February, 1992

BULLETIN

HOUSTON GEOLOGICAL SOCIETY

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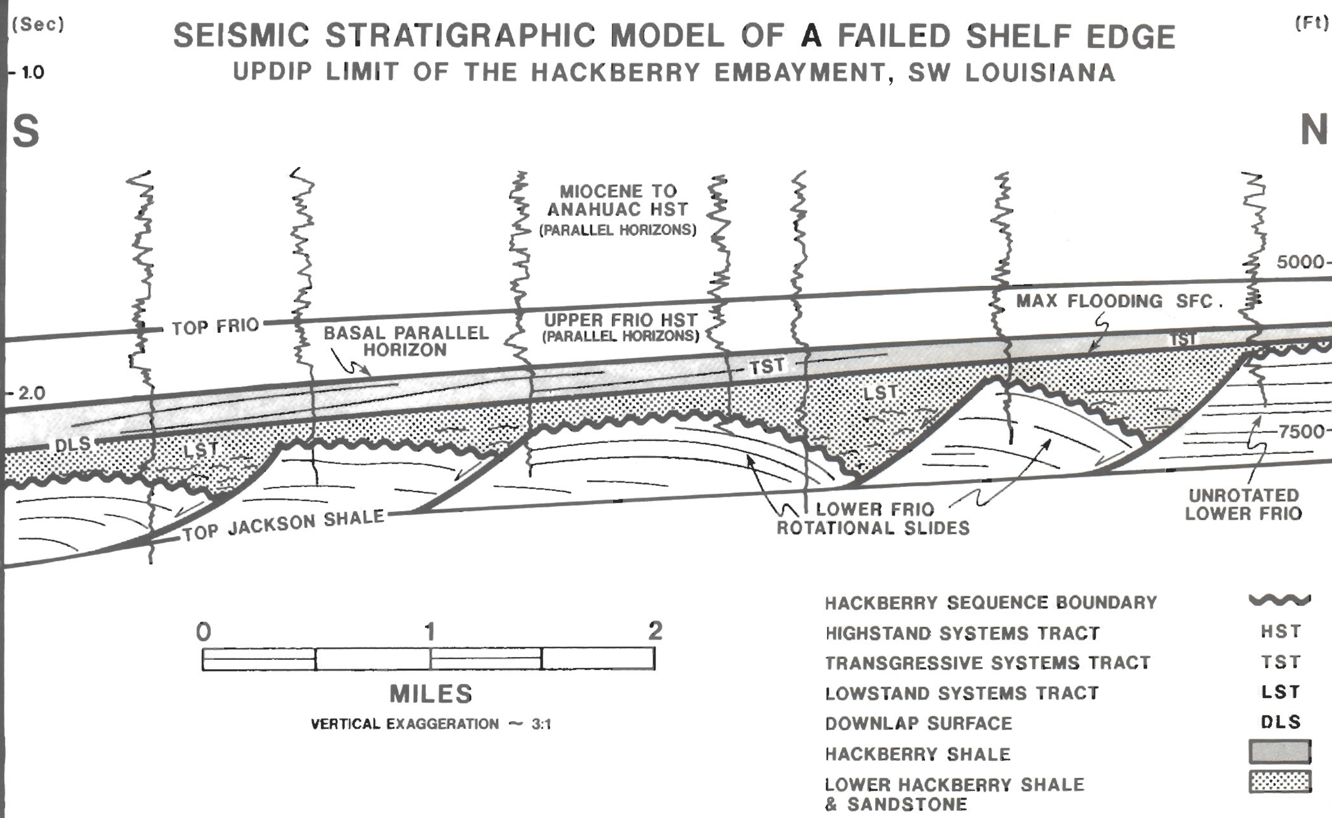

Find out more about the Hackberry Depositional System at the HGS Luncheon on Wednesday, February 26, 1992.

HAPPY VALENTINE'S DAY!

IN THIS ISSUE...

PLUS MORE!

(For February Events, see Calendar and Geo-events section, page 31)

HOUSTON GEOLOGICAL SOCIETY

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Vol. 34, No. 6 February, 1992

Manuscripts, inquiries, or suggestions should be directed to Editor, c/o HGS Bulletin, 7171 Harwin, Suite 314, Houston, TX 77036. Deadline for copy is six weeks prior to publication. All copy must be typewritten and double-spaced on standard white paper. Line drawings and other illustrations must be photo-ready. If prepared on a word processor, please send a copy of the computer disc, preferably in either Pagemaker or Ventura format.

Photographs submitted for publication are welcome, but cannot be returned.

ADVERTISING COMMITTEE

Please call
785-6402
for information about advertising.

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PRICE SCHEDULE— FEBRUARY MEETINGS

(Non-members: add $2.00 to the meal price)

See **Meetings** abstracts for times

HGS Dinner Meeting, Feb. 10
Post Oak Doubletree Inn $20.00
HGS International Explorationists Dinner Meeting, Feb. 25
Post Oak Doubletree Inn $21.00
Permian Basin/Mid-Continent Explorationists Dinner Meeting, Feb. 11
Post Oak Doubletree Inn $20.00
HGS Luncheon Meeting, Feb. 26
The Houston Club $15.00

RESERVATIONS POLICY

Reservations are made by calling the HGS office (785-6402). At the meeting, names are checked against the reservation list. Those with reservations will be sold tickets immediately. **Those without reservations will be asked to wait for available seats, and a $2 surcharge will be added to the price of the ticket. All who do not honor their reservations will be billed for the price of the meal.** If a reservation cannot be kept, please cancel or send someone in your place.

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

Contents Continued

ERRATUM: Affiliation of the authors of "Hydrocarbon Contamination in the Urban Environment" was inadvertantly omitted in the January 1992 HGS *Bulletin*. Marilyn Czimer Long is a Senior Geologist with the Texas Water Commission District-7 Houston Office and Glenn Lowenstein is a Staff Geologist with Professional Service Industries, Inc.

HAVE YOU EVER MADE A RESERVATION AND NOT SHOWN?

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

For those who are billed and do not pay, please be aware that the next time you attend an HGS lunch or dinner event, the treasurer (or representative) will ask to discuss the reasons prohibiting payment.

PRESIDENT'S COMMENTS

Welcome!! Again this month we have an amazing number of activities for you to participate in. It is a truly great testimony to the breadth and depth of talent in addition to the dedication of our members that exists in our community. In addition to our regularly scheduled technical meetings, we are most fortunate to have **two outstanding geologic conferences** to be held in Houston.

> The first is the **U. S. Geological Survey's 8th Annual V. E. McKelvey Forum** on Energy and Mineral Resources, which will take place at the **Wyndham Greenspoint Hotel** on February 18th-20th.
>
> The second is the **26th Annual South-Central Section Meeting of the Geological Society of America,** which will be held on the **Rice University Campus** on February 23rd-25th.

McKELVEY FORUM - FEBRUARY 18-20

The **McKelvey Forum,** named after former Director of the **USGS Vincent E. McKelvey,** was established in 1985 to improve communications between the **USGS** and the earth science community. The **USGS** will present the results of its current research, and provide an opportunity for the attendees to meet informally with its scientists and managers.

The **Forum** will feature two days of technical presentations and poster sessions, an evening lecture (Director's Lecture), and a one-day short course, all of which will focus on current **USGS** research on energy resources. Special features of the conference are the:

Keynote Address, entitled "Role of Water in Petroleum Formation," by **Michael D. Lewan,** whose pioneering research is expected to provide more realistic assessments of the timing of petroleum formation and amounts and types of petroleum expelled in sedimentary basins.

Director's Lecture entitled "Fractal Nature of Hydrocarbon Accumulations — Size and Spatial Distribution and Implication for Exploration and Development Strategies," by **Christopher C. Barton,** whose research can be used to estimate the volume of oil remaining in a region and to implement exploration and development strategies.

Short Course taught by **Warren Hamilton,** entitled "Recent Advances in Plate Tectonics and Continental Crustal Evolution."

The three-day registration fee is only $25, which will be used to cover the cost of refreshments. For additional Technical Program information, call **Christine Turner, USGS,** at (303) 236-1561, and for Registration information contact **Jan Kernan, BAI Inc.,** at (301) 588-4177.

G.S.A. SOUTH-CENTRAL MEETING - FEBRUARY 23-25

This meeting is being co-sponsored by the **Houston Geological Society, Rice University,** and the **University of Houston. Hans Ave Lallemant** and his hard-working crew have put together a wonderful slate of technical presentations, eight field trips, and two short courses. **Four** of the **ten different symposiums** should be of special interest to the **HGS** membership. They are:

- **Pete Vail's** "Sequence Stratigraphy of the Gulf Coast Paleocene";
- **Bert Bally's** "Comparison of North American and East European Folded Belts";
- **Andre Drosler and Bob Ginsberg's** "Response of Carbonate Platforms to Sea-Level Fluctuations";
- **Dale Sawyer and Dick Buffler's** "Tectonics and Evolution of the Gulf of Mexico Basin".

HGS members who wish to attend a field trip or short course and who do not wish to register for the entire conference ($60), may do so by paying the respective trip/course cost and a $10 administrative fee. More information and registration details are published elsewhere in this and the January Bulletin.

REGULAR TECHNICAL PROGRAM

At our **dinner meeting (Feb. 10)** the **HGS** will be hosting the **Houston Area Petroleum Landman's** group. Our speaker will be **Joe Stuckey, Esq.** of **Woodward-Clyde Consultants** on the subject of "Environmental Law Considerations for Oil and Gas Leasing", a subject of increasing concern to all of us, especially to those working in Texas. **Joe** has already given part of this talk to the Environmental Committee and received excellent reviews. I encourage you to invite the landmen you know to accompany you. Many landmen, especially in the larger companies, do not belong to the local society and will not know about it if you don't tell them.

Later in the month at our **luncheon meeting (Feb. 26), Mike DiMarco** and **Craig Shipp** of **Shell** will jointly discuss the Hackberry depositional system of S. E. Texas and S. W. Louisiana. Part of their work was presented at the GCAGS Poster Session last October where it generated a great deal of interest. This is an area of complicated geology and rapid stratigraphic changes which modern seismic and stratigraphic concepts have gone a long way to unravel.

At the **International Committee's dinner meeting (Feb. 25), Leigh Royden** and **Clark Burchfiel** of **M.I.T.,** in conjunction with the G.S.A. meeting, will present "Eastern European Mountain Belts - the Highs and Lows." This should be an important talk for those interested in the possibilities created by the opening up of eastern Europe to western investments.

The **Midland/Midcontinent Group dinner meeting (Feb. 11)** will feature **Glen Merrill** of the **U. of H.** on the Paleozoic history of the Llano Uplift, Central Texas."

And lastly, at the **Environmental and Engineering Committee (Feb. 12)** meeting, **Northrup and Associates** will present a very timely talk on wetlands determinations and assessments. If you have not attended one of this committee's meetings I want you to know they are **one of HGS's best kept secrets.** It's a great opportunity to meet and talk with the people who are out there doing the environmental work. They can really fill you in on the facts, and you won't have to rely on what is printed in the newspapers and other numerous inflammatory articles. You will definitely be better informed, and thereby better able to represent our profession to the community!!

ENTERTAINMENT EVENTS

For those romantically inclined, the **Geological Auxiliary** will hold their popular annual **Valentine Dinner Dance** on Friday, February 14th, at the Lakeside Country Club. **All HGS members are invited!! Daisy Wood** and **Annette Mather** and their Committee have been working hard on this evening for months. This is their **big event** of the year. In addition to a great meal and fellowship at a great price ($53 per couple), you will have the opportunity to listen and dance to the famous **Gillie and the Boys** playing "Dixieland music", which **Daisy** promises is both "lively and romantic". So get a group of your friends together, make your reservations now, and prepare for a fabulous evening.

WELCOME

Please welcome new committee chairs **Bill Burkman** and **Hugh Hardy.**

Bill has taken over the **Remembrances Committee** from **Charles Overton** who needs to spend increasing amounts of time on his expanding property management business.

Hugh is heading up the **HGS Foundation (Undergraduate)** which **Merrill Haas** has so capably led since its inception in 1984.

For those who may not know, during **Merrill's** tenure as chairman, the Foundation grew from nothing to over $100,000!! And since 1986, it has annually awarded $1000 undergraduate scholarships to each of the following universities: Lamar, Rice, Stephen F. Austin, Texas A&M, University of Texas, and University of Houston.

Thank you **Charles** and **Merrill,** for your dedicated service to HGS. We appreciate your work, wish you well in your future endeavors, and look forward to seeing you at future events.

MIDWAY MARK

We are now halfway through the 1991-1992 **HGS** year! At this time we still have a **few open dates for technical talks, field trips, courses, and social events.** So **if you have any suggestions** please call the appropriate chairman. Better yet, volunteer to work with the committee organizing the project. If we can't schedule it this year, we can certainly put it on the calender for early next year. We value and welcome your input and ideas!!

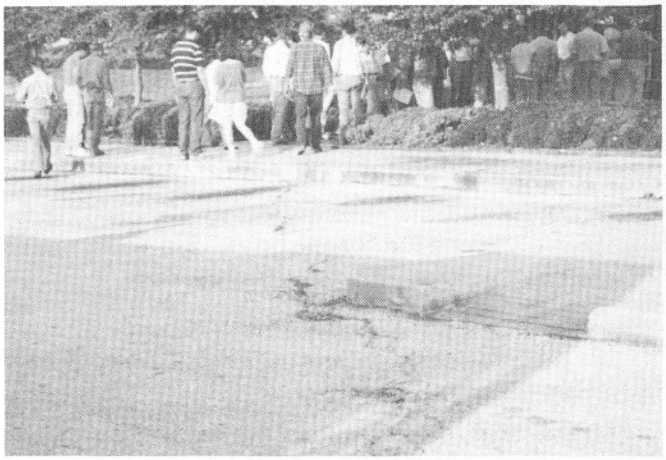
See you at the meetings!! Bring a friend!!

Cy Strong

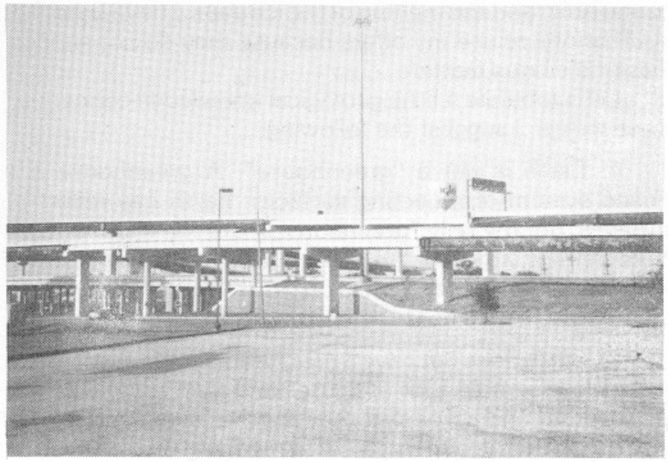
EDITOR'S COMMENTS

Those of you who missed the HGS "Environmental and Engineering Geology of North Harris and South Montgomery Counties, Texas" field trip, led by Carl Norman and Saul Aronow, and held in conjunction with the GCAGS Annual Meeting in October, 1991, may want to reserve a spot for HGS/GSA field trip #4, February 23 (see ad on page 30).

