occurred below high tide and above low tide; and subtidal, which occurred below low tide. These environments can be further subdivided into upper and lower parts (Fig. 7). Adjacent environments, such as the transitional area between intertidal and subtidal facies, can form distinctive lithofacies and herein are treated as separate facies. Within the subtidal environment there is a facies unique to the Frisco Formation, and that is, crinoidal mud mounds. The constituents, textures, and structures of each facies are described below:

Upper intertidal to supratidal.—Algally laminated mudstones predominate in this environment. Fenestral fabrics are common and there is a paucity of fossils and burrowing. Anhydrite nodules and replaced evaporites, such as silica nodules with relic anhydrite crystals, are present in this facies (Chowns and Elkins, 1974; Beardall, 1983).

Upper subtidal to lower intertidal.—This facies is typically a crinoidal wackestone. Brachiopods are also present; trilobites and bryozoans may be present, but are rare. Burrowing is the most common sedimentary feature; it probably enhances permeability of this facies for later dolomitization, which forms a reservoir-quality lithology.

Lagoons. Lagoons may form in this area and the sediments that are deposited typically are peloidal mud/wackestones.

Subtidal.—This facies can also be subdivided into upper and lower (open-marine) systems, in response to wave and current energy. Typical textures are wackestone to mudstones, with rare packstones, and they contain a diverse fauna of crinoids, brachiopods, trilobites, bryozoans, and ostracods. Delicate, thin-shelled fossils are well preserved in the lower subtidal facies. Common sedimentary structures include burrows and hummocky to nodular beds.

Shoal. Oolitic and peloidal grainstones, along with skeletal grainstones, comprise this facies. Cross bedding is common; other sedimentary structures are thin beds and ripple laminae. Where dolomitized, this facies is an excellent reservoir.

Crinoidal mud mounds. This depositional environment has been identified in, and is probably restricted to, the Frisco Formation. It formed where crinoidal and bryozoan-rich bioherms acted as baffles to trap lime mud, thus forming a mud-supported mound facies with associated grain-supported flanking and capping facies (Fig. 8; Medlock, 1984).

CYCLICITY

The above facies occur in shallowing-upward cycles or parasequences. A complete sequence is shown in Figure 9; however, it is important to recognize that complete sequences are not commonly observed, due to progradation and disconformity or unconformity. As previously discussed, the Hunton is composed of a series of progradational, aggradational sequences that built generally southward on a ramp. The composition of each particular sequence is dependent on its position on the ramp. For example, a sequence from the Henryhouse Formation on the outer ramp (e.g., southern Oklahoma outcrops) is relatively thin (<25 ft) and is

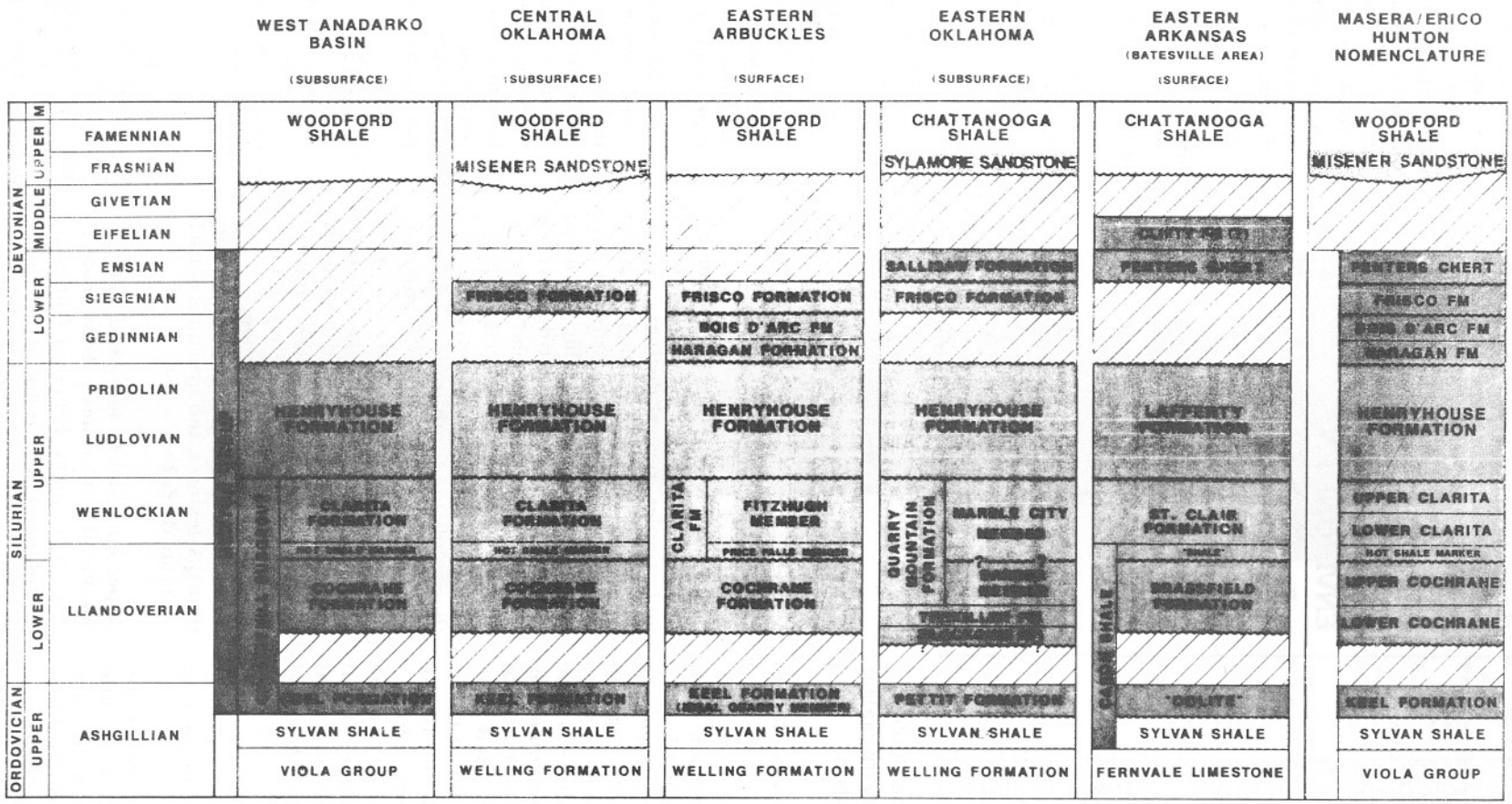


Figure 4. Correlation chart of the Hunton Group (revised from Amsden, 1975.)

continued on page 52

Article continued on page 52

GEO-EVENTS

MEETINGS

IN HOUSTON

The 1994 North American Prospect Expo,
Westin Galleria, Feb 2 - 3.

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

SPWLA Westside Luncheon,
Radisson Suite Hotel,
I-10 & Beltway 8, 11:30 a.m., Feb. 10.

Houston Geo-PC Users Meeting,
La Madeleine's,
Westheimer and Drexall,
9:30 a.m., Feb. 11.
Call Paul Britt (341-1800 ext. 30 after 6:00 p.m. for information)

GSH Technical Luncheon,
H.E.S.S., 3121 Buffalo Speedway,
11:30 a.m., Feb. 21.

SPWLA Galleria Luncheon,
Robert Skopec,
"Integration of Formation Evaluation Technologies,"
Marriott Galleria, 1750 W. Loop So.,
11:30 a.m., Feb. 15.

SIPES Luncheon,
Ron McWhorter,
"Placios Field: A 3-D Case History",
Petroleum Club,
11:30 a.m., Feb. 17.

SPWLA Northside Luncheon,
Rob Allen,
"Improving Sedimentation Maps with Logs and Current Modeling,"
Sperry-Sun Cafeteria,
3000 No. Sam Houston Pkwy. East.
12 Noon, Feb. 17.

SPWLA Downtown Luncheon,
Dale Fitz, "Quantitative Monitoring of Fluid Saturation Changes Using Cased-Hole Logs,"
Petroleum Club, 800 Bell St.,
11:30 a.m., Feb. 22.

HGA Bridge, Briar Club,
Timmons & Westheimer,
10:00 a.m. -2:30 p.m., Feb. 23.

HGS FEBRUARY MEETINGS

FEBRUARY 7, 1994
(Joint Dinner Meeting with HAPL)
"Perspectives on Some Differences Between Major Oil Companies and Independents" Joe Foster
Post Oak Doubletree Inn,
2001 Post Oak Blvd.
Social Period 5:30 p.m.,
Dinner and Meeting at 6:30 p.m.
Reservations by name only,
Telephone 785-6402.
Must be made or cancelled by noon Friday, Feb. 4.

FEBRUARY 9, 1994
(EVENING MEETING)
HGS Environmental/ Engineering Geologists
H.E.S.S., 3121 Buffalo Speedway
Social Period 7:00 p.m.,
Program 7:30 p.m.,
no reservation required.

FEBRUARY 23, 1994
(LUNCHEON MEETING)
"Exploration Opportunities for Independents - Case Histories in North and East Texas"
Robert Font
Houston Club, 811 Rusk
Social Period 11:30 a.m.,
Lunch and Meeting 12:00, Noon.
Reservations by name only,
Telephone 785-6402.
Must be made or cancelled by noon Monday, Feb. 21.

FEBRUARY 28, 1994
(DINNER MEETING)
HGS North American Explorationists
"Greater Natural Buttes Producing Area, SE Uinta Basin, Utah"
Logan MacMillan
H.E.S.S., 3121 Buffalo Speedway.
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, Feb. 25.

FEBRUARY 28, 1994
(Joint Dinner Meeting with AIPN)
HGS International Group
"The Importance of Cross-Cultural Understanding: China as a Case Study"
Richard Smith
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, Feb. 25.

SCHOOLS AND FIELD TRIPS

GSH School, Larry Beyer,
"Borehole Gravity Surveys,"
BP Plaza, I-10 & Hwy. 6
February 10,

HGS Short Course,
Multiple Speakers,
"Consumers Guide to Workstations: What Every Geoscientist Should Know",
Exxon Auditorium, 800 Bell,
9:00 a.m., - 4:00 p.m., Feb. 26.

OTHER EVENTS

HGA/HGS Wildcatter's Blowout,
Petroleum Club, 800 Bell, 6:30 p.m.,
Social & Cash Bar; 7:15 p.m.,
Dinner Buffet; 8:00 p.m.,
One Act Play by Thomas Barber,
"Decisions, Decisions", Feb. 5.

AAPG Distinguished Lecture,
Dr. R. Douglas Elmore
"Chemical Remagnetization and Paleomagnetic Dating of Fluid Migration Events: Testing the Orogenic Fluid Hypothesis."
Rice Univ., Keith Wiess Geo. Labs.,
Room 106.
4:00 p.m., Feb. 8.

CALENDAR OF EVENTS

February 1994

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2 HGA Bridge Briar Club *'94 N. American Prospect Expo., Feb. 2-3*	3	4	5 **HGA/HGS WILDCATTERS BLOWOUT** Petroleum Club
6	7 **HGS/HAPL JOINT DINNER MEETING** Joe Foster Post Oak Doubletree	8 AAPG Distinguished Lecturer Douglas Elmore Rice University	9 **HGS ENVIR/ENG DINNER MEETING** Carl Norman H.E.S.S.	10 GSH School Larry Beyer BP Plaza SPWLA Westside Luncheon Radisson Suite Hotel	11 Houston Geo-PC Users Meeting La Madeleine	12
13	14 *Happy Valentines Day* 	15 SPWLA Galleria Luncheon Robert Skopec Marriott Galleria	16	17 SIPES Luncheon Ron McWhorter Petroleum Club SPWLA Northside Luncheon Rob Allen Sperry-Sun Cafeteria	18	19
20	21 GSH Technical Luncheon H.E.S.S	22 SPWLA Downtown Luncheon Dale Fitz Petroleum Club	23 **HGS LUNCHEON** Robert Font Houston Club HGA Bridge Briar Club	24	25	26 **HGS SHORT COURSE** "Consumers Guide to Workstations" Exxon Auditorium
27	28 **HGS NO. AMERICAN DINNER MEETING** Logan MacMillan H.E.S.S. **HGS INTN'L/AIPN DINNER MEETING** Richard Smith Post Oak Doubletree					

COMMITTEE NEWS

Houston Geological Society Foundation for Undergraduate Students

The following companies or individuals made a contribution to the Houston Geological Society Foundation during November and December 1993, totaling $4910.

1. Stanley M. Leventhal and Victor M. Shainock (Indexgeo & Associates, Inc.)
2. Lynn Williams
3. Merrill W. Hass
4. Susan and Tom Black
5. Robert M. Sneider Exploration, Inc.
6. BHP Petroleum by Richard Bastron
7. H.D. Klemme
8. Harry A. & Zoe Vest
9. Wayne Jones
10. Geneos Pete Cokinos
11. Ralph R. McLeod, et.ux.
12. Scientific Computer Applications, Inc.
13. John Paul Ferguson
14. Shannon A. Hoover
15. Hugh W. Hardy
16. Bruce E. & Dianne W. Martin
17. John F. & Beth E. Thompson
18. George R. & Barbara Bole
19. Linda Raine Sternbach
20. J.B. Coffman & Assoc.
21. Howard W. Kiatta, In memory of E. Floyd Humphries

The foundation gratefully acknowledges the above generous gifts and thanks the contributors for their support. Through such gifts, the Society is able to further the education of deserving outstanding students at several universities in the Houston and surrounding area. It's never too late to send in your contribution to the HGS business office at

7171 Harwin, Suite 314,
Houston, TX 77036-2190.

Be a proud supporter!
Do it today!

Don Scherer,
Foundation Member

Houston Geological Society Receives Landmark Donation For Graduate Scholarship Fund

On June 24, 1993 Warren and Florence Calvert created a living trust which will benefit the HGS and the Memorial Scholarship Fund greatly. The Calverts have set aside a large amount of assets into their trust and have appointed the HGS to act as a future trustee. River Oaks Trust will act as custodian for the living trust. Ultimately, the HGS will transfer all assets of the trust to the W.L. Calvert Memorial Scholarship Fund.

The Memorial Scholarship Fund was established in 1974 as a means to provide aid to graduate students pursuing advanced degrees in some branch of economic geology. Warren Calvert is the Fund's founder. The Calvert's continued support over the years has made the Memorial Scholarship a success and their establishment of the living trust will help guarantee the Fund's success in the future. Their generosity is much appreciated.

John A. Adamick
Vice-Chairman
Memorial Scholarship Fund

On the Move

Mr. Michael F. Conlon has been named Vice President-Exploration of North Central Oil Corporation, Houston, Texas. Mr. Conlon previously held positions with Cabot Oil & Gas, BHP Petroleum (Americas), Champlin and Cities Service in several domestic and foreign locations. Mr. Conlon is a Geological Engineering graduate of the Colorado School of Mines

HOUSTON GEOLOGICAL AUXILIARY

HOW DID THEY DO THAT?

By the time you read this article, we should be a few days away from our Wildcatter's Blowout Party. The table decorations are going to be handmade 18" wooden oil derricks, with festive embellishments, of course. My admiration for the early wildcatters who built the real ones has increased ten-fold. How did they do it? I think it's impossible to build one that doesn't wobble, but I know they did it.

While trying to come up with a construction method for our small models, I wondered about the actual size of the ones, for instance, at Spindletop. How did they actually construct them? Who built them, drillers or carpenters? Where did all the lumber come from and how much did it cost? Did they lay them out on the ground and then raise them, sort of like a barn building or were they built from the ground up? What happened when the spacing got so tight, like we've all seen in the pictures?

After an initial attempt at finding out some information from various books, I jumped at the chance to go visit the real thing at Spindletop. So off our family went to Beaumont on a really beautiful November weekend. We visited the Texas Energy Museum and also went to the Gladys City reconstructed "boomtown". After talking to several people, we had no more answers than before. We used an old Boy Scout method to measure the height of the derrick at Gladys City and then measured what we could from the ground.

At any rate, we had a good time, dropped a bundle on interesting books about Spindletop and came home to wrestle with ice cream sticks, dowels and good ole Elmer's Glue. We had an initial marathon work session to "build" all the side panels. Those who helped were Geri Pace, Louise Smith, Mary Jo Carter, Carlita Laurent and myself. The actual putting together of all four sides was a little tricky and involved some high tech methods using telephone books and clothes pins. I'd like to thank Sean Lewis and my husband Tom, for cutting out the Texas-shaped "drilling floors" for the derricks.

Come and see the results of a lot of hard work. Sorry, they're not going to be given away for door prizes this time. We're going to use them in the Hospitality Room at the AAPG Convention here in Houston in March 1995. We are even thinking about building something about six feet tall for right outside the door to the room! With any luck, it won't wobble!

If anyone knows of where I might read a little more about the construction of the early wooden derricks, please let Tom or I know. We're still curious about how it was done.

Annette Mather

GEO-WIVES SHARE VARIED ACTIVITIES

Geo-Wives is the newcomer branch of the Auxiliary. All active Auxiliary members who have not enjoyed membership for a total of ten years in Geo-Wives are invited to join us. We meet monthly for lunch and a program. If you have not joined our group, you are missing many fun activities. So far this year we have enjoyed the following: a "Get-Acquainted Coffee" in September, we enthusiastically applauded our very own Geo Players when they presented a 3-act play "Dangerous Corner" in October, we travelled to Galveston in November for a tour of Moody Gardens, IMAX Theatre and a lovely lunch, and celebrated the Christmas holidays with a luncheon, ornament exchange and a program of original poetry by Dolores Humphrey.

In January we enjoyed a soup and salad luncheon and observed the wizardry of Jeannette Coon when she demonstrated the art of vegetable carving. February will find us touring the Menil collection and enjoying lunch at La Mora Restaurant.

For further information about activities or membership in Geo-Wives please call Linnie Edwards at 785-7115 or Hellen Hutchinson at 877-8479.

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. Norma Jean Bacho
38 Charleston North
Sugar Land, TX 77478

GEO-WIVES MEMBERSHIP FORM

_____
(Your Name)

_____
(Spouse's Name)

_____
Address Zip

_____
Home Telephone

_____
HGS Member's Company

(Dues are $7.50 per year, check payable to Geowives)

Send to:
Mrs. Hellen Hutchison
10 S. Briar Hollow Lane #63
Houston, TX 77027

PERSONNEL PLACEMENT COMMITTEE

Hopefully, by now all HGS members are aware of the **HGS Jobs Hotline (713) 785-9729.** I would like to especially thank Lynne Feldkamp (editor of the *Bulletin*) for keeping the Hotline number in front of the membership by placing it on the cover of Bulletin.

The Personnel Placement Committee has made a few changes. The most significant is that the Committee no longer keeps resumes on file. The only way to have your resume sent to a prospective employer is to implicitly follow the instructions on the recorded message of the Hotline. Please do not fax or mail your resume to the HGS office, it will not get to the proper people in time to respond to the job request you are interested in.

How the HGS Jobs Hotline works:

1. Prospective Employers call the Personnel Placement Committee with their job requests. At this time as much information as is possible about the position is obtained from the Prospective employer so it can be mentioned on the Hotline.

2. The Personnel Placement Committee then puts the information about the job on the Hotline. All requests that are received are placed on the Hotline because the Placement Committee does not keep resumes on file anymore. The Hotline is only updated when there are new requests, so it may be likely that sometimes when you call all the requests have expired. What that means is that the Placement Committee has not received any new requests and that you should probably be calling more often.

3. Requests are left on the Hotline From 7 to 14 days depending on the requirements of the prospective employers. People responding to the requests on the Hotline fax their resumes to the Personnel Placement Committee who forward to the resumes to the Prospective Employers after the time limit has expired.

4. The Prospective Employers review the resumes, select candidates and then make contact with the appropriate individuals.

Does the HGS Jobs Hotline find people jobs? YES! Approximately 15 % of the requests received are filled. Although that is not as high of a percentage as we would like, it should be kept in mind that professional head hunters only place 20 to 30 percent of their requests.

Are you doing everything possible to enhance your chances of finding employment through the HGS Jobs Hotline ?

ARE YOU:

1. Calling the Hotline every 2-3 days.
2. Submitting a cover letter along with your resume. This is your chance to help sell yourself to the prospective employer and show that you are qualified for the position. If you don't have all the qualifications that are being sought, try to show that the experience you have is similar to what is being requested.
3. Rearranging and expanding your resume in the areas that the prospective employer is interested in. It greatly increases your chances of being considered if the prospective employer can quickly see on the upper portion of the first page that you are qualified for the position.

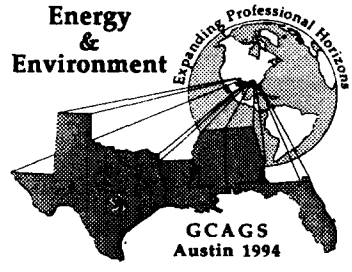
By implementing the above mentioned suggestions and continued persistence you may greatly increase your chances of benefiting from the HGS Jobs Hotline. *GOOD HUNTING.*

- Joe Eubanks

Call for Papers and Posters

Gulf Coast Association of Geological Societies
and
Gulf Coast Section SEPM
44th Annual Convention
Austin, Texas
October 4-7, 1994

Hosted by Austin Geological Society



The meeting theme, "**Energy and Environment—Expanding Professional Horizons,**" will be highlighted in sessions representing a broad spectrum of Gulf Coast geology. Along with GCAGS and SEPM sessions, there will now be sessions on environmental geology, as well as an opening all-convention symposium that will focus on environmental geology and earth resources. You are invited to submit abstracts for oral presentations, poster sessions, or core presentations.

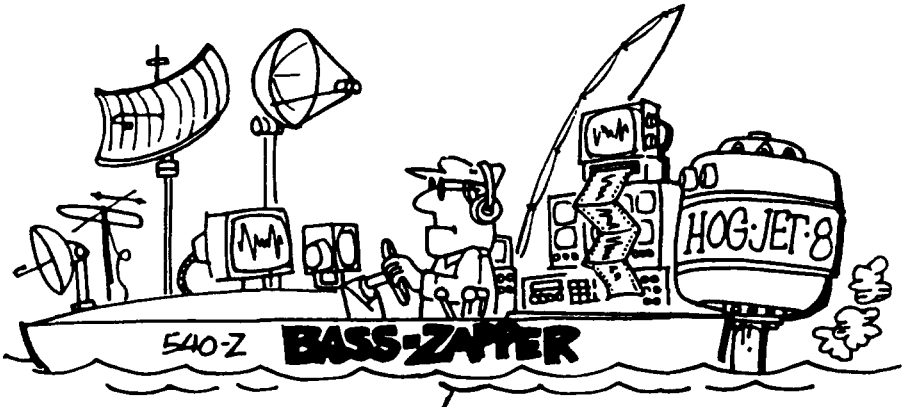
Abstracts of 250 words or less may be submitted for presentation by completing the Call For Papers form being mailed to all members of Gulf Coast geological societies. Forms are also available from the Program Chairman.

Shirley Dutton, Program Chairman
1994 GCAGS Convention
Bureau of Economic Geology
The University of Texas at Austin
Box X, University Station
Austin, TX 78713

Notification of acceptance will be by **February 8, 1994.** Full manuscripts will be required for all oral presentations. Completed papers will be due by **April 1, 1994.**

SIXTH ANNUAL
GSH/HGS/HAPL BASS TOURNAMENT

IT'S SPRING LUNKER TIME AGAIN!!!



GET YOUR PARTNER NOW!

SPONSORS WELCOME!

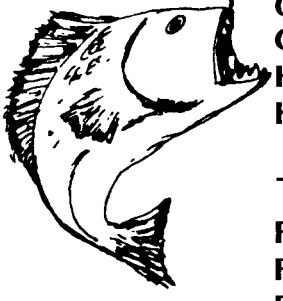
WHEN; APRIL 9th,10th 1994

WHERE; Toledo Bend (Pendleton Harbour) *New Place!*

MAKE RESERVATIONS IMMEDIATELY ! ! !
CALL 625-4912

PRIZES:

OVERALL FIRST PLACE:	TOTAL WEIGHT BASS	Artificial Lures ONLY!
OVERALL SECOND PLACE:	TOTAL WEIGHT BASS	
OVERALL THIRD PLACE:	TOTAL WEIGHT BASS	
GSH FIRST PLACE:	BIG BASS (WEIGHT)	
HGS FIRST PLACE:	BIG BASS (WEIGHT)	
HAPL FIRST PLACE	BIG BASS (WEIGHT)	



FIRST PLACE:	HEAVIEST CATFISH	Live Bait O.K.!
FIRST PLACE:	HEAVIEST CRAPPIE	
FIRST PLACE:	HEAVIEST BREAM	
FIRST PLACE:	HEAVIEST STRIPER	

Contact Harold Landers (713) 942-0595 (work) (713) 440-8718 (home)
or John Stuchell (713) 665-2372 (work) (713) 988-4305 (home)

GSH/HGS/HAPL BASS TOURNAMENT REGISTRATION FORM

Name: _____ **Partner's Name:** _____

Address: _____

Phone: (Home) _____ **(Work)** _____

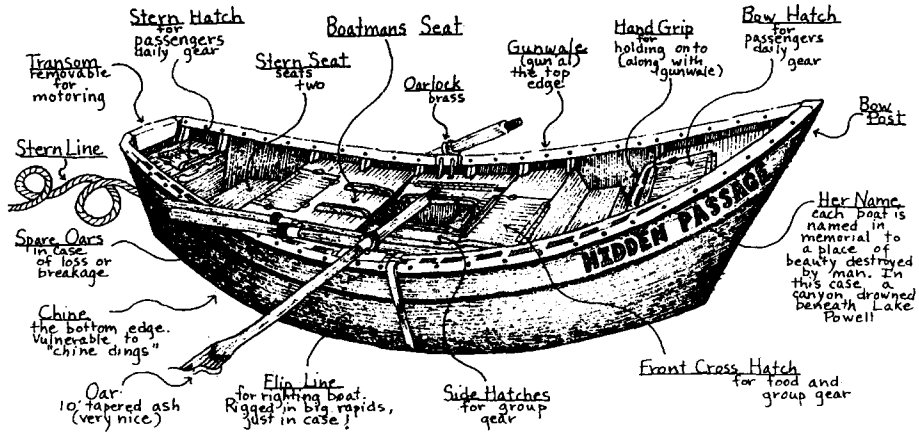
Enclose your check of $40.00/contestant payable to Geophysical Society of Houston (GSH) Bass Tournament.

Mail To: Harold Landers, c/o Wickford Energy, 2323 S. Shepherd, Suite 910, Houston, Texas 77019

GEO-RAFTING

Are you ready for a great Whitewater Experience on the Salmon River as it winds its way through the Idaho wilderness? Come and join a group of geologists and friends as we take in the rocks and picturesque scenery, while on an adventure taken in the "Spirit of John Wesley Powell", traveling in wooden dories down the "The River of No Return". Do what Lewis and Clark could not! The Salmon is the largest undammed river of the American West. It is wild and free flowing all the way into the Snake River.

We will embark on the river in the alpine setting of Corn Creek, Idaho, several hours south of Missoula, Montana, where our trip will convene. There we meet our outfitters, NORTHWEST DORIES, who offer superior quality and safe rides. And, from the time we arrive and for the next five days Northwest Dories will take care of everything for us, including personable and helpful guides and some of the most sumptuous cooking you will ever have - not even speaking of the ride on the river itself. As the river flows westward it traverses a series of canyons that it has cut through schist, gneiss, and granite of the Idaho Batholith, uplifted 60 to 100 million years ago. Along the way we will camp at unique locales on the river for four nights. We will be able to hike to high mountain meadows and beyond to a sweeping vista overlooking the mighty



Salmon. We will have the opportunity to stop and relax in hot springs that prospectors visited a century ago. The memory of the "Thunder Mountain Gold Rush" of 1898 will be revisited at an abandoned trading post that we will see. Wildlife including moose and Bighorn sheep may be encountered along the way. Our take out point from the river is near Riggins, Idaho, several hours south of Lewiston, Idaho, where we will be transported and bid our guides farewell.

The AAPG convention is being held in Denver, June 12-15, 1994. For the convenience of those who are going to be in Denver then, we are planning for our excursion to follow (June 17-23) the convention. From Houston, you are almost there and you may want to piggy back this opportunity with your convention trip. Cost for the river trip itself is estimated to be around $875 per person. Included is a five day fully outfitted dory trip, entertainment, meals, field refreshments, guidebooks, hotel before and after the trip, and taxes. Participants will need to make their own travel arrangements to and from Idaho. Air travel is most economical into Missoula, Montana, and out of Spokane, Washington. If participants coordinate with us, we may be able to make some group arrangements. Let us know ASAP. ground transportation from these locales to and from the river will be arranged once logistics are finalized.