Trip #4, "Environmental and Engineering Geology in the Houston Metropolitan Area", led by the same gentlemen, should be an "eye-opener" for geologists not actively employed in either of these areas.

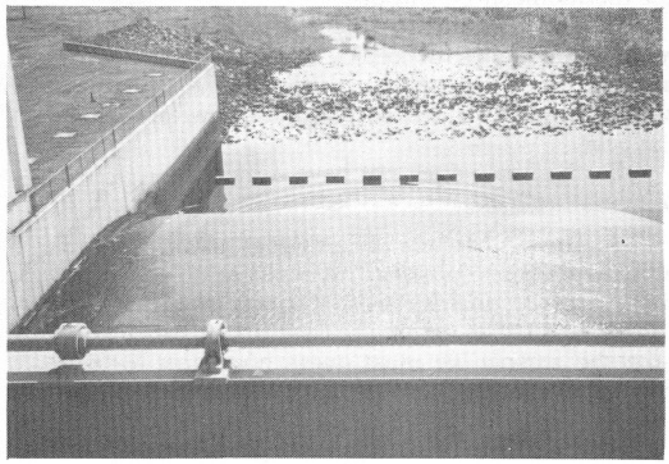


The surface trace of an active "growth fault" in metropolitan Houston.



Interchange bridges designed to accommodate the metropolitan Houston area needs.

"Iron ore" gravel pit, Montgomery County.



Stilling basin, Lake Conroe Dam.

LETTERS TO THE EDITOR

To the Editor:

I would like to comment on the cry of doom expressed in the article on page 32 of the *Bulletin* for December 1991. (Ed's. note: "The Miner's Canary: Unraveling the Mystery of Extinction", by Niles Eldredge.) Obviously, the author is not a geologist.

We have had mass extinctions and we will continue to have them. There is nothing puny man can do to cause or prevent them.

The geological voice has not been heard in the matters concerning Earth, such as the "greenhouse effect", the ozone hole, and the melting of the ice caps. I have tried, but publications refuse my offers because they do not support these ridiculous matters.

Let's tabulate a little geological knowledge concerning these things. I suggest the following:

1. Earth is not a "greenhouse". A greenhouse is a closed system of reflecting surfaces. Earth has reflecting surfaces, but the only "greenhouses" are the water bodies. Note that the largest of them, the ocean, has been subjected to the radiation for several billion years, and yet the water at the bottom is very near the freezing point.

2. Earth does not have a measurable average temperature. We assemble a lot of figures and then several people get together and agree that they are the "average temperature". Another group does the same thing with a different set that yields a different figure.

The problem is that there is no precise definition of what an average temperature of Earth is. At what elevation should the temperature be taken? At what time of day should it be taken? At what time of the month? At what time of the year? Should it be taken at ground level? How should the thermometer be shielded?

The temperature of the atmosphere varies, among many other things, according to the latitude of the point sampled, the composition of the atmosphere, the elevation above ground level, the output of the sun, and the time of the year.

Earth simply does not have a measureable "average temperature".

3. The atmosphere of Earth does not have a measureable "average composition". We take samples and analyze them carefully, on a dry basis, of course, so the analyses are useless and tell us nothing realistic about the air. After we take the sample we must guess how large a volume it represents. The surface samples are different from samples taken at significantly different elevations.

The rain has been laundering the atmosphere for several billions of years. The constituents are present according to the laws of physical chemistry, on average. They will stay that way, on average, unless there is a major change in rainfall. Doubling the amount of carbon dioxide produced will not double its presence in the atmosphere.

4. Carbon dioxide is present in the air to only an estimated 0.03%.

5. Ice caps contract in the summer and expand in the winter. They melt according to the energy from the sun that impacts them, not the temperature of the air. They have been doing this for several billion years.

Snow in the shade does not melt as fast as that in the sun.

6. Ozone in the stratosphere has been estimated to constitute 0.00001% of the atmosphere. At this dissemination, ozone is not and never has been "a protective layer". It has no measureable effect on the transmission of ultraviolet and shorter rays. When ozone is "destroyed", it is merely changed to a different molecule, such as oxygen or nitrous oxide, which impedes the passage of the UV rays probably just as much. However, it can't be measured either, it is so small.

7. Over the last few minutes, geologically speaking, we have been observing the "ozone holes." For some reason unknown to me, somebody decided that these "holes", if they actually exist, are something new. They have been around for several billion years.

We ruined a successful and useful industry by cries of doom from the uninformed.

8. The snail darter probably is no longer on the endangered list. According to published reports, it is plentiful in other rivers and streams in the south. It merely needed a better search.

9. Why the spotted owl is on the endangered list, I do not know. It has never been counted. It has extended its range through British Columbia, Washington, Oregon, and Nevada. I anticipate that it will be in the Big Thicket in a few years, say by 2,001.

10. The Houston toad held up development in the Houston area until it was "discovered" that they lived in Bastrop. They are now so plentiful that they are a traffic hazard on the highway. In a typical solution to a simple problem, we are digging tunnels for them, and plan to hold education classes, I guess. Just cost us a million dollars or so.

These are just some of the golgical facts to refute the cries of doom that are arising from the uninformed. Geologists should get into the fray and work for something that might become critical — fresh water.

L. W. Minturn
Geologist and Geophysicist
753 West Creekside
Houston, Texas 77024

GEOLOGICAL SOCIETY OF AMERICA SOUTH-CENTRAL MEETING RICE UNIVERSITY — FEBRUARY 24-25, 1992

This meeting sponsored by Rice University, the University of Houston, and the Houston Geological Society, will be held on the campus of Rice University. It is too late to preregister for the field trips or short courses, but it is not too late to consider attending the many interesting sessions, a list of which with speakers and times is given below. On-site registration fees are $60 for both days and $40 for one day for H.G.S. and G.S.A. (and affiliated societies) members and $75 and $40 for two days and one day, respectively for non-members.

(1) **Comparison of North American and Eastern European folded belts** (February 24, all day); BURCHFIEL (M.I.T.), SCHUPBACH (Maxus, Dallas), BOKOV (Bulgaria), NACKOV (M.I.T.), EMERY (Maxus, Dallas), WEIR (Amoco, Houston), SADEKAJ (Albania), BALLY (Rice), ROYDEN (M.I.T.), MUEHLBERGER (U.T., Austin), THOMAS (U. of Kentucky, Lexington), NIELSEN (U.T., Dallas), SANDULESCU (Romania), MORLEY (Amoco, Houston), PICHA (Chevron, San Ramon, CA), CSONTOS (Hungary), and TARI (Rice and Hungary).

(2) **Late Pleistocene - Holocene climatic record of the Gulf Coast** (February 24, morning); CARAN (U.T., Austin), HALL (U.T., Austin), TOOMEY (U.T., Austin), LUNDELIUS (U.T., Austin), NECK (Houston Museum of Nat. Sci.) BLUM (Southern Illinois U., Carbondale), ARANOW (Lamar U.), LAWRENCE (U. of Houston), CATE (U. of Houston), ANDERSON (Rice), and GARY (Unocal, Brea, CA).

(3) **Mesozoic and Cenozoic Micropaleontology** (February 24, morning); McNULTY (U.T., Arlington), MORRIS (U. of Houston-Downtown), WILTSHIRE (U.T., Dallas), ROSEN (Calibre, Houston), DENNE (Exxon, Houston), SCOTT (Amoco, Tulsa), EMMET (Rice), MONTGOMERY (U.T., Dallas), PESSAGNO (U.T., Dallas), PUJANA (U.T., Dallas), BERGEN (Amoco, Tulsa), and MASTERS (Amoco, Tulsa).

(4) **Hydrogeologic Controls on contaminant transport** (February 24, morning); CLEVELAND (U. of Houston), MACLAY (U.S.G.S., San Antonio), YELDERMAN (Baylor U.), BARNES (Sergent, Hauskins and Beckwith, El Paso, TX), DUTTON (U.T., Austin), BLOUNT (U.T., Austin), GRISAK (Intera, Austin, TX), DE VINE (U. of Houston), ONGLEY (Rice), GUTIERREZ (U.T., El Paso), and CECH (U.T. Hlth. Sci. Ctr., Houston).

(5) **Hydrogeology and Environmental Geology** (February 24, afternoon); REASER (U.T., Arlington), VAUTER (Baylor), MEEKS (Arkansas Mining Inst., Russellville), BLACK (U.T., Austin), HOLZMER (U.T. Austin), SHREVE (Stephen F. Austin), KROGSTAD (Kansas State U., Manhattan), HIBBS (U.T., Austin), FERRIS (U.T., Austin), WILLIAMS (U. of Arkansas, Little Rock), and SMITH (Kansas State U., Manhattan).

(6) **Response of carbonate platform to sea-level fluctuations: Cases in the Caribbean and the Gulf of Mexico** (February 24, afternoon); BOSS (U. of North Carolina, Chapel Hill), RASMUSSEN (Smithsonian, Washington, D.C.), MYLROIE (Mississippi State U.), HEARTY (U.T., Dallas), McNEILL (U. of Miami), GINSBURG (U. of Miami), WILBER (Woods Hole, MA), CORSO (Stockton State C.), HADDAD (Rice), SLOWEY (Texas A&M), NEUMANN (U. of North Carolina, Chapel Hill), YANG (U.T. Austin), ZACHRY (U. of Arkansas, Fayetteville), SCOTT (Amoco, Tulsa), and BRYAN (U. of Tennessee, Knoxville).

(7) **Sequence statigraphy of the Gulf of Mexico Paleogene: A global comparison** (February 25, all day); VAIL (Rice), WORNARDT (Microstrat, Houston), SMITH (Smith Geosciences, Houston), TEW (G.S., Alabama), BOWMAN (Rice), ECHOLS (Houston), LAWLESS (Texaco, New Orleans), BREYER (T.C.U.), SNEIDER (Rice), COSTER (Hunt Oil, Houston), EDWARDS (Houston), COLEMAN (Amoco, Tulsa), PEREZ-CRUZ (Rice and PeMex, Mexico), MANCINI (G.S., Alabama), DOCKERY (Mississippi Off. Geol.), FLUEGEMAN (Ball State U.), YANCEY (Texas A&M), BAUM (U.T., Dallas), HARDENBOL (E.P.R., Houston), SLOAN (U.T., Austin), NEAL (Rice), CAMPION (E.P.R., Houston), RAHMANIAN (E.P.R., Houston), LOUTIT (E.P.R., Houston), and MITCHUM (Houston).

(8) **Tectonics and evolution of the Gulf of Mexico Basin** (February 25, morning); THOMAS (U. of Kentucky, Lexington), BUFFLER (U.T., Austin), MARTON (U.T., Austin), WU (Rice), NUNN (L.S.U., Baton Rouge), SAWYER (Rice), PEREZ-CRUZ (Rice and PeMex, Mexico), HALL (U. of Houston), NAJMUDDIN (U. of Houston), HOOTON (U. of Houston), and HALL (Calibre, Houston).

(9) **Paleontology, stratigraphy, sedimentology** (February 25, morning); GUCCIONE (U. of Arkansas, Fayetteville), KONTROVITZ (Northeast Louisiana U., Monroe), CUFFREY (U. of Oklahoma), WATKINS (Texas Lutheran), AMSBURY (Seabrook, TX), FRANTZ (Rice), PORTER (Kansas State U., Manhattan), BILLINGSLEY (U. of Oklahoma), FOUNTAIN (U. of Florida, Gainesville), SPENCER (U. of Florida, Gainesville), and JONES (U.T., San Antonio).

(10) **The Role of planetary geology in the undergraduate curriculum** (February 25, morning); CARTER (U.T., Dallas), LOFGREN (NASA-JSC, Houston), COOPER (U.T., Dallas), BARLOW (NASA-JSC, Houston), CHRISTIANSEN (Brigham Young, Provo, UT), and LOKKE (Richland College, Dallas).

(11) **Magellan to Venus** (February 25, afternoon); STOFAN (Cal-Tech-JPL), BINDSCHADLER (U.C.L.A.), PLAUT (JPL), and SHARPTON (L.P.I., Houston).

(12) **Evolution of the Grenville basement** (February 25, afternoon); DAVIDSON (G.S. of Canada, Ottawa), RIVERS (Memorial U., St. John's, NF) VAN GOOL (Memorial U., St. John's, NF), ANOVITZ (U. of Arizona, Tuscon), LAMB (Texas A&M), QUINN (U. of Tennessee, Knoxville andRice), REESE (U.T., Austin), CARLSON (U.T., Austin), LETARGO (Texas A&M), GOBEL (Stephen F. Austin), SMITH (Trinity U.), NIELSEN (U.T., Dallas), and CONWAY (U.S.G.S., Flagstaff, AZ).

COMMENTARIES

TIME-WORN CONCEPTS vs. COMMON SENSE

by W. H. Roberts, III, Hydrexco

Over the years, many able geologists have said "I don't really care how the oil or gas got there; I just want to know where it is". I get depressed every time I hear that. I don't see how they can afford to waste the time and expense of working up and drilling "prospects" without some rational idea of how the stuff came to be where it is. The working components of "how" it happens are easy to see — if you know what to look for. Moreover, they often point right at viable prospects. The key to recognizing those working components, however, requires abandoning some time-worn and naive concepts of petroleum "origin, migration, and accumulation" (e.g. specific source rocks, buoyancy, discrete paths for migration of non-wetting fluids through water-wet porous media). Then, common sense should come into play with the use of 3-D basinal geohydrology, the *sine qua non* for hydrocarbon deposits as well as for mineral deposits in sedimentary strata. A word of caution: where oil or gas is discovered without regard for geohydrology, we should consider the possibility of being "right" for the wrong reasons. Explorationists in every discipline should understand the vital importance of water in petroliferous as well as mineral systems.

Reprinted courtesy Texas Section AIPG Newsletter, *V. 11, N. 10.*

(Letters To the Editor cont. from page 8)

With regard to the item "Have You Ever Wanted to Punch Your Boss" under "Commentaries" in the December *Bulletin;* I was in this situation several times over my 36 years in the Petroleum Exploration and Development field!

The solution in **one word** is "TRANSFER"!