For more info: *Contact Andy Gambill, Hunt Oil Corp. (713) 683-2365*
Limited to 24 participants -

Registration Form

Salmon River / Dory Trip
June 17-23, 1994

Name: _____

Address: _____

Phone (home & work): _____

Registration:

1. ASAP, PHONE CALL in feedback, interest level to Andy Gambill, (713) 683-2365
2. RESERVE A SPOT; Pay a $200 deposit NOW, and the balance by April 15, 1994 (Spend that Tax Return). Enclose check payable to HOUSTON GEOLOGICAL SOCIETY, and return with this form to PAUL BRITT, HGS FIELDTRIP COMMITTEE CHAIRMAN, Texplore, Inc., P.O. Box 450, Richmond, TX 77406

HGS SHORT COURSE

Consumer's Guide To Workstations: What Every Geoscientist Should Know

Date: Saturday, February 26, 1994
Time: 9:00 a.m. - 4:00 p.m
Place: EXXON Auditorium, 800 Bell, Houston, Texas 77002
Instructors: Well-known geoscientists and computer specialists who are workstation experts and have done extensive geologic interpretation using workstations.
Who should attend: Geologists, geophysicists, geotechs, oil company executives, consultants, computer specialists, and anyone who plans to buy or upgrade a workstation.
Course Description: Experienced workstation experts will discuss the different workstations, including Landmark and Geoquest stations, as well as geoscience systems designed for the PC. They will describe the components of a workstation and compare the different hardware and software. They will answer your questions about interpretation packages. Most importantly, **they will give you a sense of the type of system that is both economically and technically appropriate for your geologic play.**
Cost: $10.00 Pre-registration • $15.00 Registration at the Door
Mail check to: Houston Geological Society • 7171 Harwin, #314 • Houston, Texas 77036

We suggest that you send in your questions about workstations with your payment.

Name _____

Address _____

Phone _____

FIELD TRIP COMMITTEE

Geo-Rafting in Big Bend: Part II

by Gail Bergan
the write enterprise

Last spring, the HGS Field Trip Committee organized a rafting trip through Santa Elena Canyon in Big Bend National Park. Following up on the popularity of that trip, we returned to the park last November to tour the more remote canyons. Twenty-three geologists, engineers, and spouses embarked upon a three-day rafting trip through Mariscal, San Vicente, and Hot Springs Canyons, followed by a one-day bus tour of the "must see" sights in Big Bend.

We headed west on Amtrak's "Sunset Limited" on the evening of November 10, and arrived in Alpine at noon the next day. From Alpine, we rode a shuttle bus down to Lajitas where our adventure would begin. En route to Lajitas, we stopped to discuss the complex structural setting of the Big Bend/Trans-Pecos region. Other stops included Willow Mountain, with its picturesque columnar jointing, and the Terlingua Monocline. John Polasek also presented a Paleozoic prospect recently drilled by Apache Corporation and Arco in the Marfa area, which piqued our interest for the geology of Big Bend.

Upon arriving in Lajitas, we were escorted by our outfitters, Big Bend River Tours, to the abandoned Mariposa Mine in the Christmas Mountains. This site was the first to be mined for cinnabar in the Terlingua mining district around the turn of the century. Story has it that the miners clearcut all of the existing cottonwoods in the area for use in the smelting process, and only now, over 70 years later, are a few cottonwoods returning to the landscape. After exploring the old mine shafts, we were treated to the first of several amazing meals prepared by our guides, followed by musical entertainment under the impressive Milky Way.

The next morning we boarded vans and headed for the put-in at Talley. Three hours of dusty, bumpy, grueling roads awaited us as we headed for this "remotest of canyons". Nevertheless, we were treated to views of the south-facing side of the Chisos Mountains, Mule Ears, and seldom-seen areas of the park. After lunch at Talley, we boarded our rafts and floated toward Mariscal Canyon. Two gear boats preceded us down the river, moving a veritable mountain of tents, food, cooking grills, tables, dishes, lawn chairs, coolers, sleeping bags, and luggage.

The Rio Grande proved to be a peaceful, gently flowing river that allowed us to relax, get to know our fellow rafters, and concentrate on the geology of the area. Because our guides were so well versed on the local flora and fauna, we also were able to better appreciate the variety of birds and plant life that lined the river. My boatman told us that the water in this section of the Rio Grande actually comes from the Conchos River in Mexico, pointing out that the Rio Grande is essentially dry south of El Paso.

Mariscal Canyon did not disappoint us. It is a spectacular canyon with sheer, vertical, limestone cliffs. We observed the contact between the Cretaceous Boquillas and Buda Formations, a contact not exposed in Santa Elena Canyon. A sliver of Del Rio Clay, underlying the Buda Formation, is also exposed along part of the canyon. We stopped to examine a textbook example of a melange created by Tertiary block faulting. The unit was a wild jumble of Boquillas and Buda fragments set in a fine mud and spar matrix.

The river was running at low to moderate levels, so only a few swift maneuvers were required by our boatmen to navigate the "Tight Squeeze" rapids. Our first day on the river was a short one (4 miles), and at the end we relaxed on a sandy beach and explored the nearby outcrops while our guides prepared another wonderful meal. Once again we were entertained by acoustic guitar, and spent a warm, comfortable night in our tents under a starry sky.

The next day we rafted 12 miles through the rest of Mariscal Canyon, the open desert plains, the Solis Graben, and San Vicente Canyon. The Santa Elena Formation, which is the oldest exposed formation in the Mariscal Mountain anticline, gave way to the Boquillas Formation as we left the canyon. Once outside Mariscal Canyon, the open plains and the Solis Graben valley gave us an opportunity to appreciate the desert plant and animal life. The Chisos Mountains, which we planned to visit on the last day of the trip, were visible in the distance. Further downstream, we entered San Vicente Canyon, and again we were shadowed by the high cliffs of the Boquillas, Buda, and Del Rio Formations.

We stopped for the night in a grassy meadow, set up our tents, and had ample time to hike around the nearby bluffs while our hosts prepared dinner. Personally, having never used an outfitter before, this is definitely the way to go! Unfortunately, sudden wind and rain right after dinner robbed us of our musical entertainment, and forced most people into their tents for an early night.

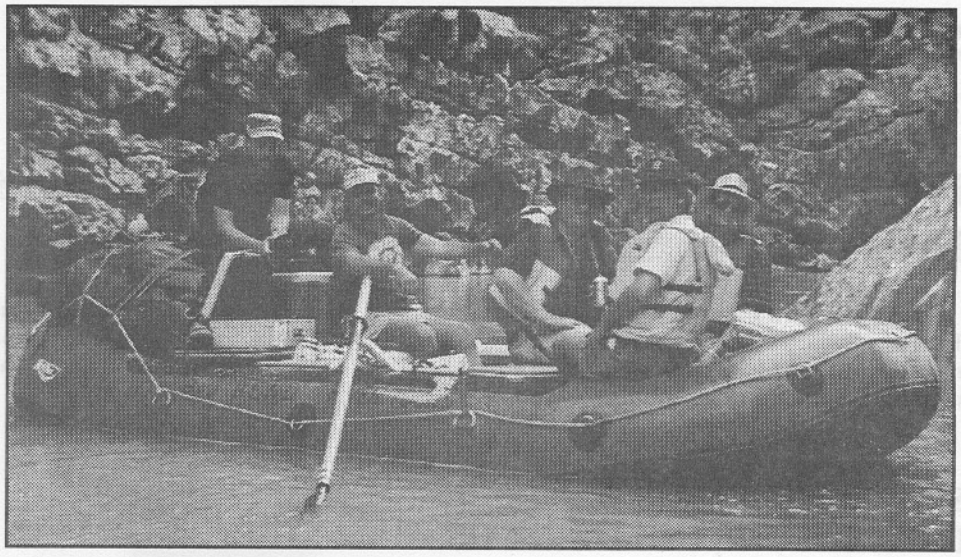
The "norther" brought cooler temperatures, and the next morning was

crisp and beautiful with clear blue skies. After a hot breakfast, we set out for our 12-mile final day on the river. The majority of the day we traveled through open desert plains with views of the Sierra Del Carmen Mountains forming a spectacular backdrop. Our guides pointed out some Indian petroglyphs inscribed on outcrops along side canyons. A group of vaqueros on horseback watched as we silently floated past the San Vicente low-water crossing. The final canyon, Hot Springs Canyon, once again showcased the thin-bedded Boquillas Formation. A dip in the historic Hot Springs while our guides prepared lunch was a treat worth waiting for. A few metates, or rock mills that the Indians used to grind mesquite beans, were also discovered near the Hot Springs. Take-out was at Rio Grande Village, where we bid farewell to our river guides and took a bus back to Lajitas.

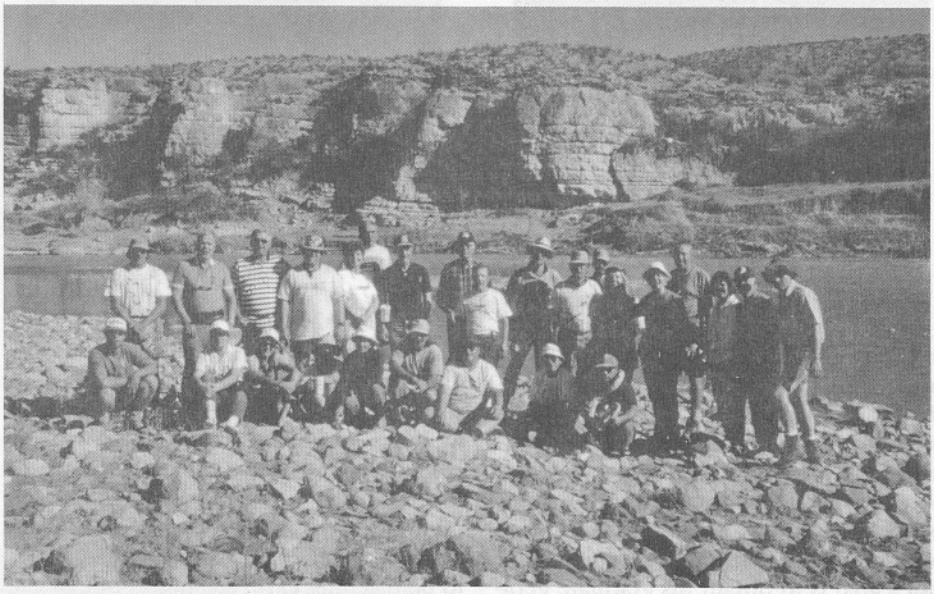
The next morning we boarded a shuttle bus and toured most of the famous Big Bend sites. Our trip leader, Martin Oldani, put these landmarks into geologic perspective for us, recounting the multiple episodes of faulting, folding, and volcanism that have occurred in the Big Bend area. The field stops included the Santa Elena Canyon Overlook, Goat Mountain Overlook, the Basin in the Chisos Mountains, the Fossil Bone Exhibit, Dog Canyon, and Persimmon Gap. All across the landscape, the resistant volcanics were etched in strong relief against the more easily eroded limestones and shales. On the way back to Alpine, a final field stop was made where the impressive Caballos Novaculite flatirons crop out in the Marathon Mountains. It seemed only minutes after this last stop that we watched a massive cold front cover the mountains with a blanket of clouds, and we congratulated ourselves on our perfect timing! After dinner in Alpine, we boarded Amtrak once again to head back to Houston.

The ideal weather, opportunity to make new friends, fascinating geology, and a tail wind made for a truly enjoyable field trip. So enjoyable, in fact, that the HGS Field Trip Committee is already contemplating a third Big Bend rafting trip through Boquillas Canyon next fall. Stay tuned! Our outfitters, Big Bend River Tours, took great care of the group and are highly recommended to anyone who plans to tour Big Bend via the Rio Grande.

Gail Bergan is owner of a technical writing and editing service specializing in geoscience documents.



Geo-rafters pause for the camera. Left to right: Jeff Skinner, Robert of Big Bend River Tours, trip leader Martin Oldani, John Polasek, and Jack St. John. Submitted by Gail Bergan.



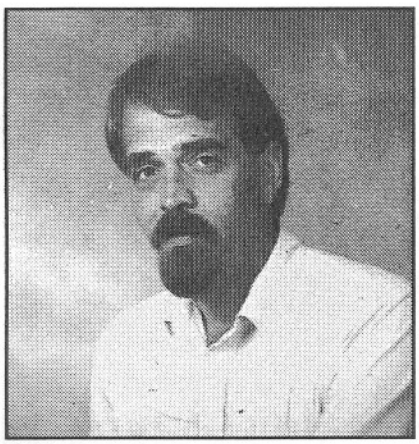
Twenty three rafters and their guides pose along the banks of the Rio Grande. Submitted by Gail Bergan.

STUDENT AWARDS

HGS Undergraduate Scholarship Foundation Presents Six Scholarships

The HGS Undergraduate Scholarship Foundation awarded six scholarships to students from local universities for the 1993-1994 academic year. The students were presented their scholarships by Foundation Chairman Hugh Hardy at the January dinner meeting. A total of $6000 in scholarships were awarded to the students listed below. These young men and women are to be commended for their accomplishments.

SCOT D. SANDEFUR
Lamar University

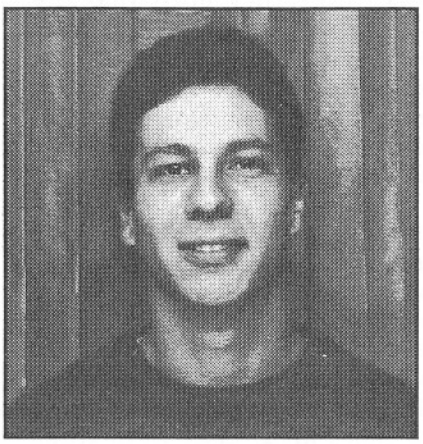


Scot is a senior at Lamar University and plans to enroll in graduate studies specializing in sedimentology or geomorphology upon completion of his Bachelor of Science degree. He is currently president of the Lamar University Geological Society. Scot developed his interest in geology during the ten years he worked on drilling rigs worldwide. Scot's goal is to obtain his graduate geology degree and become an exploration geologist working in eastern Asia.