Edwin C. Robinson
5117 Don Rodolfo Dr.
Carlsbad, CA 92008-3950

AWG TO OFFER SCHOLARSHIPS

The AWG Foundation is pleased to announce that three Chrysalis Scholarships will be awarded on March 31, 1992. The $500 awards will be given to geoscience Masters or Ph. D. candidates to cover expenses associated with finishing their theses. The Chrysalis Scholarship is for candidates who have returned to school after an interruption in their education of a year or longer. The support can be used for typing or drafting expenses, child care, or anything necessary to allow a degree candidate to finish her thesis and enter a geoscience profession.

Applications should be made by February 28, 1992. The applicant should write a letter stating her background, career goals and objectives, how she will use the money, and an explanation of the length and nature of the interruption in her education.

The applicant should also submit two letters of reference. The first, from her thesis advisor, should include when the candidate will finish her degree, what requirements are as yet unfinished, and a statement of the candidate's prospects for future contributions to the geosciences.

To obtain an application or for additional information please contact:

Chrysalis Scholarship
Association for Women Geoscientists Foundation
Macalester College Geology Department
1600 Grand Avenue
St. Paul MN 55105-1899

(GSA Meeting Sessions cont. from page 9)

(13) **Structural and Regional Geology** (February 25, afternoon); HALL (Calibre, Houston), BURKART (U.T., Arlington), YANG (U.T., Dallas), GILBERT (U. of Oklahoma), JUEDEMAN (Shell, Houston), WILLIS (Baylor), COPELAND (U. of Houston), MASTROIANNI (U. of Houston), RUHL (New Jersey Dept. of Environm. Prot., Trenton), and HOWARD (Earth SC. Tech., Barker, TX).

(14) **Posters** (February 24, afternoon and 25 all day); McCAHON (Kansas State U., Manhattan), TUCKER (U. of Southwestern Louisiana, Lafayette), SCOTESE (U.T., Arlington), WEI (Rice), GRAF (Kansas State U., Manhattan), HART (Texas Water Comm., Austin), and ALLEY-McREYNOLDS (U. of Houston).

Further information may be obtained by calling the Department of Geology and Geophysics at Rice University, 527-4880.

APPLIED SEQUENCE STRATIGRAPHY

A SYMPOSIUM ON APPLICATIONS OF SEQUENCE STRATIGRAPHY TO OIL AND GAS EXPLORATION AND PRODUCTION

Wednesday, Thursday, Friday, March 25, 26, 27, 1992
8:00 a.m. - 6:00 p.m.
Green Center, Colorado School of Mines, Golden, CO

FORMAT

Oral Presentations, Posters, Video and Computer Demonstrations, Core-Log-Seismic Workshop Exercises, Sessions with Speakers

TOPICS

Basic concepts of sequence stratigraphy; applications to hydrocarbon occurrences; carbonate, and mixed depositional systems; system-tract variability; high-resolution applications for reservoir and seal characterization; tectonic vs. eustatic control in sequence development; Rocky Mountain, North American, International case studies.

PARTIAL LIST OF SPEAKERS (TENTATIVE):

Art Berman, Jack Neal, David Bowen, Dag Nummedahl, Scott Bowman, Karen Porter, Frank Brown, Henry Posamentier, Tim Cross, Bill Ross, Tom Davis, John Sangree, David Eby, Al Scott, Frank Ethridge, Charles Kerans, Peter Vail, Gary Kocurek, Roger Walker, Margaret Lessinger, John Warme, Jeff May, Bob Weimer, Peter McCabe, Paul Weimer, Bob Mitchum

SPONSORED BY:

Rocky Mountain Association of Geologists (RMAG)
Exploration Geosciences Institute (EGI), Colorado School of Mines
Energy and Minerals Applied Research Center (EMARC), University of Colorado, Boulder

ORGANIZING COMMITTEE:

John E. Warme, Colorado School of Mines, Golden, CO
Paul Weimer, University of Colorado, Boulder, CO
Henry Posamentier, Arco Oil and Gas, Plano, TX
Steve Sonnenberg, Consultant, Lakewood, CO
Robert Basse, Celsius Energy, Denver, CO

TIME AND PLACE:

This three-day symposium will be given from 8:00 a.m. to 6:00 p.m. each day in the Green Center at the Colorado School of Mines, Golden, Colorado. Green Center is located between Illinois St. and Arapahoe St., off corner of Illinois & 16th St. Parking is located off corner of 18th & Illinois.

REGISTRATION FORM
APPLIED SEQUENCE STRATIGRAPHY

Registration fee:
Preregistration (by March 15, 1992) $175.00; On-site registration $210.00; Full-time students (I.D. # required) $50.00

Enclosed is my _____ check, _____ moneyorder in the amount of $__________

Name: ____________________

Address: ____________________

Company Affiliation: ____________________

Phone (Bus.): ____________________ (home): ____________________

PREREGISTRATION DEADLINE MARCH 15, 1992
NO REFUNDS FOR CANCELLATIONS AFTER THIS DATE
Make check payable to RMAG and send to: RMAG, 730 17th Street, Suite 350, Denver, CO 80202

MEETINGS

SEE RESERVATIONS POLICY, Page 2

HGS DINNER MEETING— FEBRUARY 10, 1992
Social Period, 5:30 p.m.,
Dinner and Meeting, 6:30 p.m.
Post Oak Doubletree Inn

JOE W. STUCKEY—Biographical Sketch

Joe W. Stuckey is Environmental Counsel, Regulatory Affairs, for Woodward-Clyde Consultants. He is a Licensed Attorney, Registered Professional Engineer, and Registered Professional Land Surveyor. He is Licensed to practice law before all Texas Courts, the United States District Courts for the Southern District of Texas and the District of Colorado, and the United States Claims Court. Stuckey's area of practice is in environmental and corporate law, with an emphasis on liability issues associated with air (including both indoor and outdoor air pollution); water; hazardous waste; infectious waste; and toxic chemicals; including real estate transactions, corporate risk management, personal injury, and property damage.

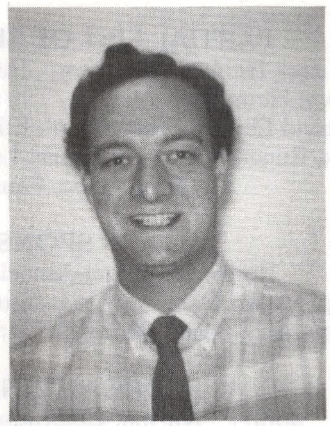
Stuckey received a B.S. in civil engineering from Texas A&M, and a J.D. from the University of Houston Law Center. He has since worked with corporations, generators, transporters, disposers, consultants, engineers, contractors, and quasi-governmental entities, involving environmental issues and permit applications including work with the Texas Water Commission, Texas Health Department, Texas Air Control Board, Texas Railroad Commission, and United States Environmental Protection Agency. His past responsibilities have included various types of environmental matters, such as environmental services contracts, remedial action, hazardous waste transportation and disposal, asbestos abatement/transportation and disposal, Superfund contracts, PRPs, CERCLA, SARA, RCRA, TSCA, AHERA, CWA, CAA, OSHA, underground storage tanks, drug policies, bankruptcies, collections, international matters, non-disclosure agreements, etc.

ENVIRONMENTAL LAW CONSIDERATIONS FOR OIL AND GAS LEASING

This talk will introduce geologists and petroleum landmen to the environmental liabilities associated with oil and gas leases. Potential personal environmental liabilities for geologists and landmen will be discussed. Special issues associated with "old" petroleum fields also will be reviewed.

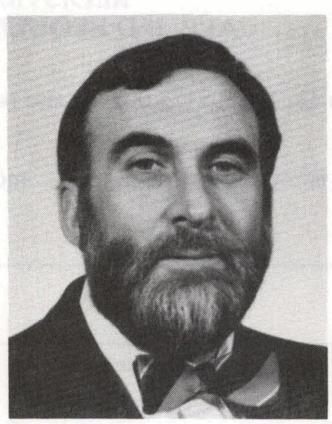
HGS LUNCHEON MEETING— FEBRUARY 26, 1992
Social Period, 11:30 a.m. - 12:00 p.m.,
Luncheon and Meeting, 12:00 p.m.
The Houston Club

MICHAEL J. DiMARCO—Biographical Sketch



Mike received a B.A. in geology from the State University of New York at Buffalo in 1979 and a M.S. in geology from Kansas State University in 1983. Following a brief teaching post at the University of Arkansas at Little Rock, Mike then obtained a Ph.D. in geology from L.S.U. in 1986. Subsequently, Mike joined Shell Western E. & P., Inc. where he worked for five years in onshore Gulf Coast exploration, mainly in clastic depositional systems. Recently, Mike has begun stratigraphic and exploration studies for Pecten International Co. in the North Africa area. His interests include stratigraphy, clastic sedimentology, and sedimentary petrology.

R. CRAIG SHIPP—Biographical Sketch



Craig received a B.S. in biology from Dickinson College (PA) in 1972, and then worked as the diving officer of the West Indies Laboratory of Fairleigh Dickinson University (NJ) in St. Croix, U.S. Virgin Islands. Craig earned his M.S. in geology at the University of South Carolina in 1980 and then worked as a staff geologist for the Marine Systems Laboratory of the Smithsonian Institution for four years. He received a Ph.D. in oceanography from the University of Maine in 1989. Craig joined Shell Development Company as a research geologist in 1988 and has worked in the Gulf Coast Tertiary and the deepwater Gulf of Mexico. His interests include marine geology, seismic stratigraphy, and shallow geologic hazards.

STRATIGRAPHIC CHARACTERISTICS AND SANDSTONE DISTRIBUTION OF THE HACKBERRY DEPOSITIONAL SYSTEM (MID-OLIGOCENE), S.E. TEXAS AND S.W. LOUISIANA: A SAND-RICH SLOPE-FAN COMPLEX

The Hackberry depositional system has been long recognized by Gulf Coast geologists by its anomalous deep-water fauna, rapid lateral variation in sandstone thicknesses, and prominent basal erosional unconformity. Hackberry sandstones also serve as major hydrocarbon reservoirs in many fields in southeast Texas and southwest Louisiana. A vertical succession through the Hackberry typically shows the basal erosional surface overlain by a variably sandy interval, informally termed the lower Hackberry sands, and capped by a thick deep-water interval, the Hackberry shale.

High-quality seismic data indicate that the Hackberry has a distinctive seismic signature. This seismic signature permits the interpretation of Hackberry lithologic characteristics in a sequence stratigraphic framework. Key elements of the seismic signature include: (1) a series of half-graben-like slumps, marking the updip limit of the Hackberry depositional system, and representing the failure of an immediately pre-existing shelf edge, (2) a basal erosional surface, in some places channelized as deep as 1800 ft. and cutting as deeply as the Eocene, representing a prominent sequence boundary upon which the Hackberry was deposited, and (3) a pronounced downlap surface with well-developed suprajacent clinoform geometries, best developed in updip positions and representing a maximum flooding surface within the Hackberry shale.

Most Hackberry sandstone is confined to the lower Hackberry sand interval immediately above the sequence boundary. The Hackberry sandstone isopach shows numerous linear to ovoid-shaped areas of thickly developed sandstone separated by areas of little or no sandstone. In some places, linear sandstone depocenters can be related to eroded and channelized slope paleotopography that is discernable seismically. Elsewhere, linear areas of thickly developed sandstone are not associated with a clear erosional expression on seismic records and may represent broadly linear, aggradational turbidite fills in paleolow positions. Other, more irregular to ovoid-shaped sand patterns represent ponded aggradational deposits in intra-slope paleolow areas and basins. Paleontologic data strongly suggest that this system was deposited at the time of the large mid-Oligocene sea-level lowstand shown on the Haq *et al.* (1987) coastal onlap curve. Deposition of lower Hackberry sands commenced when fluvio-deltaic systems bypassed the foundered shelf edge and sediment-gravity flows ensued through a tortuous network of upper slope channels, gullies, and other paleolows. Collectively, these deposits represent the upper and middle portions of a sand-rich slope-fan complex.

REFERENCE

Haq, B.U., Hardenbol, J., and Vail, P.R., 1987, Chronology of fluctuating sea levels since the Triassic. Science, v. 235, p. 1156-1167.

HOUSTON GEOLOGICAL AUXILIARY

It's always good to have something to which we can look forward in the drab month of February, and we really are fortunate to have just that in our Sweetheart Dinner Dance, to be held on February 14 at the Lakeside Country Club. There were two committee luncheon meetings for planning the event; the first at Daisy Wood's home and the second at Annette Mather's. As mentioned in the January Bulletin, Mae Barclay designed the lovely invitation, and "Gillie and The Boys" will be playing romantic tunes, so be sure to come and bring your sweetheart. Not only are Houston Geological Auxiliary members eligible to buy tickets, but Houston Geological Society members also can purchase tickets. And you can bring guests! We are enclosing an invitation in this issue for your convenience, so be sure to mail in your checks before the deadline, February 1, 1992.

A postscript about our successful December luncheon: Dave Ward, who regaled us with insider news information, donated the donation we made to him to the home for abused children.

The Bridge Buffet Luncheon I wrote about in the January Bulletin has been expanded to include other games as well. Christened "Game Day & Buffet Luncheon", it will be held at the Briar Club at 2603 Timmons and Westheimer on Tuesday, March 31, 1992, 10:00 A.M. to 2:30 P.M. Maybe you would like to play Mah Jong, Canasta, Hearts or some other game. Let the committee of Gwen Caussey, Joy Payne and Rosann Hooks know by filling in the reservation form and returning it at your earliest convenience. If you did not pick up a reservation form at the December luncheon, or misplaced your January Eclectic Log which included all details, please call Joy Payne (622-5435) or Gwen Caussey (850-7654) for information.

To those of you who would like your spouse to enjoy membership in the Auxiliary, please complete the application below and return with a check for $15.00 to the Membership Chairman, Mrs. Keith Hawkins at the address below.

Mrs. Keith Hawkins
2515 Anniston
Houston, Texas 77080
(713) 462-2925

YEARBOOK INFORMATION

(Last Name) (Your Name) (Spouse's Name)

Address ______________________

______________________ Zip________

Home Telephone ______________________

HGS Member's Company ______________________

INTERNATIONAL EXPLORATIONISTS

Chair's Column

I have been coming to the HGS International meetings since 1984 and found them to be stimulating, interesting and valuable in terms of contacts made and information exchanged. The technical talks are really what make all of us attend these sessions. The attendance shifts between meetings can be directly correlated with the timeliness of the topic and reputation of the speaker and/or the company he or she is representing. There is one aspect of the audience that is surprising: there are very few female geologists attending. Out of 75-100 attending members, there has never been an occasion when I can not count on one hand all the females in the audience. There must be more than ten percent women in the international geoscientists population. I encourage our committee to brainstorm on how to attract this group to our meetings.

We also encourage international articles in the *Bulletin*. If you have attended a field trip recently and you would like to share this experience with the members, please send highlights of your trip with some pictures to me. I attended a field trip in Tunisia as part of the AAPG meeting in London with other HGS members. I propose that we pool our resources and describe this trip to our group.

PINAR O. YILMAZ

INTERNATIONAL EXPLORATIONISTS COMMITTEE MEMBERS 1991-1992

Chairperson & Technical Program:
Pinar Yilmaz, Exxon Prod. Res. Co. 973-3070

Technical Program Assistant:
Gerrit Wind, Amoco 556-3680

Hotel Arrangements:
George Tappan,
Geoservices International 358-4061

A/V Arrangements:
Nat Smith, Consultant 861-0277

Finances & Tickets:
Don Young, AGIP 688-6281

Announcements and company representative contacts:
Thom Tucker, Marathon Oil 629-6600

Directory:
Kumar Bhattacharjee,
Sita Oil Exploration House 999-6957

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

PLEASE NOTE:

HGS INTERNATIONAL EXPLORATIONIST meeting will be on TUESDAY, FEBRUARY 25, 1992 at Doubletree Hotel, Galleria area.

EXOTIC ROCKS

We need exotic rocks for our speaker plaques. Please bring a sample of your favorite rock to the next meeting. It will help clean up the boxes you stored in the garage. We acknowledge the donor on the back of the plaque.

HGS INTERNATIONAL GROUP DINNER MEETING—FEBRUARY 25, 1992

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

B. CLARK BURCHFIEL—Biographical Sketch

Dr. Clark Burchfiel currently teaches at California Institute of Technology on a sabbatical leave from Massachusetts Institute of Technology, where he is a professor of geology. Dr. Burchfiel received his B.S. degree, with distinction, from Stanford University in 1957. He received his M.S. from the same institution in 1958. Burchfiel completed his Ph.D. in geology from Yale in 1961 and was awarded the Silliman Prize.

Clark Burchfiel worked as an assistant professor from 1961-66, an associate professor from 1966-70 and as a professor from 1970-76 at Rice University. Burchfiel became the Carey Crineis professor of Geology at Rice from 1975 to 1976. He joined M.I.T. faculty as a professor of Geology in 1977 and holds the Schlumberger Professor of Geology chair since 1984. His research interests include structural geology, regional geology, plate tectonics and orogenesis.

Outside of his academic responsibilities, Burchfiel's involvement includes chairmanship and membership on numerous committees associated with GSA, AAPG, National Science Foundation, National Academy of Sciences, National Research Council, Graduate Record Examination and COCORP. Burchfiel has edited Journal of Geophysical Research and Tectonics. Some of his other work includes American Geological Institute Visiting Scientist (1963 and 1969), visiting professor at University of Southern California (1964 and 1966), post-doctoral fellowship at Geological Institute University of Belgrade, Yugoslavia (1968), National Academy of Science Eastern Europe Exchange Program in Romania (during summers of 1970 and 1973), University of Houston Continuing Education Program (1974 and 1975), Sigma Xi National lecturer, and visiting professor at Australian National University (from 1975-76).

Burchfiel has worked as a consultant for numerous oil companies and technical firms. He is a member of Maxus Energy Board of Directors (1989-present), National Academy of Sciences, Geological Society of Australia and AAPG. He is a fellow of American Academy of Arts and Sciences, GSA, AGU and an honorary foreign fellow of Euopean Union of Geologists. He has published numerous papers, reports and books.

LEIGH H. ROYDEN—Biographical Sketch

Dr. Leigh Royden currently teaches at California Institute of Technology on a sabbatical leave from Massachusetts Institute of Technology where she is an associate professor of Geology and Geophysics. Leigh H. Royden received her A.B. degree *cum laude* in physics from Harvard in 1977. She completed her Ph.D. in geology and geophysics from M.I.T. in 1982. Royden's research interests include regional geology and geophysics, plate tectonics, thermal effects and consequences of continental deformation and mechanics of large scale continental deformation.

Leigh Royden worked as a research assistant at Woods Hole Oceanographic Institution during 1977-78. She had a joint appointment with M.I.T. and Harvard as a post-doctoral fellow during 1982-84. Royden started at M.I.T. as an assistant professor of Geology and Geophysics in 1984, and became an associate professor in 1988. She has received numerous awards and honors including Kerr-McGee Career Development Chair, M.I.T. (1984-88), Presidential Young Investigator, National Science Foundation (1985-present), Donath Medal (Young Scientist Award), Geological Society of America (1990), Visiting Professorship for Women, National Science Foundation (1991-present), and Faculty awards for Women Scientists and Engineers, National Science Foundation (1991-present).

Royden has worked as a consultant for numerous oil companies and technical firms. She co-organized Penrose, and NATO Advanced Study conferences in Hungary and Turkey. She is a member of AGU, AAPG, and GSA and works with different committees associated with National Research Council, AAPG and GSA. She has published numerous papers, reports and books.

EASTERN EUROPEAN MOUNTAIN BELTS - THE HIGHS AND LOWS

The Mediterranean region is an area of incomplete continental collision. It lies between the European and African plates, which have been converging since late Cretaceous time (80 Ma). Because the continental edges of Europe and Africa are irregular in shape, the Mediterranean region contains zones where the two continents have already collided and adjacent zones where the two continental masses have not yet collided. Within the convergence zone between Europe and Africa are small fragments made up of both oceanic and continental crust that move independently, or partly independently, from the large plates. The movements of these small fragments are responsible for the formation of all of the Alpine mountain belts west of central Turkey. In many cases the velocities of these small fragments may be much faster than those of Europe or Africa and their directions of motion can be oblique or even orthogonal to the direction of convergence between the two large plates. Old ocean floor has been subducted beneath the fragments and new ocean floor has been created in their wake by back-arc type extension.

Because the Mediterranean region is young and many of the tectonic systems within it are active today, it is possible to relate different structural and morphological styles present within Mediterranean mountain belts to the dynamic processes and larger-scale tectonic systems within the mountain belts formed. We recognize two fundamentally different structural styles in mountain belts of the Mediterranenan region, and these mountain belts can also be shown to have formed in two different dynamic environments. Classic mountain belts with high topography, such as the Alps, also have cores of high-grade metamorphic rocks, display significant deformation of crystalline basement, and commonly develop antithetic thrust belts. These mountain belts have formed in areas where the two fragments were pushed together to form a mountain belt faster than the invervening crust was subducted. In contrast, other mountain belts have been formed in areas where the intervening crust was subducted faster than the two fragments were pushed together. These mountain belts look very different. They have low topography, low-grade metamorphism, lack significant deformation of continental crystalline basement, and display extensional deformation in the back-arc region. Examples of this type of mountain belt are especially well developed in eastern and central Europe, such as the Apennine and Carpathian mountain belts.

The concepts derived from studying these two different types of mountain belts within the Mediterranean region can be applied throughout the world and throughout geologic history. The geologic record contains some beautifully preserved examples of incomplete continental collision. In many cases, however, incompletely-collided zones are only the early stage in a progressive collision process, and mountain belts formed during the early stages of collision are strongly modified during subsequent post-collisional convergence. These mountain belts formed during the early stages of collision are difficult to recognize in areas where collision has continued to completion, but probably account for some of the paradoxical relationships observed in old collisional mountain belts.

REMEMBRANCES

Andrew B. Bacho, Jr., November 20, 1991.

Jerome A. Brock.

Edward D. Pressle, November 27, 1991.

Charles W. Stuckey, Jr., November 26, 1991.

Frank B. Hartley, Jr., age 66, August 31, 1991.

Edward J. Smith, Jr., age 84.

HGS INTERNATIONAL EXPLORATIONISTS ANNOUNCEMENT

The Geological Society of America South Central Section meeting will be held on February 23-25, 1992 at Rice University. Please note the program and abstracts of the following symposium:

COMPARISON OF NORTH AMERICAN AND EASTERN EUROPEAN FOLDED BELTS

(Sponsored by the International Division of the G.S.A. and the International Explorationists Group of the H.G.S.)

Monday, February 24, 1992
Start 8:00 a.m. End 5:00 p.m.
Hamman Hall, Rice University

Session Chairpeople:
A. W. Bally, M. A. Schupbach, P. O. Yilmaz

8:00-8:25 a.m.	Burchfiel, B. Clark
8:25-8:50	Schupbach, Martin A.
8:50-9:15	Bokov, P.
9:15-9:40	Nockov, Radoslav A.
9:40-10:00	BREAK
10:00-10:25	Emery, Martin
10:25-10:50	Weir, G. M.
10:50-11:15	Sadekaj, I.
11:15-11:40	Royden, Leigh H.
11:40-1:30	LUNCH
1:30-1:55 p.m.	Muehlberger, William R.
1:55-2:20	Thomas, William A.
2:20-2:45	Nielsen, Kent C.
2:45-3:00	BREAK
3:00-3:30	Sandulescu, Mircea
3:30-3:55	Morley, Christopher K.
3:55-4:20	Picha, Frank J.
4:20-4:45	Csontos, Laszlo
4:45-5:00	Tari, Gabor

LATE CENOZOIC OROGENIC BELTS OF THE MEDITERRANEAN REGION AND THEIR NORTH AMERICAN COUNTERPARTS

BURCHFIEL, B. C., and ROYDEN, L. H., Department of Earth Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139

Cenozoic orogenic belts of the Mediterranean region are dominated by deformation related to synthetic subduction and can be subdivided into two end members based on the presence or absence of contemporaneous back arc extension. Dynamic interpretations of these two end members indicate that those belts formed contemporaneously with back arc extension developed in a tectonic environment dominated by slab pull within the subduction zone and those belts without back arc extension formed in an environment dominated by plate convergence driven by large scale plate motions external to the orogenic belt. These two dynamic environments are expressed in the characteristics of the two types of orogenic belts. Those belts dominated by slab pull (such as the Apennines, Hellenides and Carpathians) have low topography, marginal thrust belts dominated by flysch, low grade metamorphism, lack significant involvement of continental crystalline basement, and lack antithetic thrust belts, whereas those dominated by convergence due to external plate motions (such as the western Alps, Pyrenees, and Caucasus) have high topography, marginal thrust belts consisting of shallow water passive margin sediments and molasse, cores of high-grade metamorphic rocks, significant involvement of crystalline basement, and often develop antithetic thrust belts.

North America contains rare Cenozoic convergent orogenic belts, but pre-Cenozoic orogens contain several examples of belts developed in these two different dynamic settings. The Paleozoic Ouachita and Antler belts and parts of the Precambrian Wopmay belt are best interpreted to have formed in a tectonic environment dominated by slab pull, whereas the late Paleozoic Southern Appalachians, and the Precambrian Thelon orogens are best interpreted as dominated by large scale plate motions. This subdivision of orogenic environments can be extended to non-collisional belts where oceanic lithosphere is subducted. For example, the early Mesozoic evolution of the US Cordilleran orogen may have been dominated by a slab pull tectonic environment whereas the late Mesozoic evolution may have been dominated by a tectonic environment of rapid large-scale plate convergence.

TECTONIC POSITION, HYDROCARBON EXPLORATION, AND FUTURE POTENTIAL IN BULGARIA

SCHUPBACH, Martin A., Maxus Energy Corporation, Dallas, TX

Eastern Europe can be subdivided into several tectonic units. All of these are productive.

The Pannonian-Carpathian system is controlled by a roll back of a subducted plate resulting in the formation of the Carpathian fold belt and the Pannonian basin. The topography of the Carpathian fold belt was less than an "Alpine-type" fold belt, and is associated with a thicker, flysch-dominated foredeep. Hydrocarbons occur in all of these tectonic settings. The Dinarides are considered to be an "Alpine-type" collision-dominated fold belt, but contain no production except in the Durres basin in Albania, which is controlled primarily by major transverse faults crossing the Dinarides. The Balkan fold belt has a multiphase history. Production in the Fore-Balkan is controlled by Late Cretaceous shortening that produced inversion and/or an intracratonic fold belt. The Black Sea area of northern Bulgaria and Romania is part of the Moesian platform and contains stable Jurassic and Cretaceous carbonate banks. Production occurs in offshore Romania. The Moesian platform itself is productive in Romania along the Carpathian foredeep. The Southern Permian basin which extends eastward from the southern North Sea into Poland is well known for its giant gas reserves in Rotliegende and Zechstein reservoirs. Overlying the Permian basin are several individual oil-and-gas-producing Mesozoic basins which were inverted during the Late Cretaceous. Their Eastern European equivalent is the Polish trough along the Tornquist line.

The future exploration of eastern Europe primarily is in underexplored production plays that require application of new technologies and new capital investments.

The search for new hydrocarbon plays should be initiated by regional studies, by asking new questions and by applying new ideas and concepts. Lately, for example, this has been done in the Pannonian-Carpathian region, resulting in a new tectonic understanding and a much better interpretation of the various hydrocarbon habitats. Similar approaches should be undertaken to evaluate the hydrocarbon potential of other Eastern European basins.

TECTONIC POSITION OF THE BALKANIDES AND HYDROCARBON EXPLORATION

BOKOV, P., Research Scientific Institute for Mineral Resources, Sofia, Bulgaria; GOCHEV, P., Geological Institute of Bulgarian Academy of Sciences, Sofia, Bulgaria; OGNYANOV, R., Committee or Geology, Sofia, Bulgaria

The oil and gas prospective areas in northern and southeastern Bulgaria and the adjacent regions on the Black Sea shelf are accepted as a part of the Carpatho-Balkan oil- and gas-bearing province. The peculiarities of the tectonic structures are conditioned by some specific, mostly collision processes during the Paleozoic, Mesozoic, and Tertiary. They are deciphered now with the help of the depth seismic explorations, and magnetotelluric, thermal, gravimetric, and magnetic data, in combination with geological mapping of south Bulgaria. The usual type of seismic data and well control as well exist in north Bulgaria and the Black Sea shelf zone; some of this information has been published. Now an attempt is made for a general overview of the three regions of some parts of the Moesian platform; Fore-Balkan, Balkan, and Srednogorie region; and the western part of the Black Sea megadepression, as well.

Prospects of the Mesozoic and Tertiary sediments in north Bulgaria have been comparatively well studied, but questions remain for southeastern Bulgaria and the Black Sea shelf zone, coming from unresolved problems concerning the geological structure. Future regional exploration is expected to discover new deposits in the reef trends of Paleozoic, Triassic, and Late Jurassic-Valanginian age, and connected with usual local Tertiary and Mesozoic structures and vast overthrust structures of the Balkan and southward, in both the offshore and onshore.