JENNIFER ANNE MAHR
Rice University

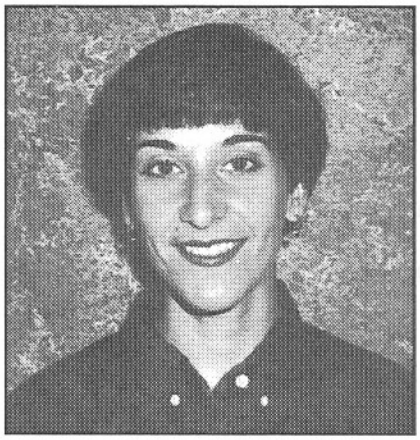
Jennifer will graduate with her Bachelor's degree in Geology in May of 1994. She has been a research assistant since her freshman year at Rice, primarily studying carbonate sedimentology. She is currently working on a senior thesis involving micropaleontology and glacial records. Jennifer also plans to obtain her teaching certificate this year and hopes to be teaching earth science at one of the secondary schools in Houston later this year.

THOMAS MOSSBURG
Texas A&M University



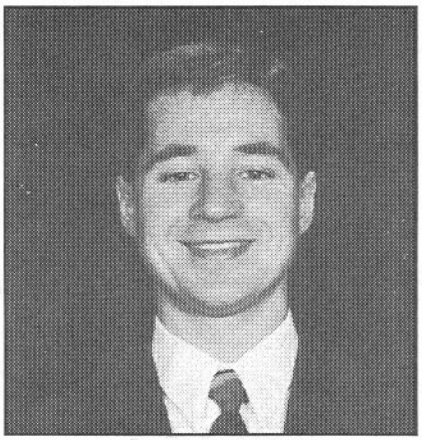
Thomas is a senior at Texas A&M and will graduate with his Bachelor of Science degree in Geology in December 1994. He is a member of the Texas A&M Geological Society and Phi Eta Sigma Freshman Honor Society. Thomas has been awarded several scholarships while at A&M and also is a student worker in the map room of the university library. His future plans are to pursue a graduate degree specializing in structural or environmental geology.

KATHLEEN RAINS
Stephen F. Austin St. Univ.



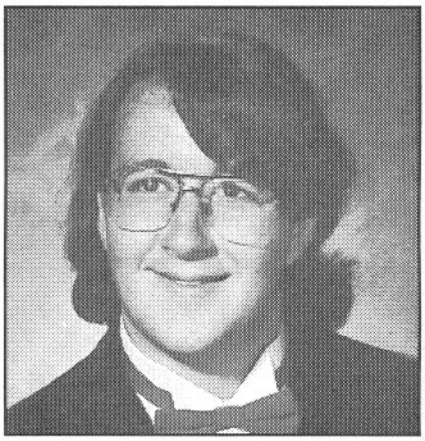
Kathleen Rains is a junior at Stephen F. Austin State University and is currently working towards a Bachelor's degree in Environmental Geology with a minor in Chemistry. She has been on the Dean's List for the past two semesters and is the recipient of several scholarships. Kathleen is an officer in the SFA Geology Club and is a member of Sigma Gamma Epsilon (an earth science honor society). In addition to her school activities, she is a wife and mother of three boys. Kathleen's goal is to continue her education after graduation by attending graduate school at Stephen F. Austin.

MARK T. SINK
University of Houston



Mark is a junior at the University of Houston and is working toward a Bachelor of Science degree in Geology. He decided to study earth science after being exposed to the geology of Europe and North America during four years of service as an Army radar technician. Mark also credits military service with teaching him the dedication necessary to succeed in college. He currently works at UH as a research assistant helping to develop an educational data base for K-12th grade earth science instructors. Mark plans to pursue an advanced degree in geology upon completion of his undergraduate studies.

THOMAS A. STIDHAM
University of Texas



Tom is a senior at the University of Texas and will graduate with Bachelor of Science degrees in Geology (Honors) and Zoology in May 1995. Tom's primary interests are in paleontology. His senior thesis topic is "The Stratigraphy and Biostratigraphy of the Marathon Formation, Solitario, Trans-Pecos, Texas". He is also working on a separate project describing some of the amphibians and squamates from the Aguja Formation in Big Bend, Texas. Tom is a member of the AAPG, IPA, AAAS, PS, SVP, and SEPM. After graduation, he plans to enter graduate studies and specialize in the paleontology of lower vertebrates.

Houston Geological Society Grand Canyon Field Trip

August 7-15, 1994
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Please make reservations for the following to raft the Colorado River through the Grand Canyon from Lee's Ferry to Lake Mead. Bus transportation will be provided from Flagstaff to the canyon and return to Flagstaff.

Name Address Telephone No.

1) _____

2) _____

3) _____

Enclosed is a deposit of $100 per participant made payable to the Houston Geological Society. Total cost, excluding transportation to and from Flagstaff, is $1475 subject to no more than a $50 increase. The deposit is 90% refundable if the trip is cancelled and 100% refundable if the trip is held and a replacement is found. By the end of 1993 an additional $400 will be requested, a nd a final payment made by June 1, 1994. Contact Lazor for any participant under age 14.

Send check and reservation form to Dave Lazor, 11115 Fonda, Houston, TX 77035, Phone (713) 728-0917.

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GEOPHYSICAL SOCIETY OF HOUSTON

Environmental Applications - Special Interest Group 1994 Schedule

SIG Purpose: Address environmental applications of the geosciences on public health issues and geochemical shallow investigations.

SIG Format and Program for 1994: During 1994 the SIG will begin to paint its own picture of the environmental landscape and highlight where conventional geophysics can be applied. Throughout the year topics can be added to the pallet based on member interest and needs. The 1994 program developed from suggestions from members. Those members who volunteered to be a leader for a 1994 program are shown below. The program leader for the meeting-of-the-month may use any format that encourages participation and effective communication.

Meetings are tentatively set for the fourth Thursday of the indicated month at the Houston Engineering and Science Society (HESS) building located at 3121 Buffalo Speedway.

The date, general topic, and principle speaker/program coordinator for the sessions are:

March, 1994 Application of Hazard Surveys to the Onshore Environment.
Program Coordinator: Mr. Bill Gafford, AMOCO (366-7873)

May, 1994 Application of Geophysics to Waste Management and Underground Chemical Contamination. Program Coordinator: Dr. H.C. Clark, Rice Univ. (529-0090 Home)

Sept., 1994 NORMS (Naturally Occurring Radioactive Materials), Hazardous Chemicals and Toxicology. Program Coordinator: Dr. S. Hrabar, GEMS^2 (683-0638)

Nov., 1994 Integration of Geoscience Databases for Field Operations.
Program Coordinator: Mr. James Moulden, Jr., Energy Graphics (467-0250)

Stephanie Hrabar is the SIG Leader for 1994; call her at 713/683-0638 for details or questions about the program.

ENVIRONMENTAL/ ENGINEERING FEATURE

Quality Assurance and Quality Control in the Development and Application of Ground-water Models[1]

Paul K.M. van der Heijde[a] and Osman A. Elnawawy[b]

This report describes quality assurance and code testing in ground-water modeling. The quality assurance procedures presented cover both development and application of ground-water modeling codes. An important part of quality assurance is code testing and performance evaluation. The section on code testing and performance evaluation discusses past efforts to test ground-water simulation codes and document their performance and presents the three-level testing procedure developed by the International Ground Water Modeling Center and the Center's approach to developing benchmarks for the first two test levels.

Introduction

Ground-water modeling has become an important methodology in support of the planning and decision-making processes involved in ground-water management. The effective application of computer simulation codes in modeling field problems is a qualitative procedure, a combination of science and art. A successful model application requires a combination of knowledge of scientific principles, mathematical methods, and site characterization paired with expert insight in the modeling process, often to be provided within the framework of a multi-disciplinary team effort. As participants at the workshop on "Modeling for Water Management" organized by the European Institute for Water (Como, Italy, May 21-22, 1987) formulated: "Modeling imposes discipline by forcing all concerned to be explicit on goals, criteria, constraints, relevant processes, and parameter values."

Ground-water models provide an analytical framework for obtaining an understanding of the mechanisms and controls of ground-water systems and the processes that influence their quality, especially those caused by human intervention in such systems. For managers of water resources, models may provide essential support for planning and screening of alternative policies, regulations, and engineering designs affecting groundwater. This is particularly evident with respect to ground-water resources development, ground-water protection, and aquifer restoration.

In discussing ground-water modeling, distinction should be made between model development and model application. Model development consists of three components: (1) research aimed at obtaining a quantitative understanding of the studied ground-water system; (2) software development; and (3) model testing and evaluation. Often, model development, and particularly code development, is driven by immediate and long-term needs of ground-water resources management. Model application is part of a larger set of activities aimed at solving site- or problem-specific issues and includes such activities as data collection, interpretation and storage, system conceptualization and model design, formulation of alternative problem solving scenarios and engineering designs, and post-simulation analysis.

Although a consensus may exist as to what ground-water modeling entails, the definition of a "model" per se is somewhat nebulous. In hydrogeology, the term "ground-water model" has become synonymous with conceptual groundwater models, mathematical groundwater models (including analytical and numerical models), computer models, and simulation models. Furthermore, the term "ground-water model" may apply either to a computer code without site-specific data or to the representation of a site-specific system using such a generic code, together with pertinent data.

In the full report (see end of paper) a ground-water model is defined as a nonunique, simplified, mathematical description of the subsurface component of a local or regional hydrologic system, coded in a computer programming language, together with a quantification of the simulated system in the form of boundary conditions, system and process parameters, and system stresses. The generalized computer code usable for different site- or problem-specific simulations is referred to as a (computer) simulation code or a generic simulation model. A ground-water modeling study

1 Reprinted from the U.S. EPA Project Summary, May, 1993, Publication No. EPA/600/SR-93/011, 3 pp.

a Colorado School of Mines, Golden, CO 80401

b Indiana University/Purdue University at Indianapolis, Indianapolis, IN 46204

is defined as the development and use of a ground-water model (i.e., code and data) to solve specific ground-water management problems. Sometimes, such a ground-water model is the result of the application of one or more simulation codes to a generalized ground-water management problem; e.g., in support of promulgating government-mandated regulations. Generalizing such a management problem may be based on the use of concepts and data describing an "average" or "hypothetical" site representing targeted sites.

Sometimes a model is described in terms of the mathematical solution technique employed. Most commonly used terms are "analytical model," "semi-analytical model," and "numerical model." An analytical model is a model in which the solution of the mathematical problem (governing equation and boundary conditions) results in a closed-form or analytical expression for the state variable, continuous in the space and time domains. In a numerical model a solution for the mathematical problem is found, discrete in both the space and time domains, by using numerical approximations of the governing partial differential equations(s). In a semi-analytical model, complex analytical solutions are approximated by numerical techniques, resulting in a discrete solution in either the space or time domain.

Developing efficient and reliable software and applying such tools in ground-water management requires a number of steps, each of which should be taken conscientiously and reviewed carefully. Taking a systematic, well defined and controlled approach to all steps of the model development and application process is essential for its successful utilization in management. Quality Assurance (QA) provides the mechanisms and framework to ensure that decisions are based on the best available data and (modeling-based) analyses.

Sections in the full report provide background information on quality assurance and define the role of QA in ground-water modeling. They present a functional and practical quality-assurance methodology, written from the perspective of the model user and the decision-maker in need of technical information on which to base decisions. An important part of quality assurance is code testing and performance evaluation. The section on code testing and performance evaluation presents the three-level testing procedure developed by the International Ground Water Modeling Center, the development of test problems and related benchmarks for the first two test levels, and a discussion of the implementation of the testing procedure.

Quality Assurance in Ground-water Modeling

Quality assurance in ground-water modeling is the procedural and operational framework put in place by the organization managing the modeling study, to assure technically and scientifically adequate execution of all project tasks included in the study, and to assure that all modeling-based analysis is verifiable and defensible. QA in ground-water modeling is crucial to both model development and model use and should be an integral part of project planning and be applied to all phases of the modeling process.

The two major elements of quality assurance are quality control (QC) and quality assessment. Quality control refers to the procedures that ensure the quality of the final product. These procedures include the use of appropriate methodology in developing and applying computer simulation codes, adequate verification and validation procedures, and proper usage of the selected methods and codes. To monitor the quality control procedures and to evaluate the quality of the studies, quality assessment is applied. Each project should have a quality assurance plan (QA plan), listing the measures planned to achieve the project's quality objectives.

"Quality assurance" is a term used in many different disciplines and environments. Its meaning and implementation differs from field to field. For example, there is a significant difference between QA in software engineering, software quality assurance (SQA), and QA in industrial production. Also there are significant differences between data QA and software QA procedures.

Literally, quality assurance assures the quality of the product (code, model) or activity of concern (modeling). A more workable description is that QA (in modeling) guarantees that the quality of the model-based analysis and advice (to decision-makers) satisfies quantitative quality criteria or measures. As the principal idea behind QA is accountability, and the main mechanism is maintaining record (hard copy and electronic files, reports) of all activities and results, a more proper term might be quality documentation.

Taken in a broad sense, QA provides a methodological and administrative framework to do the best we can within the limitations of our current understanding of nature and available technology.

That QA always assures acceptable quality of a code development project or a modeling study is an idle hope. However, adequate QA can provide safeguards against faulty codes or improper modeling. Regulators and decision-makers should understand that there is no way to guarantee that modeling-based advice is entirely correct, nor that the simulation code used (or any scientific model or theory, for that matter) can ever be proven, verified or validated in the strictest sense of these terms. Rather, a model can only be invalidated by disagreement of its predictions with independently derived observations regarding real systems.

It should be noted that a major role of QA/QC is to provide communication between the modeler and his/her peers, and between modeler and decision-maker, giving the latter a sense of the accuracy, uncertainty, and reliability of the modeler's advice. Therefore, QA should not apply to the work of junior modelers only, but should also be adhered to by expert modelers.

There are various cautions to be made. QA should never become so stifling that experienced modelers are discouraged to take new avenues not previously explored, or that an inappropriately large part of the budget of a project is consumed by responding to bureaucratic requirements. When QA regulations become bureaucratic red tape, the time and cost of QA may take away precious resources from the data collection and problem analysis activities. Furthermore, the risk is present that QA deteriorates and becomes only a checklist installing false confidence in modeling results.

Code Testing and Evaluation Procedures

The usefulness of predictive simulations based on ground-water models is

often limited by our inability to indicate and quantify the reliability of such model results. Researchers have developed various techniques to assess confidence levels for model predictions, so that water resources managers can account for uncertainties in the decision-making process. For example, several investigators present a methodology based on the application of decision analysis to engineering design in a hydrogeological environment. The methodology involves the coupling of a decision model based on a risk-cost-benefit objective function, a simulation model for ground-water flow and contaminant transport, and an uncertainty model that encompasses both geological uncertainty and parameter uncertainty.

One area of concern is the credibility of the simulation codes used and the generic models they represent. As discussed in the full report, an important aspect of the credibility of a simulation code is its reliability. The reliability of codes is established by applying a comprehensive, systematic review and testing procedure. The quality assurance aspects of such a procedure have been discussed in Section 2.2 of the full report. Another section presents a systematic code verification and performance testing protocol, based on the use of analytical solutions and synthetic data sets as benchmarks. Although the full report provides some example test problems, it does not contain actual benchmarks. A comprehensive set of benchmarks for two- and three-dimensional ground-water flow and transport models will be presented in a follow-up report.

Conclusions

There is an urgent need for comprehensive, systematic testing of all types of ground-water models and for the establishment of a verification and validation protocol. Ground-water management decisions should be based on the use of technically and scientifically sound methods of data collection, information processing, and interpretation. Because few experimental investigations have tested multidimensional theories, conceptualization, and associated computer codes, it is extremely important to conduct further research aimed at developing and executing verification and validation studies for prominent ground-water models. It may be argued that from a ground-water management point of view further efforts should be directed towards model testing studies rather than toward the development of more complex models.

In recent years, the International Ground Water Modeling Center has developed a testing procedure and methodology for model evaluation as part of its efforts to implement a comprehensive quality assurance program. The current project attempts to systematically analyze the scientific considerations and collect the technical elements for implementation of such a methodology. The next step is the application of this comprehensive methodology to actual computer codes.

Acknowledgements

The complete report, entitled "Quality Assurance and Quality Control in the Development and Application of Ground-water Models," (Order No. PB93-178226; Cost: $19.50; subject to change) will be available only from:

National Technical
Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer,
Joseph R. Williams,
can be contacted at:
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SEPTEMBER 1993 J.S.K.

Continued from page 32

typically composed of open marine calcareous shales and mudstones that shallow upward into subtidal mudstones and wackestones (Fig. 10). Farther up the ramp (e.g., Anadarko basin and shelf), equivalent Henryhouse strata are represented by thicker sequences (>50 ft) composed, from bottom to top, of the following: (a) lower subtidal mudstones and wackestones, (b) shallow subtidal wackestones, packstones, and grainstones, and (c) lower intertidal wackestones and packstones. On the upper ramp (e.g., northwest Oklahoma shelf), the sequences are usually composed of intertidal to supratidal deposits that are sometimes truncated by local intra-Henryhouse unconformities.

SEQUENCE STRATIGRAPHIC MODEL

One of the keys in developing an understanding of a potential pay is to integrate all data from cores, outcrops, samples, logs, etc., into a comprehensive model that can be used to evaluate reservoir characteristics for exploration and exploitation purposes. It is particularly important to understand facies vs. log response, even if it's only qualitatively, to provide a framework for detailed correlation and discovery.

FACIES VS. LOG RESPONSE

In the Chimneyhill through Bois

Depositional Texture recognizable					Depositional texture not recognizable
Original components not bound together during depositions				Original components were bound together during deposition... as shown by intergrown skeletal matter, lamination contrary to gravity, or sediment-floored cavities that are roofed over by organic or questionably organic matter and are too large to be interstices.	Crystalline carbonate
Contains mud (particles of clay and fine silt size)		Grain-supported	Lacks mud and is grain-supported		
Mud-supported					
Less than 10% grains	More than 10% grains				(Subdivide according to classifications designed to bear on physical texture or diagenesis.)
Mudstone	Wackstone	Packstone	Grainstone	Boundstone	

(DUNHAM, 1962)

Figure 5:. Dunham's classification chart (Dunham, 1962).

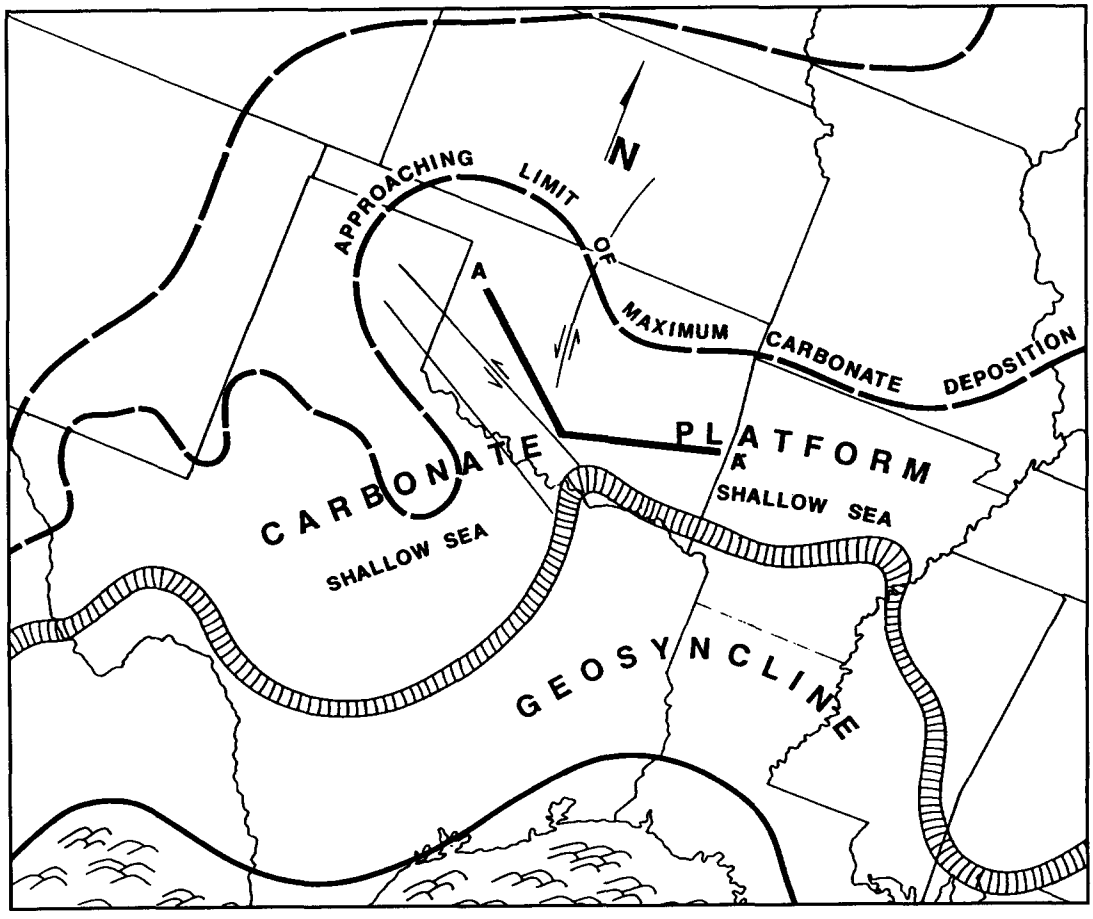

Figure 6. Depositional setting during Hunton time in Midcontinent.

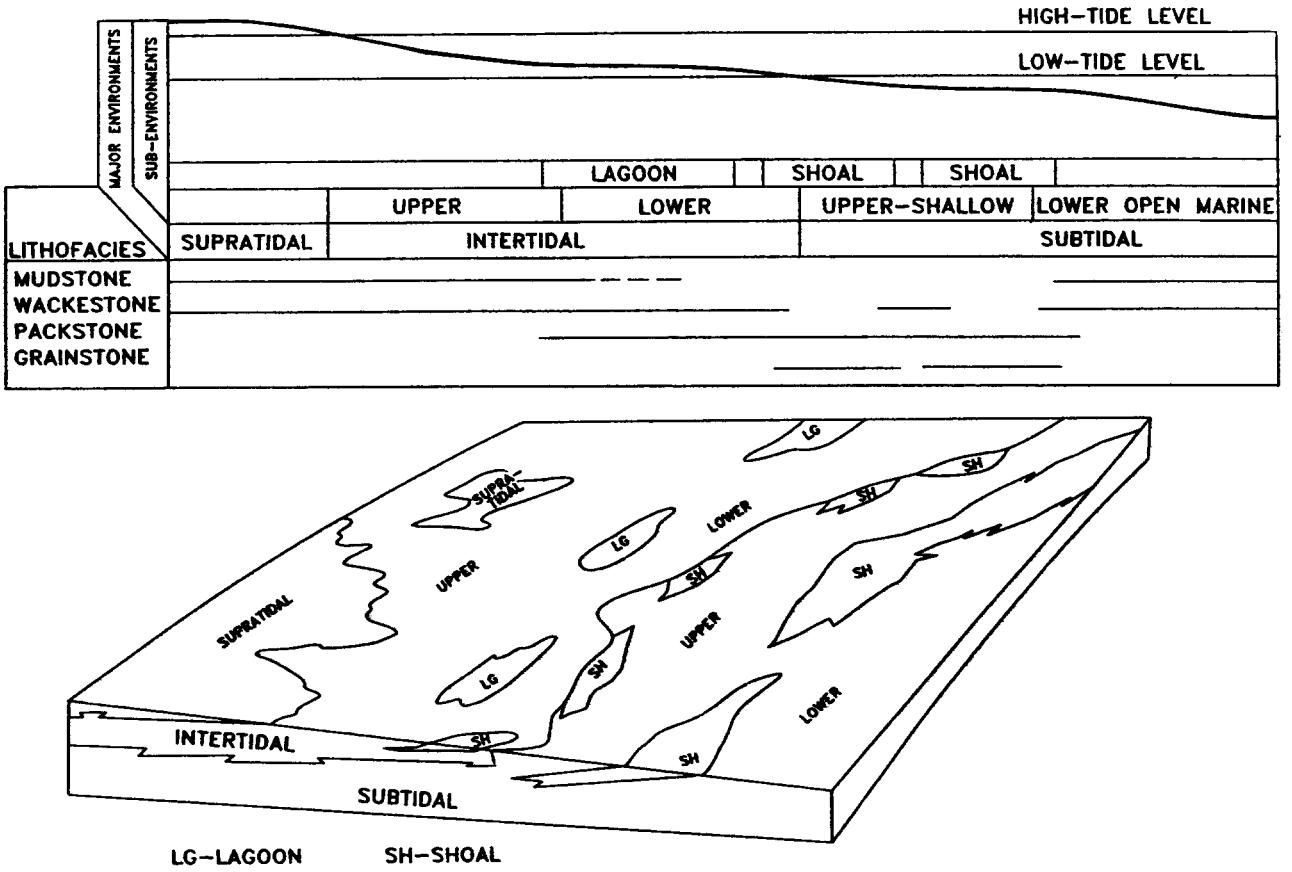

Figure 7. Depositional model for Chimneyhill through Bois d'Arc strata.

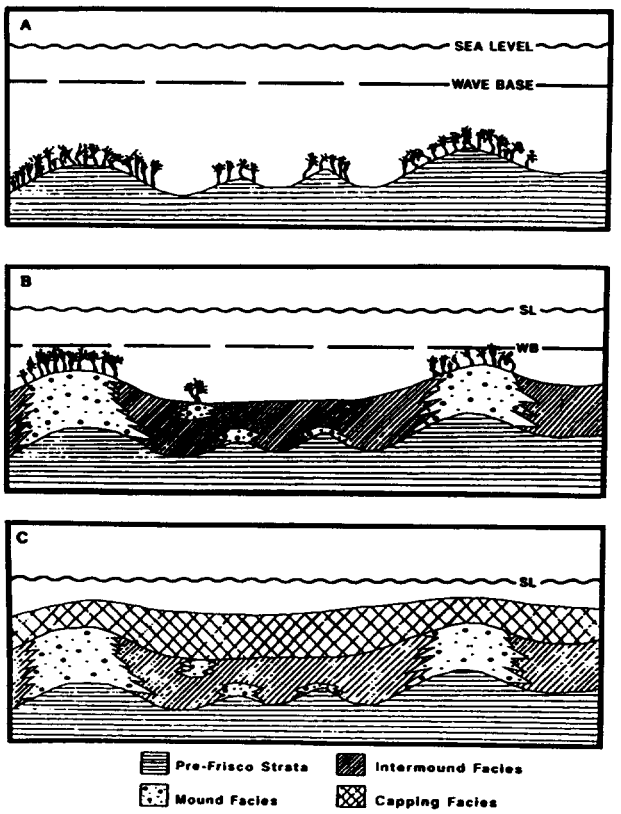

Figure 8. Depositional model for Frisco Formation.

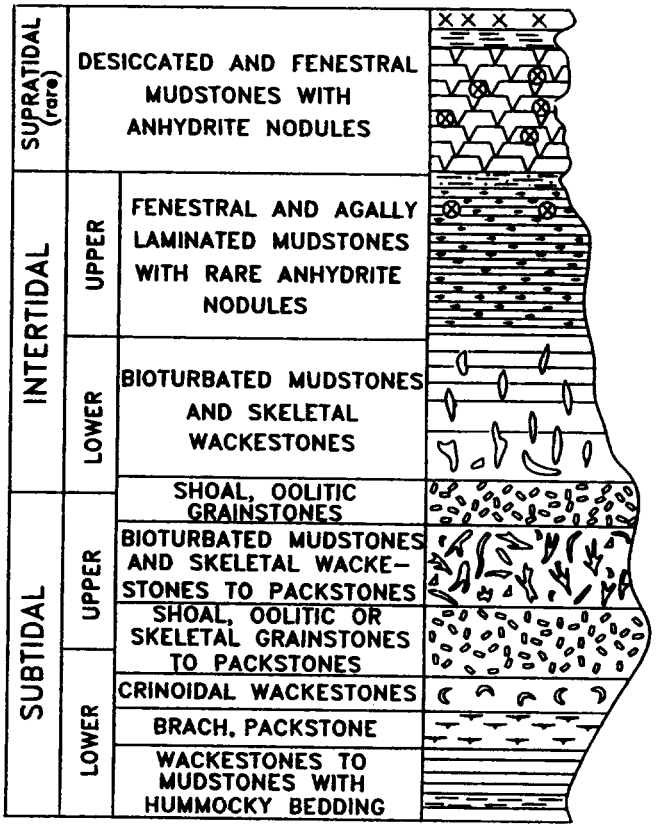

Figure 9. Idealized sequence showing relationship of lithofacies to depositional environments.