THE ALPINE OROGEN IN THE EASTERN BALKAN PENNINSULA (BULGARIA)

NACKOV, Radoslav, A., Department of Earth, Atmospheric and Planetary Sciences, Mass. Inst. of Tech., Cambridge, MA 02139

In Bulgaria two major tectonic units are distinguished: The Moesian "platform" to the north and the orogen to the south. They are separated by the thrust front of the fold-thrust belt (Balkanides s.l.). The tectonic setting of the area is similar to the border region between the Central Cordilleran fold-thrust belt and the less deformed American continental margin (craton). The Moesian unit should be considered a relatively less deformed unit of the European continental margin. The orogen consists of three types of structural units defined by rock composition, deformation and metamorphism. The first type is parautochthonous and similar in rock composition to the Moesian unit. The second type has an allochthonous origin and is comparable to southern European accreted terranes. The third type should be called a "suspect terrane" due to their unclear origin and position. Alpine sutures have not been proven.

According to the type of sedimentary infilling, rock sequences and structural data, four main superimposed basins and paleogeodynamic environments can be distinguished: Triassic - shallow shelf and initial rifting; Early Jurassic-Early Cretaceous - passive margin of unclear basin type; Late Cretaceous-Middle Eocene - back-arc basin; Middle Miocene - foreland basin. Since the Middle Miocene, a taphrogenic stage has been imposed on the southern area. The type of basins changed under synsedimentary orogenic phases, caused by collisons in the convergent zone between

Continued on page 44

INTERNATIONAL BRIEF

Spotlight on . . . CASPIAN SEA*

By George Tappan

The Caspian Sea is the world's largest salt lake. It has no outlet, and although the surface level fluctuates, it averages about 30m below sea level. The basin is part of the eastern Paratethys which began to develop in early Paleogene during the Alpine-Himalayan movements. It consists of three distinct sub-basins, separated by major structural features.

About one-third of the sea has water depths exceeding 200m. Production has been developed in areas with depths up to 60m, and five oil and gas fields have been discovered in deeper water. The southern part, with its high density of confirmed structures, is the most studied. The middle portion has not been well studied, and the northern part, even less. Hydrocarbon potential from 30 oil and gas fields is estimated at 10 billion tons. Twenty-eight of the fields are in the south, 21 in Azerbaijan, 7 in Turkmenia. Two are in Kazakhstan in the north.

Offshore development began in Azerbaijan in 1960. Since then, 21 fields have produced 10 million tons of oil and condensate, and 9 million cubic feet of gas, about half their recoverable reserves. All fields are multipay with 3-20 producing intervals from mid-Pliocene sandstones. More than 3000 wells have been drilled from over 1000 platforms. Maximum water depth for a platform to date is 150m. Water depths in the deep basin range from 300m to 980m.

The southern Caspian Sea is characterized by a deep basin on the west and a shallow shelf on the east. It is separated from the middle sub-basin by the Caucasus-Kopet Dagh fault line, which also represents a line of collision between the Cimmerian continents to the north and the Turan plate on the south. A ridge of uplifts, the Apsheron-Prebalhanian zone, extending roughly between the Baku and Cheleken peninsulas forms a narrow topographic high in the sea. All major fields in the area are related to this regional feature.

Well-defined anticlinal trends parallel the high in a NW-SE direction in the northwest, near Baku, and southeast, near Turkmenia. Individual structures on the west are generally steep-sided, have high relief, and may be diapiric with mud piercement to the surface. Oil and gas seeps from the upturned edges of Pliocene beds on the Apsheron Peninsula have been known from antiquity.

South of the Baku area the orientation of trends is more north-south. Structures on the Turkmen shelf are more gentle. The northeastern quarter has several large east-west trending features. Wells drilled on the west have penetrated a stratigraphic sequence from Oligocene to Pleistocene, on the east from Cretaceous to Quaternary.

Water depths in the middle Caspian Sea reach a maximum of 790m. The thick sedimentary sequence ranges from Paleozoic to Quaternary. On the eastern flank the Paleozoic basement is overlain by Permian-Triassic transitional sediments, and a Mesozoic-Cenozoic cover. The Mangyshlak and Preklma-Kizlar zones of uplifts extend into the sea from the east and west forming a linear topographic high between the central and northern sub-basins. Productive reservoirs in the Mangyshlak fields in Kazakhstan range from Triassic to Paleogene. Production from the Dagestan piedmont on the west is from the Jurassic, Upper Cretaceous and middle Miocene. The greater Caucasus fold system foredeep in the southwest is filled with upper Paleogene-Neogene molasse sediments, which are productive offshore. Dagestan's peak production at 2.17 MM tons of oil and 1.6 billion cubic meters of gas in 1970, has declined to about 640M tons per year. In place reserves are estimated at 200 MM tons, on and offshore.

The longitudinal axis of the northern Caspian Sea is almost at right angles to the middle Caspian. Water depths

CASPIAN SEA AREA

*Reprinted with permission from the *International Exploration Newsletter*, October 14, 1991.

Continued on page 43

TECHNOLOGY UPDATE

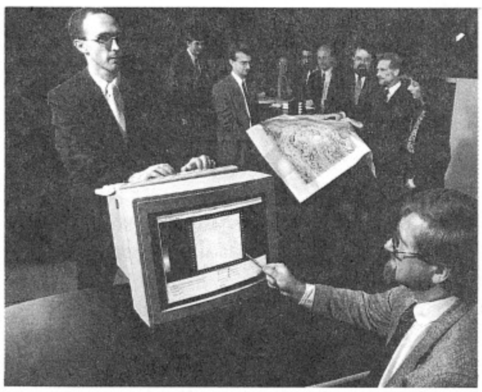
Seismic Processing Breakthrough

GECO-PRAKLA's new one-pass depth migration algorithm and massively parallel computing combine for high-fidelity results with significantly reduced turnaround.

GECO-PRAKLA has announced the latest in a long line of tools designed to improve reservoir imaging: a new algorithm for 3D, one-pass depth migration implemented on a massively parallel supercomputer.

This new algorithm greatly improves the fidelity and quality of processed seismic data and has particular promise in areas of complex geology such as subsalt, salt dome and gas prone areas.

> *"The algorithm's superb fidelity offers excellent imaging of 3D seismic data and allows results to be delivered in drastically reduced time frames compared to conventional supercomputers in use today."*
>
> *Colin Hulme, North and South America Region Data Processing Manager, GECO-PRAKLA*

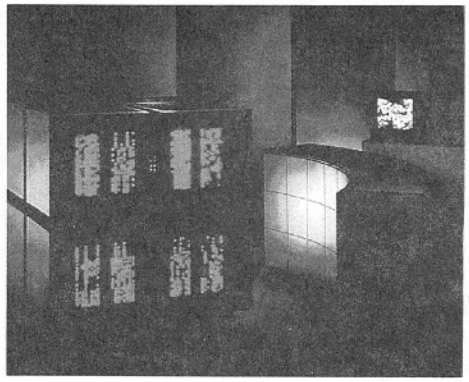


Part of the team from GECO-PRAKLA, Schlumberger Laboratory for Computer Science, and Thinking Machines Corporation that developed the technique for 3D, one-pass depth migration.

With conventional supercomputers, this high-fidelity technique is not practical. However, the new GECO-PRAKLA implementation utilizes massively parallel supercomputers. To achieve this, GECO-PRAKLA geoscientists collaborated with computer scientists at the Schlumberger Laboratory for Computer Science in Austin, Texas, as well as with parallel processing experts from the Thinking Machines Corporation. The resulting implementation is a major breakthrough, making the use of this algorithm practical for 3D imaging in depth using a CM-2 Connection Machine* system.

The CM-2 Connection Machine has as many as 65,536 processors working together to solve the problem. This army of processors, each vastly simpler than a supercomputer, teamed together can significantly outperform conventional supercomputers and return results with greatly reduced turnaround.

The GECO-PRAKLA technique eliminates the quality/speed trade-off when processing turnaround is critical, such as evaluating data prior to lease sales or licensing rounds.



The CM-2 massively parallel supercomputer uses thousands of processors to achieve speeds in tens of gigaflops, coupled with gigabytes of main memory and very fast I/O subsystems.

This combination of excellent data quality and fast turnaround is as close as your nearest GECO-PRAKLA region data processing office. Please contact a data processing manager for additional information on one-pass, high-fidelity depth migration.

*CM-2 and CM-2 Connection Machine are marks of Thinking Machines Corporation

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GEOTALES FROM FAR AWAY

LAND AND SEA OF THE MIDNIGHT SUN

by Charles T. Feazel

EDITOR'S NOTE: The following is excerpted from Chip Feazel's recent book, White Bear: Encounters with the Master of the Arctic Ice *(Henry Holt, 1990, 240 p.) and is reprinted with permission of the publisher. Copyright ©* 1990 Charles T. Feazel.

How foolish is man's view of his own valor. I fancied myself an intrepid explorer, fazed by nothing from pole to equator. This self-image was shattered during my first ten seconds in the Arctic. My first reaction to this world I'd come so far to savor was fear. I was under attack by a huge furred creature galumphing toward me at incredible speed down the gravel runway. I didn't know what it was. As it came closer, this dark, disorganized mass resolved itself into the largest dog I have ever seen, before or since. An immense, friendly Newfoundland, it was the size of a small pony, a mountain of shagginess as high as my waist, with a slobbery tongue that alternately hung — huge, pink, and dripping— and disappeared into a cavernous mouth.

"He sleeps underneath our transmitting station," said a young electronics technician, "even when it's sixty below outside."

I asked if the dog seemed as happy during the winter as he was in August. "Yeah," said the technician. "He can't come inside anyway — I don't think he'd fit through the door."

"When we go out to feed him" said the Coast Guardsman, "it's as still as a tomb and twice as cold. You can throw a cup of hot coffee into the air and hear it tinkle — frozen — when it hits the ground."

Behind him the buildings spoke with eloquent silence of winters endured. Their insulating walls were twelve inches thick. The buildings were connected by boxlike passages so no one would have to venture outside during blizzards. Outside the structures, hand ropes offered pedestrians guidance during whiteouts, arctic snow and fog storms of such blinding intensity that in them it's easy to become totally disoriented only a few feet from safety. The structures were held together with pins positioned for instant release in case of fire, man's greatest fear in the Arctic. "When all the water is frozen," I learned from a veteran of five arctic winters, "you don't fight fires — you just pull the building apart so the flames can't spread."

The summer thaw had exposed tools lost in snowbanks and foundations in need of repair. Only a few weeks of warmth were available for the work. With the shortening days came hints of the returning cold. Construction went on around the clock. Even though the sun never really sets during the summer, daytime temperatures rose and fell slightly. By the evening twilight I found ice covering the meltwater ponds. Like an unstoppable train grinding slowly closer, the cold was coming.

"Don't let today fool you," the young technician said. "Up here, we have only two seasons: July and winter."

This arctic deep freeze is the kingdom of the white bear. His realm encompasses all the cold lands and seas at the top of the globe. Polar bears are marine mammals, as comfortable in the water as walrus, whales, and seals. They live in, on, and beside the Arctic Ocean (although they have been spotted, drifting on ice floes, well to the south). Bears wander (or drift) as far south as Labrador, Newfoundland, Lake Winnipeg, Kamchatka, Hokkaido, and northern Norway. They travel as far as one hundred miles inland. One of the best-studied concentrations of polar bears in the world lives entirely outside the Arctic, on the western shore of Hudson Bay, well south of latitude 60° north. Some polar bears live in the James Bay region, at the same latitude as London or Berlin. Bears do not live in antarctic regions — despite the sketches of cartoonists who draw polar bears sharing the ice with penguins (these artists stretch the truth across the icecaps, literally poles apart).

In the Arctic 'you don't fight fires — you just pull the building apart so the flames can't spread.'

The absence of polar bears from antarctic waters causes a curious contrast in behavior between northern and southern seals. In the Arctic the main danger to seals is from polar bears, who hunt them when they lie on top of the ice. In antarctic waters danger lurks in the sea: the leopard seal is the predator to be feared, and it attacks smaller seals in the water. A veteran of icebreaker cruises to both regions describes the difference: "Up north, when the ship crunches through the ice, the seals slip into the water. They know that danger comes from above and that sounds transmitted through the ice signal threats. In the south, seals wait until the ship is almost on top of them before they leave the safety of the ice. In fact, I'm afraid we may have squashed a few seals who didn't get out of the way."

The two regions, north and south, though at first glance similar (they are both, of course, cold, remote, and sparsely populated), are fundamentally different. The arctic region is an ocean surrounded by land; the antarctic, a continent surrounded by water. The distinction means much more than colors on a map. The distribution of land and sea controls the climate: much colder temperatures are reported from the Antarctic, where the mercury has dipped to -129° F, the lowest temperature ever recorded on earth. The Arctic Ocean, cold as it is, is warmer than Antarctica's rocky mountains, and it moderates the temperatures of the northern regions. Water is the best place on Earth to store heat. This property makes the oceans vast thermal regulators, whose effects reach far inland. Even so, arctic winter temperatures often drop to 60 degrees below zero, and -90° F has been recorded at Verkhoyansk, in the interior of Siberia.

One aspect of life — and only one — becomes simpler in the Arctic than in more temperate lands. For those of us continually bewildered by temperatures reported in Celsius and Fahrenheit, it's comforting to know that 40 degrees below zero reads the same on either scale. A small matter, perhaps, but at 40 below, you take what few comforts you can.

Long before the Arctic was explored, ice bears were said to live at the North Pole. They were called *polar* bears long before the North Pole was "discovered." In our own time the name has been verified: polar bears are indeed found at the Pole. When the nuclear submarine *Skate* surfaced through the ice near the North Pole and a lookout scrambled up through the hatch, the first thing he spotted was a bear — no doubt the most surprised polar bear in history.

The name of the region is a gift from Nanook: *arktos* is the Greek word for "bear." Greeks, and later, Romans, pointed north by finding a constellation in the night sky that we call the Big Dipper. They named it the Great Bear. The northern regions became *Arktikos*, "Country of the Great Bear." Thus, in turnabout fashion, the bear wears the name of the Pole, and the Arctic wears the name of the bear.

The Arctic contains three poles: (1) the "cold pole," where the lowest arctic thermometer readings are recorded, located in central Siberia and more a region than a specific site; (2) the north magnetic pole, located in Canada's Arctic Islands, west of Greenland, a continually shifting nomad, where a compass needle points straight down; and (3) the true North Pole, an imaginary spot that can't be located on the earth's surface at all, because it lies in a field of mobile ice with no land nearby.

The North Pole is an abstraction, a concept defined by Greek mathematicians three thousand years before Robert E. Peary first planted a flag. Peary's flagpole, set in the ice, moved with the wind-drifted floe; by the time he returned to civilization to claim his mark in history, his mark was no longer at the Pole, which he'd sought for so long. (Recent evidence suggests that he may never have gotten there at all.)