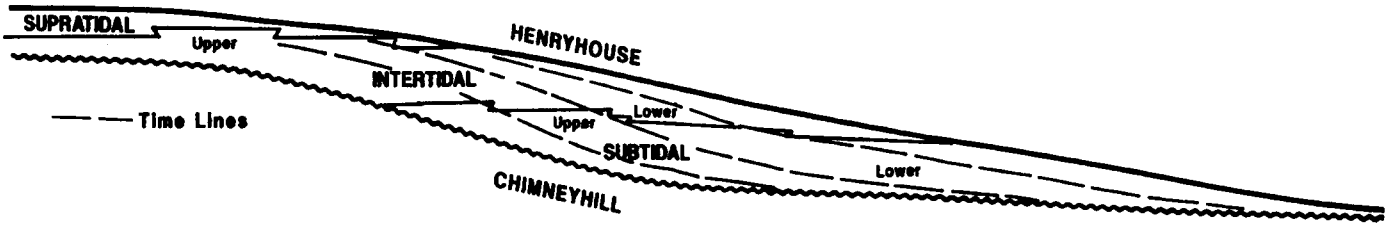

Figure 10. Depositional model showing details of progradation and aggradation.

d'Arc section, the most consistent factor which controls log response is shaliness. Fine clastics typically occur in the lower energy environments, such as the open marine and lower subtidal settings. Fine clastics are also found in the upper intertidal to supratidal environments, due to windblown deposition, and they may be winnowed by currents into the low-energy subtidal facies.

A typical sequence or parasequence has a low-energy, high-energy, and low-energy configuration from base to top. The effect is that the upper subtidal to lower intertidal environments have the cleanest (lowest) gamma-ray response and the highest resistivity; the open marine to lower subtidal settings have the poorest (highest) gamma-ray response and the lowest resistivity; and the upper intertidal to supratidal responses are in between, and can be quite "shaly" in areas where there is a concentration of windblown clastics (Fig. 11). Of course, there are many variations and exceptions to those observations; this is especially true in areas of high porosity and high water saturations, where the gamma-ray log will show "clean," but the resistivity will be low.

UNCONFORMITIES

The pre-Woodford unconformity is the hiatus most commonly associated with the Hunton Group. There are also several intra-Hunton unconformities, such as those found at the Silurian-Devonian contact and the base of the Frisco. This later unconformity is the most important because it represents the period of maximum erosion and truncation of the Hunton, even though the time gap is only 1-2 million years. The amount of erosion is substantiated by the stratigraphic relationship of the Frisco to the underlying units (i.e., Frisco can be found resting unconformably on Chimneyhill to Bois d'Arc strata; Fig. 12).

CORRELATION

An extensive network of cross sections was built that included strike and dip sections at a density of at least one per township. The area covered by these cross sections includes the Anadarko basin in Texas and Oklahoma, the Arkoma basin in Oklahoma and Arkansas, and central and southern Oklahoma. Although Hunton outcrop nomenclature has been used by others extensively on the surface, with some accuracy, in the subsurface the use of these names has been extensively misapplied and has led to great confusion in external correlations of the Hunton Group. For example, in central Oklahoma and the Anadarko basin, the uppermost porous unit of the Hunton is often named, and correlated with the Bois d'Arc; in fact, however, the Bois d'Arc has been truncated over most of this area, and the uppermost porous unit is usually Henryhouse or Frisco.

Evaluation of these cross sections and integration of core and outcrop data first revealed that there was not a typical Hunton section for correlation purposes; in fact, at least three type logs are required to understand the stratigraphic relationships of the intra-Hunton sequences. Figure 12 shows the correlations and sequence relationships from west to east among the type sections for the Anadarko basin, southern Oklahoma, and the Arkoma basin.

RESERVOIR CHARACTERIZATION

Porosity, and thus reservoir development, is facies dependent in the Hunton, although there are several processes which influence porosity development. An evaluation of the diagenetic history of the Hunton reveals that the two most important processes are dolomitization and dissolution (Fig. 13).

POROSITY DEVELOPMENT

Significant porosity formation in the Hunton usually occurs in oolitic, dolomitized grainstones (Keel and Henryhouse), and dolomitized, burrowed wacke/packstones (Cochrane, Henryhouse, and Haragan/Bois d'Arc). These units are typically subjected to at least three stages of dolomitization and multiple stages of dissolution in the form of karstification or connate fluids (Manni, 1985) The relationship of dolomitization and facies is shown in Fig. 14.

Porosity development in the Frisco is different than in most other parts of the Hunton; most porosity in the Hunton is related to dolomitization, whereas the Frisco is rarely dolomitized. It typically has inter- and intraparticle porosity combined with moldic to vuggy porosity.

The Penters is unusual in that it has been subjected to intense karstification, typically associated with porosity occlusion; however, the high percentage of chert combined with dolomite develops an extensive fracture system that can drain hydrocarbons from the intercrystalline porosity in the dolomite.

TRAP AND GEOMETRY

Most of the Hunton fields would be classified as structural/stratigraphic traps, with emphasis on stratigraphic. The most common type of reservoir configuration in the Hunton is where porous facies are truncated by either the pre-Woodford unconformity and/or intra-Hunton unconformities along a structural nose. This is particularly true of most of the Henryhouse section in the Anadarko basin, which develops reservoirs wherein the traps are formed by truncation (by unconformity) and both the seal and the source rock are the Woodford Shale (Fig. 15).

Another common reservoir configuration in the Hunton is trapping by permeability barriers caused by facies

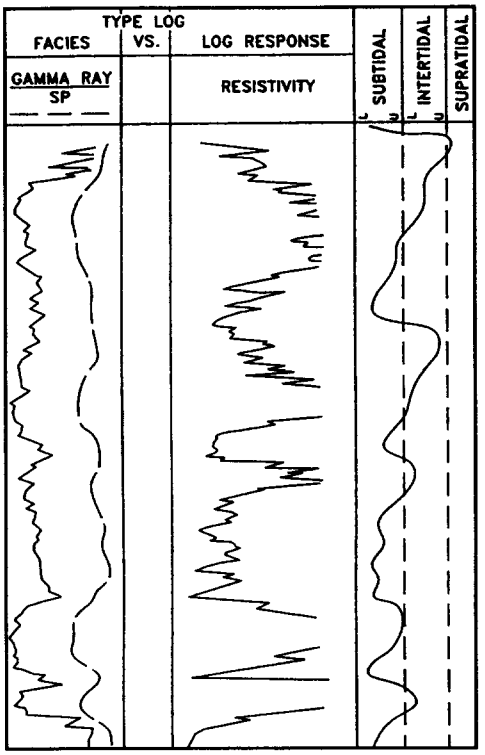

Figure 11. Log showing typical response of SP, gamma-ray, and resistivity curves to depositional environments.

changes or karst profiles along structural noses or faults (Fig. 15).

In the Arkoma Basin, fractured reservoirs and Hunton fields are more commonly related to structural configuration (e.g., Bonanza Field).

CONCLUSIONS

The Hunton Group is a shallow-marine carbonate composed of limestones, dolomites, and calcareous shales that prograded and aggraded onto a ramp. These carbonates are cyclic and can be divided into sequences within formational boundaries that are recognizable in outcrops, cores, and logs. These sequences commonly are separated by disconformities or unconformities and can be correlated regionally. Furthermore, reservoir development in the Hunton Group is facies dependent and reservoir-producing lithofacies can be correlated and mapped (Figs. 16,17).

Use of core, outcrop, and log relationships, integrated with a comprehensive sequence-stratigraphy model, can greatly enhance success for exploration programs or field development.

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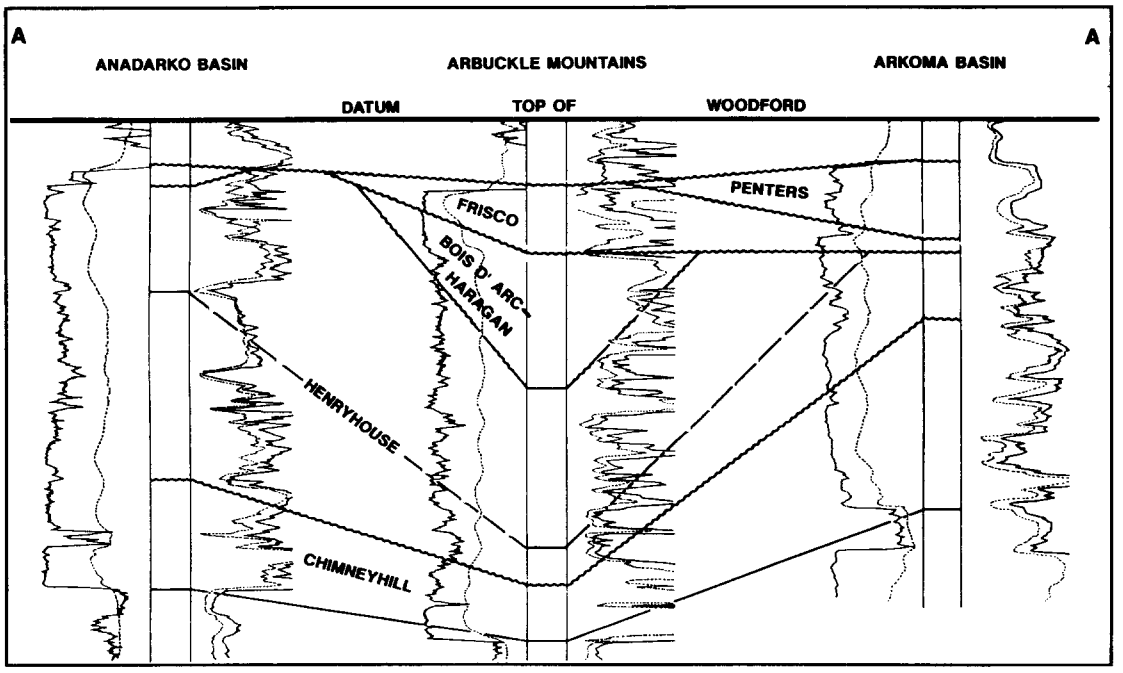

Figure 12. Cross section showing the correlation of type logs for the Anadarko basin, Arbuckle Mountains (southern Oklahoma), and Arkoma basin.

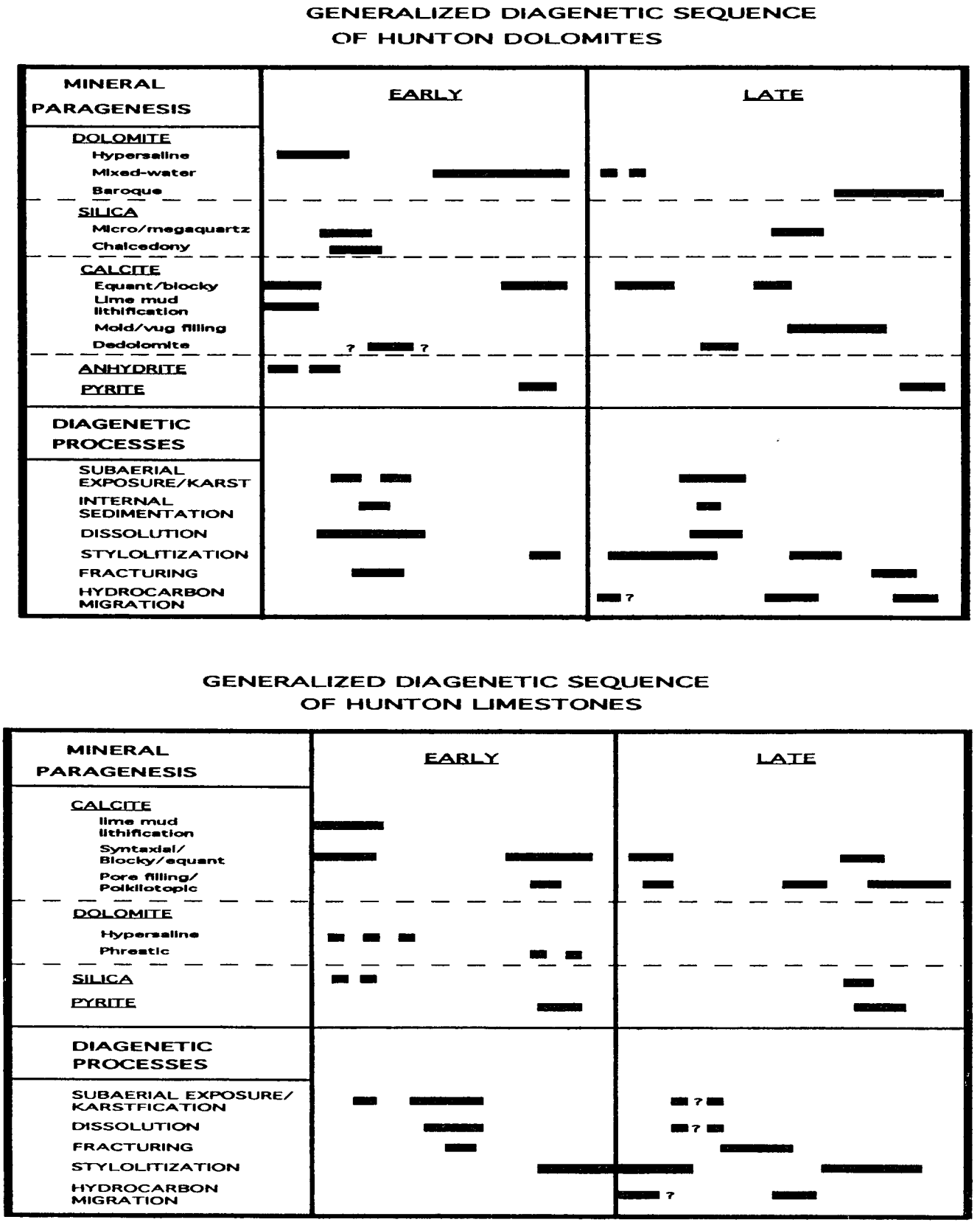

Figure 13. Generalized diagenetic sequence of Hunton dolomites (above) and Hunton limestones (below).

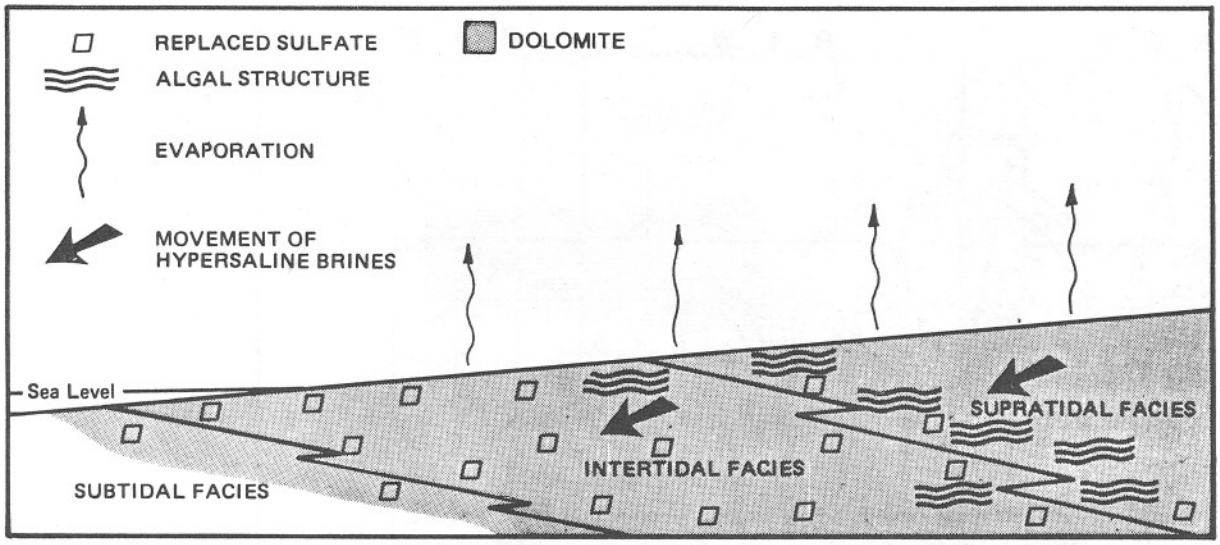

Figure 14. Diagram showing the relationship of dolomitization to depositional facies.

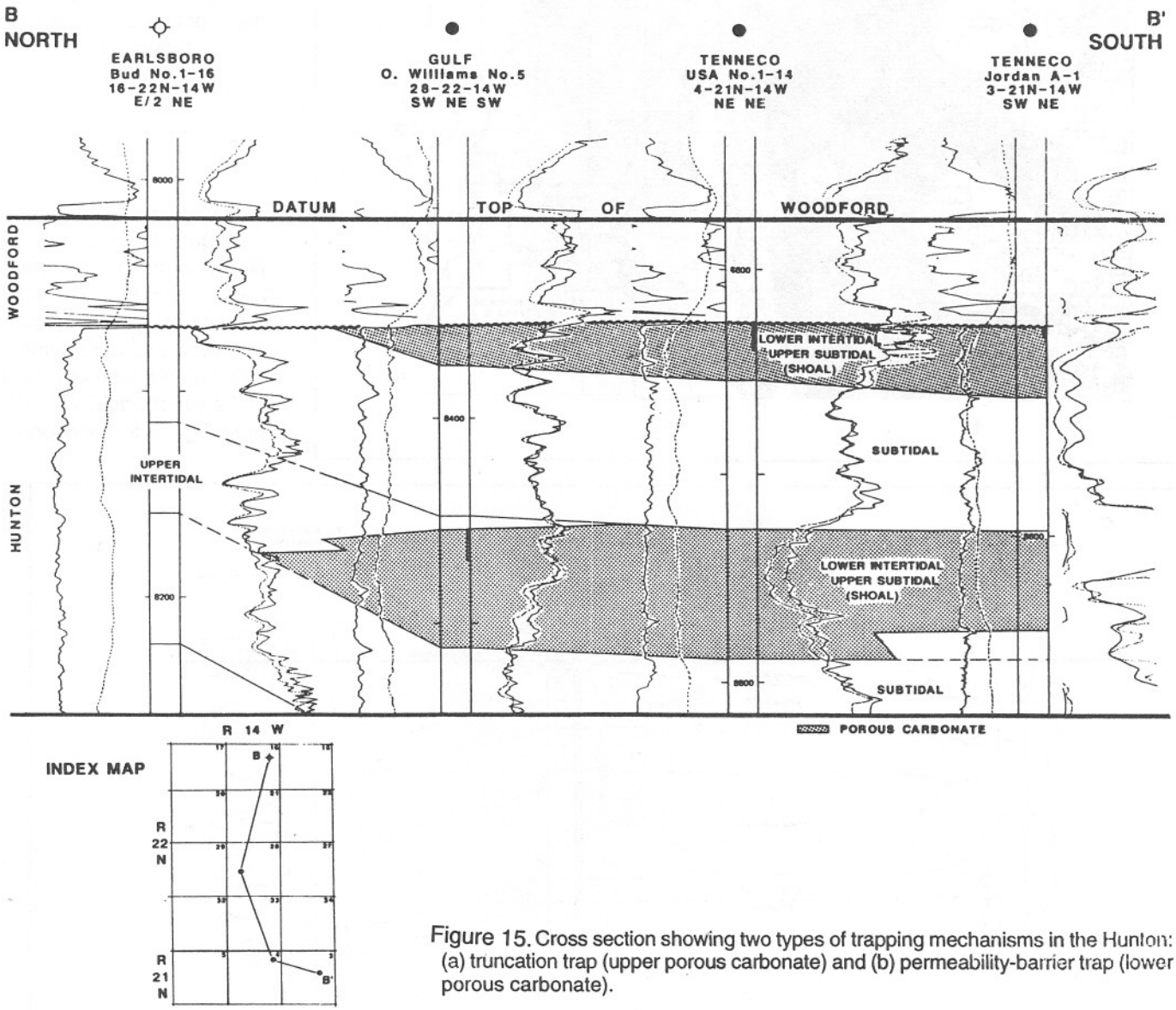

Figure 15. Cross section showing two types of trapping mechanisms in the Hunton: (a) truncation trap (upper porous carbonate) and (b) permeability-barrier trap (lower porous carbonate).

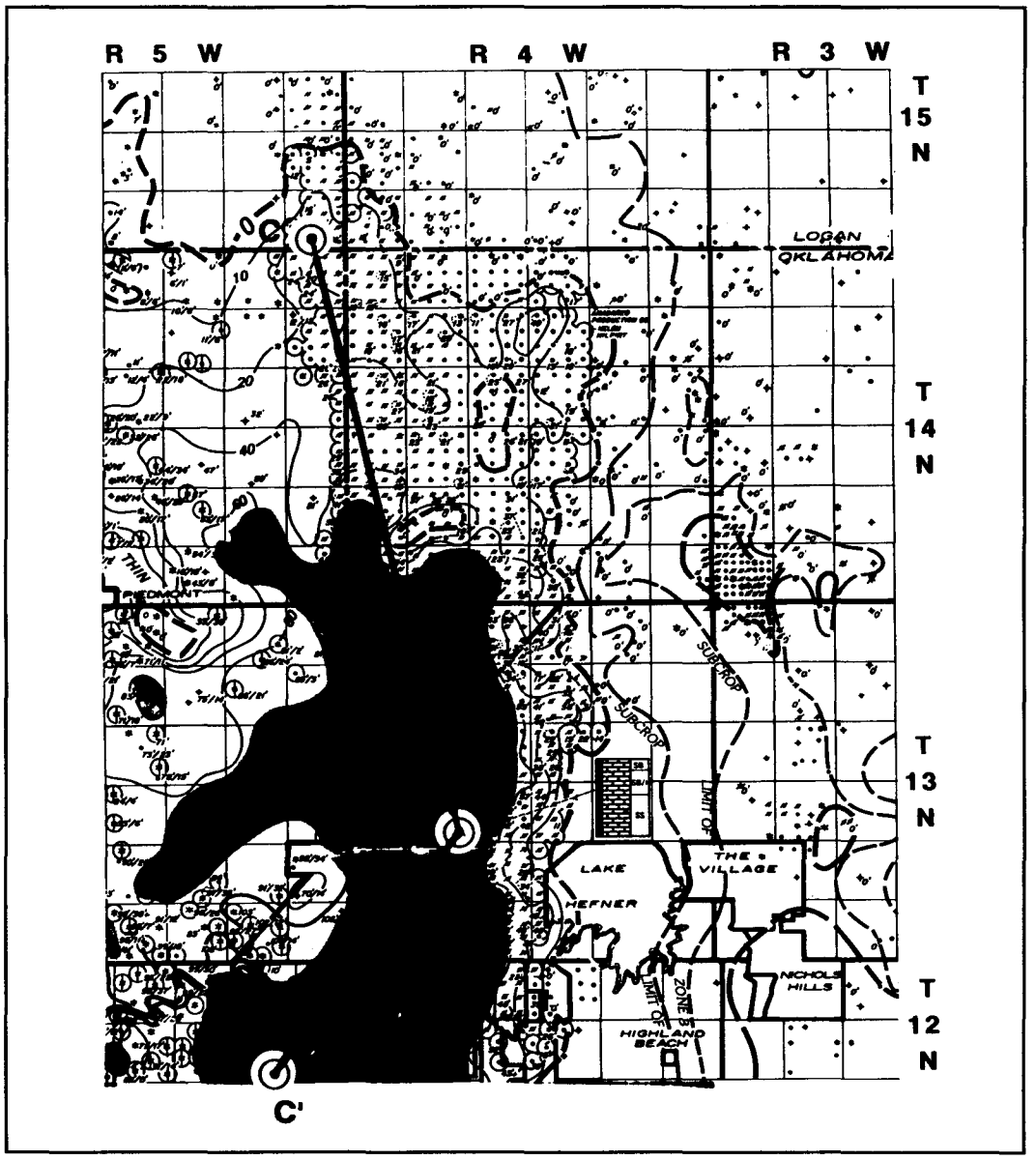

Figure 16. (at left) Isopach map of Frisco limestone at West Edmond field (smaller squares are 1 mi²). Cross section C-C' shown in Figure 17.

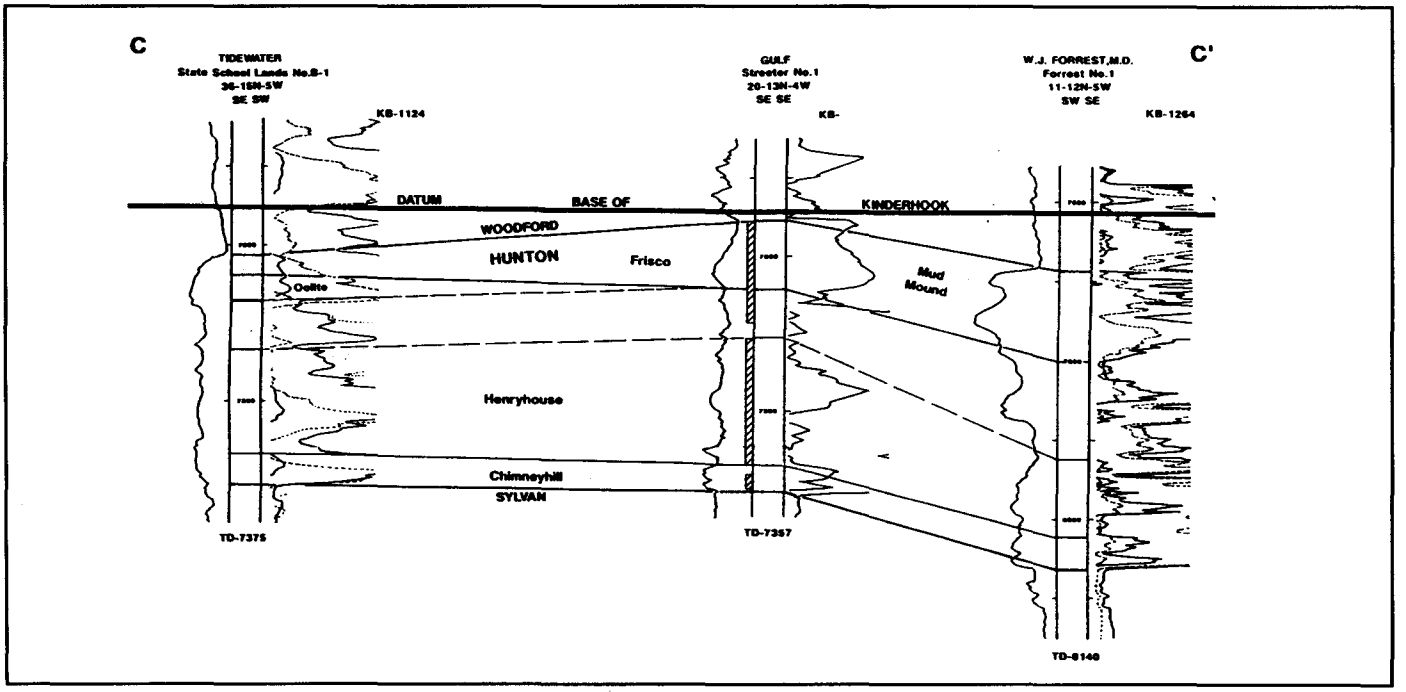

Figure 17. (below) North-south stratigraphic cross section C-C' showing the relationship of the Frisco reservoir and underlying oolitic Henryhouse reservior in the West Edmond field (see Fig. 16 for location.)

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BUSINESS OF GEOLOGY

How Can You Say You're In The Oil Business, When You Don't Know The Competition?

by Paul Oman

I have trouble believing that anyone can say they're in the oil business, if they can't identify their competition. As unpleasant as it sounds, geologists, geophysicists and engineers that simply do their jobs of locating and producing hydrocarbons are little more than well-paid factory workers or tiny cogs in the big-wheel-of-business. That may be fine with you so long as the paycheck arrives every other week, but as a self-employed professional, I like to think of myself as more than a mere cog. I like to know, and take some responsibility for, both my role in the big picture and for my ability to support myself without accepting an automatic paycheck. Given the current state of affairs, and the potentially gloomy future, you had better start thinking that way too. Let me tell you from personal experience, petroleum skills aren't very transferable.

Ask a petroleum professional who his competition is and you'll be surprised at the answers. While they can follow horizons across hidden faults, their ignorance in the real reasons of why they're asked to do it can be a disappointment.

Is the competition Shell or BP? Is it OPEC? Or is it something too tacky to talk about, something like pork bellies?

When Shell has a discovery, is it at your expense? When they score a win, do you lose a little bit? Unless you're running an Exxon filling station and there is a Shell station across the street, the answer is no. Shell is generally not the competitor.

If you feel OPEC is the competition, will you at least admit they have the ability to produce more oil, more cheaply and longer than you can (don't force me to start quoting finding costs and reserve figures) barring any artificial leveling factor such as import fees, tariffs, etc.? If OPEC is your competition, why have you purposefully thrown your lot in with the obvious under-dog? Do you like the idea of selling a lesser product at a higher price? If OPEC was the competition, we wouldn't even be in business.