The North Pole is a mystical place; it exerted such a powerful pull on nineteenth-century explorers that they risked everything in its pursuit. Legends of splendid treasures and rumors of a Northwest Passage to the Orient drew earlier adventurers to the Arctic, but after the 1850s, the Pole itself became the goal. All glory, it seemed, would fall to the first to reach the northernmost point on the globe. From a modern perspective it all seems rather pointless, but the Pole continues, even today, to be a place of compelling mystery, a spot whose very name fires the imagination and

Continued on page 34

ENVIRONMENTAL/ENGINEERING GEOLOGISTS

HGS ENVIRONMENTAL/ENGINEERING COMMITTEE DINNER MEETING FEBRUARY 12, 1992

Time: 6:00 - 6:30 p.m., Social
6:30 - 7:30 p.m., Program

Location: Italian Market and Cafe
2615 Ella Blvd.
(behind Memorial Northwest Hospital)

Speaker: Tom Northrup
President, Northrup & Associates

Subject: Current Perspectives in Wetlands

HGS ENVIRONMENTAL/ENGINEERING COMMITTEE SHORT COURSE TUESDAY, MARCH 24, 1992

Time: 6:00 - 9:00 p.m.

Cost: $30; $15 for unemployed HGS members

Location: Paul Revere High School Auditorium
10500 Briar Forest

Speaker: Mr. Massoud Tabrizi

Subject: Petroleum Storage Tank and Other Hazardous Waste Removal and Remediation Techniques

MASSOUD TABRIZI—Biographical Sketch

Mr. Massoud Tabrizi is the Manager of Environmental Services with Environmental Technology Inc. (Magnolia). He has over 15 years of experience in this field and is known for his excellent presentations.

For further information call Zubair Haq (495-9828).

ENVIRONMENTAL NOTES:

HOUSEHOLD HAZARDOUS WASTE: CLEANING PRODUCTS

by the Texas Water Commission

The alternatives to household cleaning products listed below easily replace their toxic counterparts. However, if you use a toxic product, please try to fully use the contents so that only remnants line the container. Safely store any unused products until your community holds a household hazardous waste collection day.

For oven cleaners, toilet cleaners, disinfectants, laundry bleaches, mothballs, and ammonia-based cleaners, empty containers should be rinsed with water. The container may then be disposed at your municipal landfill, while the rinse water can be reused, or poured down the drain with great quantities of water.

With or without excess contents, never discard drain cleaners, rug and upholstery cleaners, or floor and furniture polishes in the trash; safely store until a community collection.

OVEN CLEANERS: corrosive & toxic
alternative: baking soda, water, and steel wool pads

TOILET CLEANERS: corrosive, toxic, irritant
alternatives: toilet brush & baking soda; mild detergent

DISINFECTANTS: corrosive & toxic
alternative: 1/4 to 1/2 cup borax in 1 gallon hot water

DRAIN CLEANER: corrosive & toxic
alternatives: plunger or snake; flush with boiling water, 1/4 cup baking soda, and 2 oz. vinegar

AMMONIA & ALL-PURPOSE CLEANERS: corrosive, toxic, irritant
alternatives: *for surfaces:* vinegar, salt & water mix; *for bathroom:* baking soda & water; *also:* 1/2 cup of borax, 1/2 teaspoon liquid soap, 2 teaspoons TSP (a mineral available in hardware stores) in 2 gallons of water (removes wax buildup as well)

RUG & UPHOLSTERY CLEANERS: corrosive & toxic
alternative: sprinkle baking soda on rug, then vacuum

FLOOR & FURNITURE POLISH: flammable & toxic
alternative: 1 part lemon juice, and 2 parts olive or vegetable oil (shake well before applying)

LAUNDRY BLEACH: corrosive & toxic
alternatives: 1/2 cup white vinegar, baking soda or borax

MOTHBALLS: toxic
alternatives: cedar chips, newspapers, lavender flowers

METAL POLISHES: toxic
alternatives: *for brass & copper:* lemon and salt or lemon and baking soda; *for chrome:* apple-cider vinegar; *for silver:* paste of calcium carbonate (a powder available at drug stores) and olive oil — allow to dry before polishing with a soft, white cloth

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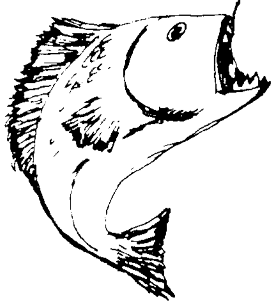

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Contact Joe Alcamo at 531-2979 or Bill Roach at 659-6111 for additional information.

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ENVIRONMENTAL BRIEF

QUARTERLY STATUS REPORT OF SUPERFUND SITES IN HARRIS COUNTY, TEXAS*

*Excerpts from the U.S. EPA Publication "Quarterly Status Report of Superfund Sites in Texas", July 1991.

Superfund is the common term for the *Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)* as amended in 1986, the federal law that provides remedies for abandoned hazardous waste sites. The U.S. Environmental Protection Agency (EPA) administers and enforces CERCLA in Texas in cooperation with the Texas Water Commission (TWC). The State of Texas currently has 28 sites on the EPA's *National Priorities List (NPL)* of hazardous waste sites. This paper includes a brief description of the current status of sites in the Houston area but is not intended to replace the site-specific fact sheets that are published throughout the life of a Superfund site.

BRIO REFINING

Also Known As: JOC Oil Aromatics, Inc.; Lowe Chemical Co.

Location: Southern Harris County; 2 miles north of Friendswood

National Priorities Listing History: Proposed Date: 10/15/84; Final Date 03/31/89

Current Project Phase: Remedial Design

Contact: Stan Hitt, EPA, at (214) 655-6735

Information Available at: South Campus Library of the San Jacinto Junior College

The Brio facility was operated as an oil refinery by various owners between 1957 and 1982. Unlined pits holding waste materials were closed by covering them with soil. Between 500,000 and 700,000 cubic yards of soil on site are contaminated with hazardous materials such as heavy metals, volatile organic compounds (VOCs), and fuel oil residues. Ground water under the site contains high levels of VOCs.

Large-scale biotreatment and incineration demonstration studies were conducted at the site during the Remedial Investigation/Feasibility Study phases. In 1988, EPA announced that its proposed remedy was incineration; however, a bio-treatment alternative would be considered in lieu of incineration provided that biotreatment could achieve the level of treatment deemed necessary for remedial action. The potentially responsible parties have selected a remediation contractor and it appears that incineration will be the treatment technology used at the site.

A Consent Decree was signed in June 1989 that allowed the potentially responsible parties to begin dismantling the process facility and associated tanks. This work was completed in December, 1989.

In late 1988, EPA reached agreement with a group of potentially responsible parties. This agreement was fashioned in a document known as a Consent Decree. Following a lengthy public comment period (August 30 through December 30, 1989) for the Consent Decree, the document was filed for entry with the Southern District Court of Texas, on December 3, 1990. On April 4, 1991, the Court signed the Consent Decree, thus allowing EPA to proceed with site remediation.

The Homes, Environment, and Lives in Peril (HELP) citizens' group was awarded the Technical Assistance Grant (TAG) on January 31, 1991. If you need further information regarding the TAG, please call (214) 655-2240 or 1-800-533-3508.

CRYSTAL CHEMICAL

Location: Western Harris County; Rogerdale Road in Houston

National Priorities Listing History: Proposed Date: 07/23/82; final Date: 09/08/83

Current Project Phase: Remedial Design and PRP Negotiations are underway.

Contacts: Lisa Marie Price, EPA, (214) 655-6735

Information Available at: Houston Central Library

The Crystal Chemical Company began producing arsenic-based pesticides in 1968 but then declared bankruptcy in 1981. Containers of raw and finished materials were stored on the ground where they spilled and leaked into the soil and ground water. Heavy rains caused waste ponds to overflow. Monitoring indicates little or no migration of the contaminated ground water outside the site boundaries; however, off-site soil contamination does exist.

EPA issued a *Record of Decision* in September, 1990 that calls for the off-site excavation of arsenic-contaminated soil down to 30ppm; the on-site treatment of all arsenic-contaminated soil above 300ppm using the *in-situ* vitrification (ISV) process; and once the soil treatment is completed, capping of the entire site. The arsenic-contaminated ground water will be extracted and treated.

The Westchase Business Council has applied for the $50,000 TAG. If you need additional information regarding the citizens' grant, please call (214) 655-2240 or 1-800-533-3508.

DIXIE OIL PROCESSORS

Also Known As: DOP

Location: Southern Harris County; 20 miles southeast of Houston near Friendswood

National Priorities Listing History: Proposed Date: 06/88; Final Date: 10/89

Current Project Phase: Pre-Remedial Design

Contact: Stan Hitt, EPA, at (214) 655-6735

Information Available at: South Campus Library of San Jacinto Junior College

Dixie Oil Processors, Inc. was the most recent operator at this 27-acre site, beginning oil recovery operations in 1978. Liquid organic wastes such as phenolic tars and glycol cutter stock were converted into creosote, fuel oil extenders, and other petroleum products. Former owners operated olefin washing and copper recovery processes. Shallow ground water and soil are contaminated with volatile organic compounds (VOCs) and heavy metals including copper and lead.

EPA decided that the process facility should be dismantled and removed, as well as the drums which will be disposed off-site. Dismantling of the surface tanks was completed in December 1989, under the terms of a Consent Decree Order. EPA is presently evaluating its enforcement options concerning the remedial action.

The Homes, Environment, and Lives in Peril (HELP) citizens' group was awarded the Technical Assistance Grant (TAG) on January 31, 1991. If you need more TAG information, please call (214) 655-2240 or 1-800-533-3508.

FRENCH LIMITED

Location: Northeast Harris County; 2 miles southwest of Crosby and 1 mile east of the San Jacinto River

National Priorities Listing History: Proposed Date: 10/23/81; Final Date: 09/08/83

Current Project Phase: Remedial Design Approval

Contact: Judith Black, EPA, at (214) 655-6735

Information Available at: Crosby Library

This site consists of a 15-acre waste pit and a 7-acre lagoon. The pit received 100,000 barrels of industrial waste each year from 1966 to 1974 and was then abandoned. The lagoon received heavy metals, phenols, PCBs, and acids. The company declared bankruptcy in 1973. At the site, ground water, sludges, surface water, soil, and air are contaminated with volatile organic compounds (VOCs), phenols, heavy metals, and PCBs.

EPA has negotiated with the French Limited Task Force, a group of potentially responsible parties, to implement in-situ biodegradation, treatment of surface water, and ground water recovery and treatment. Actual design of the remedy began in the summer of 1989 and is currently under review by EPA for approval.

The Barrett-Crosby Civic League has applied for the $50,000 citizens' grant. The application was received on March 11, 1991. Please call (214) 655-2240 or 1-800-533-3508 for information.

GENEVA INDUSTRIES

Also Known As: Geneva Industries/Fuhrman Energy

Location: Harris County; Houston, on Caniff Road; 2 miles east of Hobby Airport

National Priorities Listing History: Proposed Date: 09/08/83; Final Date: 09/21/84

Current Phase: Remedial Design of ground water treatment system

Contacts: Gary McGill, TWC, at (512) 463-8182; or Mark Fite, EPA, at (214) 655-6715

Information Available at: Houston Central Library and the South Houston Branch Library

Geneva Industries/Fuhrman Energy is a 13-acre abandoned petrochemical manufacturing and reprocessing facility. PCBs were produced from 1967 to 1984. Ground water, soil, surface water, and sludges were contaminated with polychlorinated biphenyls (PCBs) and volatile organic chemicals (VOCs).

A total of 62,400 tons of soil have been excavated and taken to an off-site landfill. The remaining portions of the source remediation were completed in June 1990, with a ribbon-cutting ceremony held in August 1990, commemorating completion of the source control phase of this project. Ground water pumping wells will be installed during early 1992.

LIFT Endowment has withdrawn its letter of intent to apply for a Technical Assistance Grant (TAG). For information on the $50,000 grant available to a citizens' group, please call (214) 655-2240 or 1-800-533-3508.

HIGHLANDS ACID PIT

Location: Harris County; 15 miles east of Houston, 1 mile from The Highlands

National Priorities Listing History: Proposed Date: 07/23/82; Final Date: 09/08/83

Current Project Phase: Supplemental Sampling being conducted

Contacts: Peter Waterreus, TWC, at (512) 475-2335; or Chad Prior, EPA, at (214) 655-6715

Information Available at: Sterling Municipal Library and the Highlands Community Center

The site is a 6-acre peninsula in the San Jacinto River and was used as a dumping site for highly acidic sludge. Ground water and surface water contaminants include heavy metals, volatile organic compounds (VOCs), including toluene and benzene, and sulfate. The upper sand aquifer has been heavily contaminated, but no private or public wells currently withdraw water from it.

An estimated 33,000 tons of contaminated waste was excavated from the site and taken to a permitted facility. The ground water in the area continues to be monitored by the Texas Water Commission (TWC) and four unused wells were plugged in 1989. Continued ground water sampling and analysis will be conducted by the TWC to monitor the effectiveness of the remedial action.

LIFT Endowment has withdrawn its letter of intent to apply for a Technical Assistance Grant (TAG). For information on the $50,000 grant available to a citizens group, please call (214) 655-2240 or 1-800-533-3508.

INDUSTRIAL TRANSFORMERS

Also Know As: Sol Lynn; Industrial Transformer Site

Location: Harris County; City of Houston; South Loop 610 West

National Priorities Listing History: Proposed Date: 10/15/84; Final Date: 03/31/89

Current Project Phase: Remedial Design/Remedial Action

Contacts: Robert Rountree, TWC, (512) 463-7995; or Mark Fite, EPA, at (214) 655-6715 regarding ground water. John Meyer, EPA, at (214) 655-6735 regarding contaminated soils.

Information Available at: Houston Central Library

This is an abandoned transformer reclamation and chemical supply company. Three lots are contaminated with PCBs and the ground water is contaminated with trichloroethylene (TCE).

EPA and Gulf States Utilities signed a Consent Decree regarding implementation of a chemical dechlorination process to treat the PCBs in the soil. This Consent Decree was entered in the Southern District of Texas, Houston Division Court on January 8, 1990. No comments were received during the public comment period which ended in late September 1989. Design work for this portion of the site should be completed in mid-1991. The implementation phase should take about six months.

In 1988, EPA decided to pump and treat the contaminated ground water. The design for the ground water portion is being done by the Texas Water Commission.

LIFT Endowment has withdrawn its letter of intent to apply for a Technical Assistance Grant (TAG). For information on the $50,000 grant available to a citizens group, please call (214) 655-6715 or 1-800-533-3508.

NORTH CAVALCADE STREET

Location: Harris County; northeast Houston

National Priorities Listing History: Proposed Date: 10/15/84; Final Date: 6/10/86

Current Project Phase: Remedial Action underway

Contacts: Louis Rogers, TWC, at (512) 463-8188; or Deborah Griswold, EPA, at (214) 655-6715

Information Available at: Houston Central Library

The site is an abandoned wood treating facility. Tests indicated that surface soils as well as shallow ground water are contaminated with creosote compounds. The shallow ground water is also contaminated with arsenic. In 1988, EPA selected a remedy which includes biological treatment of the soils and extraction/treatment of the ground water.

The Texas Water Commission (TWC) is preparing the engineering design for the ground water remediation which was scheduled to be completed in early fall 1991. TWC is also designing the soil remediation, scheduled for completion in spring 1992. During the design phase, pilot tests will be conducted to optimize the soil remedy. These tests will be performed from spring 1991 to winter 1991/92. Other field work was completed in May, 1990. The ground water remediation itself is scheduled to begin early 1992. The completion date is not certain at this time. The soil remediation should begin in late 1992 and finish 3 to 4 years later.

Continued on page 50

PERMIAN BASIN/MID-CONTINENT EXPLORATIONISTS

PERMIAN BASIN AND MID-CONTINENT EXPLORATION MEETING— TUESDAY, FEBRUARY 11, 1992 Post Oak Doubletree Inn, 6:00 p.m.

Our speaker will be **Dr. Glen K. Merrill** from the University of Houston, Downtown Campus. His topic will be the **Paleozoic History of the Llano Uplift,** Central Texas. Dr. Merrill has written the guidebook for this area and during the past ten years has led many geological societies' field trips through this region's fascinating stratigraphy.

Surrounding the granite core of the uplift lies exposed the entire Palaeozoic section which we office explorationists see as wiggly lines. The Ellenburger, the Barnett, and the Bend all have their type localities on the Llano Uplift. Come see the updip expression of these producing formations on a "Tuesday night field trip" as Dr. Merrill shows the work he and his partner, Robert Grayson from Baylor University, are doing to unravel the depositional systems and the tectonic events of the area.

ON THE MOVE

Vince Matthews has been named president of Penn Virginia Resources Corporation and Penn Virginia Marketing Corporation, both located in Duffield, Virginia.

James F. Burkholder has joined AGIP Petroleum Corporation in Houston, Texas as exploration geologist, Gulf of Mexico. He was previously a geological consultant with Seagull Energy Corporation.

Dr. T. R. LaFehr, President of LCT Houston, Inc. has relocated to the company's Houston headquarters as part of a corporate expansion plan. In order to be closer to clients and facilitate growth in software and marine operations, the Denver office of LCT has been merged with the Houston office at 1155 Dairy Ashford, Suite 306, Houston, Texas 77079. Phone (713) 558-8383, Fax (713) 558-8384, Telex 910240866.

Fairfield Industries Inc. announces the election of **Walter Pharris,** Executive Vice President, to the Board of Directors of Fairfield Industries. **Michael Farrelly** has been promoted to Vice President for International Marketing.

The Houston Geological Society Field Trip Committee

presents the following field trips, in cooperation with the

Geological Society of America - South-Central Section Meeting, Houston, February 1992

Participants who are not registered for the GSA meeting will be charged a $10 additional registration fee.
All trips will depart by bus from the Rice University stadium parking lot.
Please call the HGS office at 785-6402 for additional information and trip descriptions.

TRIP #3 — NASA - JOHNSON SPACE CENTER TOUR:
Lunar Samples & Planetary Imagery
Saturday, February 22, 8:00 a.m. to approx. 3:00 p.m.

LEADERS: John W. Dietrich and David L. Amsbury, NASA Johnson Space Center, Houston, Texas.

FEE: $18 per person (includes bus transportation and refreshments). Each must be a U.S. citizen or present a valid green card for admission to NASA.

LIMIT: 45 persons

TRIP #4: ENVIRONMENTAL & ENGINEERING GEOLOGY IN THE HOUSTON METROPOLITAN AREA
Sunday, February 23, 8:00 a.m. to approx. 6:00 p.m.

LEADERS: Carl Norman (University of Houston) and Saul Aronow (Lamar University)

FEE: $40 per person (includes transportation, lunch, refreshments and guidebook)

LIMIT: 45 persons

TRIP #5: UNITED SALT CORPORATION HOCKLEY MINE
Hockley, Texas
Saturday, February 22 (two sessions: 5:30 a.m. - 11:00 a.m. and 8:15 a.m. - 1:30 p.m.)

LEADERS: Daryl Wilson (United Salt Corp.) and Jeff McCartney (Texas Brine Corp.)

FEE: $50 per person (includes transportation, breakfast with first session, lunch with second session, refreshments, and guidebook materals).

LIMIT: 20 persons (10 per session)

TRIP #6: RECENT SEDIMENTS OF SOUTHEAST TEXAS:
Exploration, Environmental & Engineering Implications
Saturday, February 22, 7:30 a.m. to 6:00 p.m.

LEADER: Rufus J. LeBlanc, Sr. (Rufe LeBlanc School of Clastic Sediments, Houston).

FEE: $40 per person, (includes transportation, guidebook, lunch and refreshments)

LIMIT: 45 persons

Please send your registration and a check made out to "HGS FIELD TRIPS" to:
Paul Britt, Elf Exploration, 1000 Louisiana, Suite 3800, Houston, Texas 77002
(Participants not registering for the GSA meeting **add $10** special registration fee)

TRIP(S): ______________________ AMOUNT REMITTED: ______________________

Name: ______________________ Company: ______________________

Address: ______________________ Phone: ______________________

City, State, Zip ______________________ Fax: ______________________

FEB. CALENDAR of EVENTS 1992

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
						1
2	3	4	5	6	7	8
9	10 **HGS** **DINNER MEETING** **J. Stuckey** **Post Oak Dbltree**	11 **HGS** **PERMIAN/MID-CONT.** **DINNER MEETING** **Glenn Merrill** **Post Oak Dbltree** AWG Dinner Mtg. Morningside Thai	12 **HGS ENV./ENG.** **Committee Mtg.** **Italian Mkt.**	13 SPWLA Westside Luncheon	14 HGA Couples Party Lakeside C.C.	15
16	17	18 SPWLA Galleria Luncheon USGS McKelvey Forum - Wyndham Greenspoint, Feb. 18-20	19 GeoWives Tour & Luncheon	20 SIPES Luncheon Cary Wright Petroleum Club SPWLA Greenspoint Luncheon	21	22 **HGS/GSA** **Field Trips** **Rufus LeBlanc** **Recent Sediments of** **SE Texas,** **Hockley Mine,** **& NASA Space Center**
23 GSA Short Courses Bally *et al* Feb. 23-24 Wright *et al* Feb. 23 **HGS ENVIRON.** **FIELD TRIP** **Norman & Aronow** GSA Annual Meeting - Rice University, Feb. 23-25	24 GSH Noon Luncheon Ralph Baird Houstonian	25 **HGS/GSA INT'L.** **DINNER MEETING** **Royden & Burchfiel** **Post Oak Dbltree** SPWLA Downtown Luncheon	26 **HGS** **LUNCHEON** **Shipp & DiMarco** **Houston Club**	27	28 American Society of Environmental History Conference U of H, Feb. 28-March 3	29

GEO-EVENTS

MEETINGS

IN HOUSTON

HGS/HAPL Joint Dinner Meeting, J. Stuckey, "Environmental Law Considerations for Oil and Gas Leasing", Post Oak Doubletree Inn, 5:30 p.m., Feb. 10.

HGS Permian Basin/Mid-Continent Dinner Meeting, Dr. Glen K. Merrill, "Paleozoic History of the Llano Uplift", Post Oak Doubletree Inn, 6:00 p.m., Feb. 11.

AWG Dinner Meeting, Morningside Thai Restaurant, 6710 Morningside Drive, 6:00-8:00 p.m., Feb. 11. (If planning to attend, call Anglia Sweet 556-7067).

HGS Environmental/Engineering Geology Committee Meeting, T. Northrup, "Current Perspectives in Wetlands", Italian Market, 2615 Ella Blvd., 6:00 p.m., Feb. 12.

SPWLA Westside Luncheon, Holiday Inn-Houston West (I-10 at Hwy 6), 11:30 a.m., Feb. 13.

SPWLA Galleria Luncheon, Marriott Galleria, 1750 West Loop South, 11:30 a.m., Feb. 18.

USGS McKelvey Forum on Energy and Mineral Resources, Wyndham Greenspoint Hotel, Feb. 18-20.

GeoWives Tour and Luncheon, Tour of Wortham Center, 10:00 a.m., Luncheon at Charlies "517", 11:15 a.m., Feb. 19.

SPWLA Greenspoint Luncheon, Baroid Cafeteria, 3000 North Sam Houston Parkway East, 12 Noon, Feb. 20.

SIPES Luncheon, Cary Wright, "McAllen Ranch Field - Making an Old Gem Sparkle", Petroleum Club, 11:30 a.m., Feb. 20.

GSA South Central Section Annual Meeting, Rice University, Feb. 23-25.

GSH Noon Luncheon, Ralph Baird, "Shallow Drilling Hazards - an Update", Houstonian, 11:30 a.m., Feb. 24.

SPWLA Downtown Luncheon, Shell Plaza Club, 4900 One Shell Plaza, 11:30 a.m., Feb. 25.

HGS & GSA International Joint Dinner Meeting, Leigh Royden & Clark Burchfiel, "Eastern European Mountain Belts - The Highs and Lows", Post Oak Doubletree Inn, 5:30 p.m., Feb. 25.

HGS Luncheon, R. Craig Shipp and Michael J. DiMarco, "Hackberry Wedge of Southeast Texas and Southwest Louisiana", Houston Club, 11:30 a.m., Feb. 26.

American Society of Environmental History Conference, University of Houston, Feb. 28-March 3.

SCHOOLS AND FIELD TRIPS

HGS/GSA Field Trips, Rice University stadium parking lot.

J. W. Dietrich and D. L. Amsbury, "Nasa Johnson Space Center Tour", 8:00 a.m. - 3:00 p.m., Feb. 22.

Continued on page 43

COMMITTEE NEWS

1991 GCAGS TENNIS TOURNAMENT RESULTS

Championship	Men's (A)	Men's (B)
First Place	Pete Laux DeKalb Energy	Robert Maurer
	Mike Walker	Ray Garcia
Second Place	Bruce Coffman Oryx Expl.	Henry Cullins
	Bill Scott Petro Log	Al Dee
Third Place	Rick Ealand Tim Beek	Jim Bresnan David Vork
Fourth Place	Graham Livesey Charles Nagell	George Hinds Ed Bush

Championship	Women's (A)	Women's (B)
First Place	Norma Jones Sally Black Hall	Kathy Lippert Pam LaCosta
Second Place	Lee Ann Grush Harriet Correll	Amy Maynard Sandra Williamson

The next Annual HGS Tournament will be April, 1992.

Thanks to the tournament committee for an excellent tournament: Norma Jones, Don Scherer, William Scott of Petro-Log (for balls and door prizes), and Ken Nemeth.

First Place Men's A - Pete Laux and Mike Walker

First Place Men's B - Ray Garcia and Robert Maurer

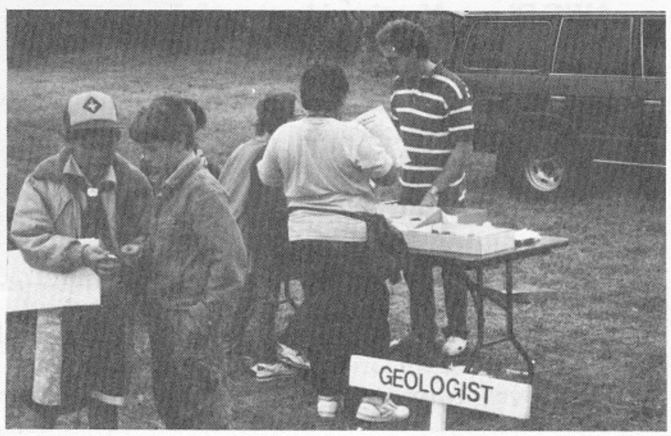
First Place Women's B - Kathy Lippert and Pam LaCosta

DANCES WITH WEBELOS

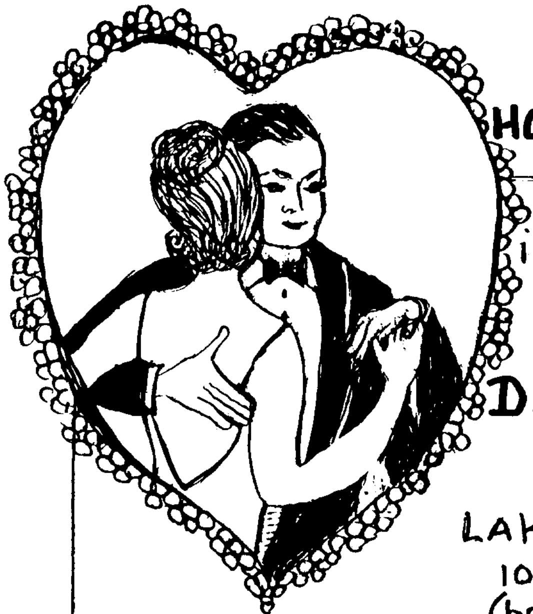
On November 16th, representatives of the Explorer Scout Committee, Dan Helton, George Krapfel, and Lillian Roberts traveled to Camp Brosig near Sealy, Texas and became "honorary Webelo scouts" when they donated their Saturday to help approximately 150 Webelos (fourth and fifth graders) from the Houston area attain their Geology Activity Badges. To achieve their Geology Activity Badges the scouts were to fulfill five of the six requirements related to mountain building, volcanoes, and rock and mineral identification.

By the end of each session, the scouts were able to tell if they had a good pocket knife by using Moh's Hardness Scale, recognize the different rocks formed by magma and lava, and tell how plate tectonics operates. A hands-on experience with an extensive mineral collection was afforded the scouts by John Chronic of the HGS Academic Liaison, the Houston Gem and Mineral Society, and Conoco.

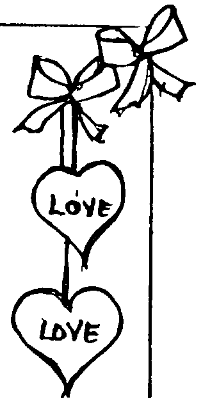
Also, on November 23rd and 24th Explorer Posts 2004 and 2005 went camping in Central Texas (Hill Country) at Blanco State Park. A total of 26 students were in attendance. Despite the freezing temperatures at night it warmed up enough during the day so that students could enjoy such sites as Enchanted Rock and Pedernales Falls State Parks.



George Krapfel explains rock and mineral uses to Webelo Scouts.



HOUSTON GEOLOGICAL AUXILIARY



invites you to attend a

SWEETHEART DINNER DANCE

at

LAKESIDE COUNTRY CLUB
100 Wilcrest Drive, Houston
(between I-10 and Westheimer)

FRIDAY, FEBRUARY 14, 1992

7:00 P.M. Social, Cash Bar
8:00 P.M. Dinner
DANCING 7:30 TIL 11:30 P.M.