The real competition is pork bellies. It's also scrap iron and chicken feed. You and I are in a commodity industry, just as if we were exploring for scrap iron, tallow and glass. Our parent companies, or investors, don't really care if they ride the oil commodity or the pork belly commodity profit wave. The one that returns the biggest bang for the buck is the one they'll support. If oil is not making as much money as pork guts why do oil instead of pork bellies? Forget dumb arguments like "national security". Businesses operate for profits (i.e. shareholder gain); national security is just a by-product. Besides, wouldn't national security be even greater if we left the oil in place for when we needed it, instead of producing it now?

As an oil professional it's your task to make the hydrocarbon exploitation/commodity business more attractive to income-seeking people and companies than pork bellies or scrap iron. You've got to operate within the realities of supply and demand, something you can't control, but must live with. Tax incentives and tax breaks can shift things in your favor, and while that may mean the difference between employment or unemployment, it still seems like cheating to me.

Be aware that your high salary, seismic sections and computer workstations cost much more than a skinning knife and the wages of a man willing to gut a pig. Those high-tech expenses are either part of the solution to higher profitability or part of the problem. It's your job to make them part of the higher profit solution.

Perhaps now that you know who the competition is you'll have a better chance of keeping your share of the American Dream.

Mr. Oman owns PROTEC, a company providing marketing and positioning services to high-tech firms.

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USEFUL UTILITIES

U.S. Geological Survey Will Preserve Enormous Core Sample Collection At Denver Facility

The Core Research Center at the USGS has recently acquired a major addition of drill bit cuttings and core chip samples that will be housed at its facility in Denver. The cuttings collection was obtained from American Stratigraphic (Amstrat) and represents 230 million feet of subsurface information from 50,000 wells in 25 states. The new inventory of cuttings adds to the 1.4 million feet of core currently housed at the facility.

The USGS Core Research Center was established in 1974. The original purpose of the center was to obtain and preserve cores that were in danger of being discarded or destroyed. It has since grown to be one of the largest and most frequently utilized public core libraries in the United States. According to Tom Michalski, Curator of the Core Research Center, most of the cores have been donated to the facility by companies in the petroleum and mining industries, as well as federal and state agencies, and various universities.

The petroleum industry traditionally has relied on cuttings examination as a direct indication of hydrocarbons. In addition to information gained from evaluation of samples while drilling, there are many other uses for a well maintained inventory of drill cuttings. Traditional binocular examination can be used to visually assess effective porosity, permeability, and hydrocarbon presence where cores were not taken. After visual calibration to cores with known petrophysical properties, interpretations can be made in "cuttings only" wells with respect to these same properties. Typical applications range from augmenting log analysis and bypassed pay evaluation to evaluating reservoir heterogeneity for secondary recovery projects. Many "high-tech" applications such as SEM, X-ray diffraction, and enhanced image analysis also can be applied to cuttings with results comparable to cores.

American Stratigraphic decided to eliminate its library because of the high maintenance costs. Under strong encouragement from AAPG, RMAG, and industry, the Survey agreed to acquire and store the cuttings for public use. The loss of a library of this magnitude would certainly have been a major loss to the oil and gas industry.

The samples took four months and 75 truck loads to move. New shelves and material-handling equipment were purchased, and more storage area was acquired. The samples currently are being sorted and shelved, and the file should be in place and totally available for use by December 1993. Parts are available now, and being actively utilized.

The total cost of this project was $250,000. Because the Survey has no funding to offset these costs, a Joint Advisory Committee for cuttings preservation was formed and is presently seeking funds to help cover the cost of transferring the samples to USGS. A tax-deductible contribution to help save this vast collection, can be made to RMAG Cuttings Preservation Account, % Rocky Mountain Association of Geologists, 730 17th St., Suite 350, Denver, CO 80202. In Addition to the new library, the Survey is building a new cuttings observation room that will be equipped with cubicles, tables, microscopes, UV boxes, chemicals, vented hood and sink, and other tools of the trade. This facility will be completed and open to the public at no cost in June 1994. The cost of this facility is not included in the $250,000 and is not a part of the funds being raised.

The Center also has obtained from Amoco a complete set of unwashed cuttings. This collection contains sample sets from 655 wells in Texas, Louisiana, and northern Gulf of Mexico. They will be added to the Amstrat set, making this one of the largest collections of cuttings and core chips available to the industry.

USGS is providing a tremendous service to the industry. It is now time for the oil and gas industry to show its support by making a financial contribution to offset the cost incurred in rescuing and preserving these extremely valuable and irreplaceable resources. Let's all do our part to insure that the Amstrat collection will be available for use now and in the future by showing our support for this important rescue project.

For further information or questions, contact Steve Goolsby at 303/893-1718, or Lorraine Druyff at 303/825-5212.

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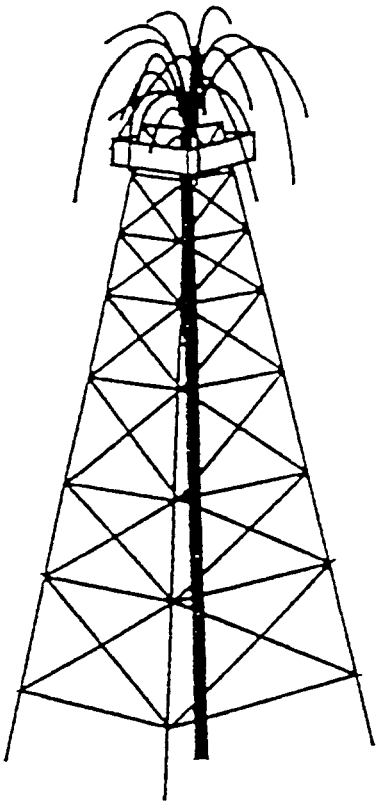

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A restored top is an estimate of the depth that the top of a formation or marker would have had in a well, if it were not faulted out (Tearpock and Bischke, 1991). The use of restored tops can provide additional and critical points of control to improve the structural interpretation around a controlling fault.

The prospect map in Figure 1 was drawn without taking into account the restored tops for wells near the fault. The control for this interpretation is primarily downdip from the crest of the structure. In Figure 1, two drilling locations were proposed - one in the upthrown and the other in the downthrown fault block. The faulted out wells are the only wells that can provide additional data near the fault for the preparation of the map. Figure 2 was drawn after restoring the tops for those wells.

Notice that the interpretation changes significantly with the restored tops for Wells Nos. 3 and 11. The reserves for Reservoir C-3 are reduced by 46 percent and the reserves for Reservoir C-5 are reduced by 42 percent. In addition, the proposed well for Reservoir C-5 will be a dry hole.

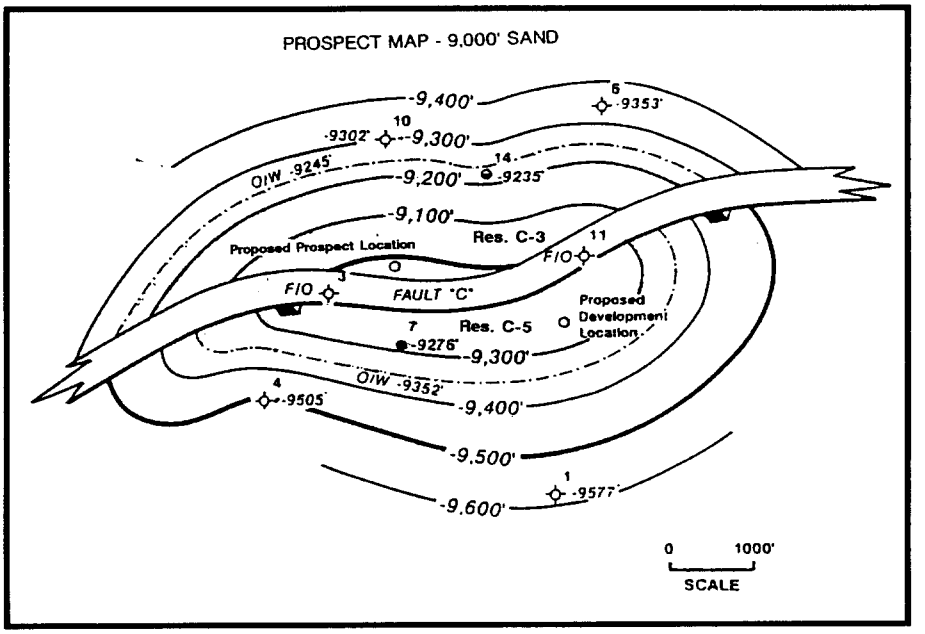

Figure 1

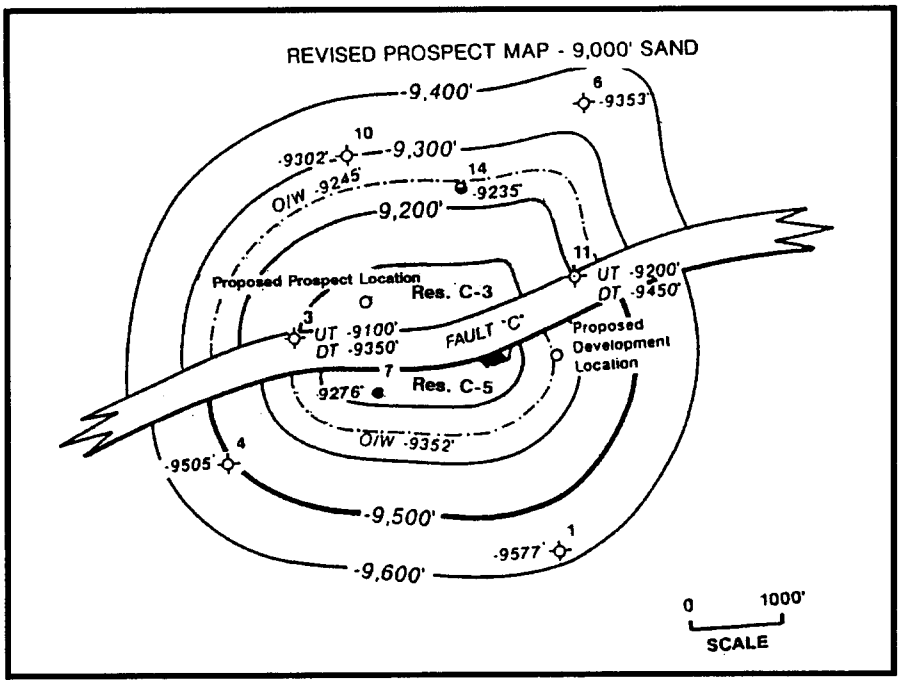

Figure 2

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Holiday Inn–Arena
Binghamton, New York

Abstract Deadline:
Past due 1993

Submit completed abstracts to
H. Richard Naslund
Department of Geological Sciences
SUNY
Binghamton, NY 13902-6000
(607) 777-4313

NORTH-CENTRAL SECTION
April 28–29, 1994
Western Michigan University
Kalamazoo, Michigan

Abstract Deadline:
Past due 1994

Submit completed abstracts to
Ron Chase
Department of Geology
Western Michigan University
Kalamazoo, MI 49008
(616) 387-5500

CORDILLERAN SECTION
March 21–23, 1994
San Bernardino Hilton
San Bernardino, California

Abstract Deadline:
Past due 1993

Submit completed abstracts to
Joan E. Fryxell
Department of Geological Sciences
California State University
5500 University Parkway
San Bernardino, CA 92407-2397
(909) 880-5311

SOUTHEASTERN SECTION
April 7–8, 1994
Virginia Tech
Blacksburg, Virginia

Abstract Deadline:
Past due 1993

Submit completed abstracts to
A. Krishna Sinha
Department of Geological Sciences
Virginia Tech
Blacksburg, VA 24061-0420
(703) 231-5580

ROCKY MOUNTAIN SECTION
May 4–6, 1994
Tamarron Resort
Durango, Colorado

Abstract Deadline:
Past due 1994

Submit completed abstracts to
Jack A. Ellingson
Geology Department
Ft. Lewis College
Durango, CO 81301
(303) 247-7244

GSA Annual Meeting
Seattle, Washington, October 24–27, 1994

Abstract Deadline: July 6, 1994

Submit completed abstracts to
Abstracts Coordinator
Geological Society of America • 3300 Penrose Place • P.O. Box 9140 • Boulder, CO 80301-9140
(303) 447-8850

1994 ABSTRACT FORM REQUEST

To: GSA Abstracts Coordinator, P.O. Box 9140, Boulder, CO 80301-9140

Please send ____ copies of the 1994 GSA abstract form. I understand that the same form may be used for all 1994 GSA meetings—(the six Section Meetings and the Annual Meeting).

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ANNOUNCEMENT: AMOCO OFFERS TRAINING

Amoco Internal Training Courses are now being offered on a selective and space available basis to the Industry at break-even costs. Below is a brief description of current offerings; To register or to obtain additional information contact David R. Matuszak, 501 WestLake Park Blvd. Houston, TX 77079; Phone (713) 366-3444; Fax (713) 366-2102.

1. **Hydrodynamics In Hydrocarbon Exploration,** Feb. 28 - Mar. 2, 1994. **Location:** Amoco Production Company, 501 Westlake Park Blvd, Houston, TX 77079, Room 14.160. **Instructor:** Eric Dahlberg, Calgary, Alberta, Canada. **Cost:** $675 per participant, includes workbook and tuition. **Who Should Attend:** Geologists, Geophysicists and Engineers involved in Domestic and International Exploration as well as Reservoir Geologists dealing with water-related development problems. **Registration Deadline:** Feb. 21, 1994.

2. **Coal Degas and Source Rock Seminar,** May 15-19, 1994. **Locations:** Okefenokee Swamp, Georgia and Amelia Island, Florida, **Instructor:** Art Cohen, Univ. of South Carolina, Columbia, South Carolina **Cost:** $1500 per person, includes workbook, lodging, most meals, all coffee breaks, and boat rentals. Participants are responsible for transportation to and from the field. This is a four day combination lecture-field trip providing first hand observation in the Okfenokee Swamp of organic sedimentation processes and geologic and hydrologic requirements for peat and coal seam formation. There are about 8 non-Amoco slots available in this seminar and they will be assigned on a first come, first serve basis. **Who Should Attend:** Geologists, Geochemists, and Engineers involved in coal degas and source rock projects. **Registration Deadline:** March 15, 1994.

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