RESERVATIONS BY SATURDAY, FEB. 1, 1992
$50.00 MEMBER COUPLE
$53.00 GUEST COUPLE

MAKE CHECK PAYABLE TO HGA
2515 ANNISTON DR.
HOUSTON, TEXAS 77080

BLACK TIE OPTIONAL

NAME ______________________
ADDRESS ______________________
____

NO. OF GUESTS ATTENDING ________ AMOUNT ENCLOSED ________

Geotales, continued from page 21

chills the soul. Over most of the Northern Hemisphere, men, women, and children point to the North Star, Polaris, and tell of its earthly sister, the North Pole. And any child who's heard of Santa Claus can tell you where he lives.

The Pole still draws explorers, from adventurers who brave the rigors of skis, dogsleds, or snowmobiles to passengers seated comfortably aboard transpolar commercial jets, who pause from leisurely meals to glance out the aircraft windows and shudder as the pilot describes the frigid scene below. Exceptionally hardy golfers can even slice and hook from the top of the world, according to the latest travel brochures. For a place that is literally no place, the Pole has a remarkable following. It is the best-known least-visited spot on the earth.

Because the earth's axis — a line through the planet connecting North and South poles, around which we rotate each day — is tilted, the North Pole spends part of the year (summer) inclined toward the sun and part of the year (winter) facing away from it.

A tilted axis offsets the path of the sun's rays across the globe. At the Pole itself the year consists of one long "day": six months of light, six of darkness. Some 1,630 miles farther south, at latitude 66.5° north, the effect is still apparent but diminished. For one twenty-four-hour day in the dead of winter, the sun never rises; for one twenty-four-hour summer day, the sun never sets (the British Empire had nothing on an arctic summer). This latitude, like the Pole itself, has a magical grip on the human mind. So important is this geographic abstraction, this boundary drawn on maps of the earth but related to celestial mechanics — significant because its effects could be read in the sun's motions by primitive people long before their shamans, seers, and scientists could explain the phenomenon — that long ago it was given a name. All things important to humans have names. The imaginary line encircling the earth at 66.5° north of the equator is called the *Arctic Circle*.

This line of demarcation that encompasses Nanook's world is crossed with great ceremony aboard ship. Any sailor who submits to indignities prescribed by Boreas Rex and his royal court is proclaimed a "true and trusty brine-encrusted blue-nose." My circle crossing included obeisance to the king and his queen, and kissing the belly of the Royal Baby, a rotund chief boatswain's mate whose navel had been smeared with engine-room grease. After a haircut from the royal barber (which took three weeks to grow back to normal), I crawled through a trough of galley slops and was hosed down with frigid seawater. The Arctic Circle, once crossed, is not easily forgotten.

A different definition of the arctic environment relies on the northern limit of trees (but even in the "treeless" tundra there are ground-hugging varieties of plants that grow to tree height in warmer settings). Still another definition is based on climate: meteorologists define the arctic realm as that area north of a line of 50° F average temperatures during the warmest month of the year. Regardless of how it's defined, the Arctic wears impressive titles. My favorite descriptive term for the Far North — simply because it rolls from the tongue with such eloquent elegance — is *hyperborean*.

To the polar Eskimos, or Inuit, this area is *nunassiaq*, "the beautiful land." It is a region still largely unknown, even in this age of satellite reconnaissance. Only as recently as 1968 did surveyors of David Humphrey's aborted polar expedition confirm Robert Peary's 1900 discovery of Kaffeklubben ϕ (Coffee Klatsch Island), north of Greenland, as the northernmost piece of land in the world. Only in 1978 did surveyors from the Danish Geodetic Institute discover a still more northerly island — a patch of gravel rising barely above the sea north of Kaffeklubben. They named it Oodaaq, for one of Peary's 1909 companions to the Pole. It nudges unobtrusively into the Arctic Ocean as the last outpost of the land, at 83° 40′ 32.51″ north latitude.

Within the Arctic lie innumerable surprises. A summer sun that rolls like a brilliant gold coin around the horizon instead of arcing overhead. Coal and dinosaur bones that record past subtropical times. Mammoth tusks beneath the sea, marking former dry-land migration routes. Icebergs, daughters of the mighty glaciers, that plow the ocean floor with their toes as they drift, leaving furrows fifteen feet deep. Ancient lichens that grow only 1 day each year and lie dormant the other 364 because the climate is so hostile. Nuclear submarines that play deadly games of hide-and-seek beneath the ice. Optical illusions called sundogs that flank the sun's disk during ice fogs. Double and triple mock moons. Mirages, caused by layers of cold air, that show land where there is no land. Above all, the true symbols of the Far North, the silent, shifting curtains of the aurora borealis, the Northern Lights.

The Arctic is a special world, described by a sixteenth-century explorer as "the place of greatest dignitie" on earth and by an experienced arctic traveler of this century as "the most horrible part of the world." It is a place of contrast. Water dominates the scene, in the form of snow, compacted snow called *firn* or *neve*, glacial ice, sea ice, icebergs, seawater, meltwater, lakes, streams, rivers, clouds, fog, and ice crystals that hang suspended in the air like light-shattering prisms. Even so, the high Arctic is truly a desert. The farthest north gets very little precipitation, because cold air can't hold much moisture. The polar desert is as dry as the Sahara; it receives less than ten inches of precipitation each year. Deserts are, by definition, largely deserted. The interior of the Greenland icecap is as empty — as devoid of life — as any spot on the planet.

In the Arctic Ocean the contrast between summer and winter is reflected in the water's surface. For a few weeks of summer the edge of the pack ice retreats poleward and large areas of open water host an abundance of life, including millions of seabirds. In autumn, as the temperature of the saltwater drops to 28° F, tiny ice crystals form at the ocean's surface, giving the water a greasy appearance. As the air temperature falls a skin of flexible ice covers the sea, a layer only an inch or two thick. Waves that ripple the remaining open water are subdued by the ice but can still tear the sheets into fragments. Floating, jostling, and splashing one another, the tiny flat ice islands acquire raised edges and rounded outlines. They resemble overturned Frisbees. These albino lily pads, these frozen flapjacks, are known as pancake ice.

Eventually, when the air temperature drops well below zero, the entire ocean surface freezes to a depth of ten to twelve feet. Multiyear ice that survived the summer with only superficial melting is rafted with new floes in a jigsaw puzzle that covers thousands of square miles. Circumpolar winds push and drag at the ice. The sheets split apart, exposing the black water that lurks silently beneath. These water-filled cracks are called *leads*. In winter the liquid is ephemeral: within hours the ice has reclaimed the spot and frozen over the opening, forming an opaque cataract that covers the ocean's dark eye. It is this white covering that makes the Arctic so cold. It reflects more than 70 percent of the sun's light and heat back into space. The icepack also functions as a gigantic lid, covering the sea and preventing the sun's rays from warming the water, or the ocean from warming the air.

The ice moves in a clockwise drift around the Pole. At various times in the past this pattern has been documented by ships frozen in the ice, riding as passengers on the immense turntable at the top of the globe. From 1893 to 1896 Fridtjof Nansen's *Fram,* deliberately frozen into the icepack as an oceanographic experiment, drifted from Siberia to the Greenland Sea. Earlier the ship *Jeanette,* caught in the ice in 1881 north of Russia's Lena River delta while seeking a Northwest Passage, emerged in pieces aboard drifting floes off the southwestern coast of Greenland.

Ice that makes this circuit is the true *polar pack*. Ice that remains frozen to the shoreline or grounded on the seafloor is termed *fast ice*. In between, where massive frozen walls and icy pinnacles grind past one another in an awesome display of nature's power, is the *shear zone.*

As the flat sheets of ice crunch into adjacent floes, titanic forces crumple their edges into *pressure ridges,* collision boundaries where jumbled ice rubble is fused into elongated mounds with deep roots that reach downward like the keels of ships. The superstructures of pressure ridges rise twenty, thirty, forty, or more feet above the frozen surface. The keels extend down even deeper. In the arctic icepack in winter, the flat surface of the ice cover is unrelenting: pressure ridges are a relief to the eye, offering the only reprieve from flatness and whiteness. To surveyors and explorers, pressure ridges are adversaries to be conquered. To anyone on the ice, pressure ridges mean danger: behind any one of them, unheard and unseen, polar bears may pace the snow-covered surface.

The debris field of a high pressure ridge is an almost impenetrable pile of blocks, each slab tens of feet across, stacked in chaotic disorder, strewn like a giant handful of pale dominoes. Its beauty depends on whether you admire it from afar or struggle from one side of it to the other, dragging a sledge laden with two hundred pounds of supplies.

In the spring leads open again, and the cycle of arctic life begins anew. Whales migrate north as soon as they find enough leads to permit them to surface and breathe, for as mammals they are prisoners of the air. Seals can winter in the Arctic, because they use the claws on their front flippers to scrape breathing holes from beneath the ice, but whales must find open leads. Even the narwhal, the unicorn of the sea, who uses his ivory tusk to fight for females, doesn't break ice with it.

As the sun returns, meltwater lakes form atop the floes, fresher than seawater, because salt was largely excluded from the ice during the fall freeze. On land the spring thaw brings forth profuse vegetation. Hundreds of species of flowering plants and thousands of kinds of mosses and lichens thrive even on the northernmost land areas. New-formed lakes are home to millions of insects, including enough mosquitoes to daunt even the hardiest explorers.

What never thaws in the Arctic is permafrost, permanently frozen soil that lies just a few inches below the surface and extends over a thousand feet down. The earth freezes from the top down and thaws only at depths where the planet's interior is warmer than the freezing point of water. Permafrost, more than frigid air temperatures, makes arctic life difficult for modern man. From Eskimo igloos, wonderfully insulated by the air trapped in the snow, to modern structures with freezer doors to keep the cold out, not in, man's engineering creations have allowed him to thrive in extreme cold. What he can't do well, however, is dig into, drill through, or build on permafrost. Only since the discovery and development of the Prudhoe Bay oil fields have engineers found ways to keep deep structures warm and the surrounding permafrost cold at the same time.

Permafrost-frozen plumbing is no joke. I have been acutely embarrassed as a guest at an arctic radar installation when I've watched the contents of the toilet rise and overflow the bowl because of a frozen line that everyone but me had been warned about. Above-ground plumbing and heating ducts, oil pipelines, and other necessities of civilized life are a consequence of the permafrost and must seem strange complications to older Eskimos. They remember that the only concern with frozen ground was burial of the dead (which even today must often be delayed until spring). Eskimos use the permafrost to their advantage, as a deep freeze for storing seal and whale meat through the warmer months.

Permafrost is harder than many rocks: in its way, it *is* a rock. All the solid forms of water are rocks. Geologists will tell you that snow is a sediment; compacted snow, a sedimentary rock. Because the snow and ice of a glacier flow and recrystallize, glacial ice is a metamorphic rock. Sea ice and pond ice are igneous rocks, because they form by the cooling of a molten liquid. It seems odd to think of water — such a familiar, everyday substance — as progenitor of an igneous rock. The polar territories play such games with our senses, toy with our temperate experiences, and confuse our concepts based on a warmer world.

The northern regions, cold as they are, are recovering from a much colder time. Although some parts of Alaska and Siberia were never covered by glaciers during the four great Pleistocene ice ages, many of the northern lands were buried by ice one, two, or even three miles thick. As the great continental ice sheets melted, sea level rose, flooding coastal areas worldwide. Drowned shorelines are common in temperate and tropical regions. Northern shorelines, however, notable for their icegouged fjords, are rising out of the sea. Why this gigantic uplift of glaciated terrains?

Geologists speak of *isostatic rebound,* the recovery of huge continental areas from having sunk into the earth's crust, pushed down by the weight of all that ice. If you unload heavy cargo from a ship, the hull floats higher in the water. The continents, relieved of their icy burden some ten to fifteen thousand years ago, are still rising, still floating higher. Beaches that once graced the shoreline now hang suspended on the walls of fjords, ten, or a hundred feet above the water.

Glacial evidence is everywhere in the Arctic. The ground is covered with ice-dropped stones, with outwash sands from glacial streams, and with debris plucked from surrounding hills and crushed to flourlike fineness by relentless grinding at the base of the ice sheets. The sculptured surface left behind recalls the ice ages as a not-so-distant memory.

Crossing this terrain is difficult in winter, almost impossible in summer, except in areas of open water where boats can maneuver. When snow covers the land, traveling is done by dogsled or snowmobile — there are no roads through most of the arctic regions. Except in sporting events, however, dogsleds are rare today in the Arctic, although in Greenland and parts of Canada dogs are still used for winter transportation along the coast. Snowmobiles have their uses, but something important has been lost with the disappearance of dog teams from the north country. With dependence on gasoline comes the danger of being caught in a blizzard without it.

Dogs had many uses. Cut free from their sled traces, they could encircle a bear and hold him until the hunter arrived. They could provide companionship, and they lifted the hunter's spirits with their voices on the trek. Dogs could even be used as food by desperate nomads in an unforgiving world. The snowmobile offers none of these benefits; it is a cold, impersonal mass of steel and plastic, fast and efficient when it's running right, cantankerous and useless when it's not.

When a snowmobile engine snarls, bears usually turn and run. When the machine sits quietly in the snow, however, Nanook may investigate. Larry Brooks, an engineer with years of arctic experience, tells of an expedition to study multiyear ice floes in the Chukchi Sea west of Point Barrow, Alaska. Working from the icebreaker *Polar Sea,* the scientific party had armed Coast Guard enlisted men posted on bear watch. "We had bears ambling through there a lot that time of year," Brooks reports, matter-of-factly. "While we were laying out ice-survey stakes, one walked into the middle of our operation. We retreated to the safety of the ship. The bear investigated most of our equipment, sniffed the marker flags, knocked a few of them down, and sauntered over to our snowmobile. He sniffed about the snow machine for a minute, and then became fascinated by its leather seat. He ripped off the seat cover and ate it. The bear walked a few yards, spit up the remains of the cover, and ambled off. I guess if it wasn't made out of seal hide, it wasn't worth eating."

Traveling beyond snowmobile range across the vast frozen landscape means flying with a special breed of aviator. In the Arctic, especially, the pilot's creed — "There are old pilots and bold pilots, but there are no old, bold pilots" — acquires a deadly seriousness. Any pilot who is equally at home landing a Twin Otter on frozen sea ice or a Hercules C-130 on a gravel beach is someone I'd trust to fly me anywhere. These are men I've seen running, screaming, and laughing like maniacs in blue-lipped nakedness through frigid waterfalls that tumble directly off the glaciers. They could out-macho Indiana Jones, but they're meticulous fliers, checking everything twice, leaving nothing to chance. The history of polar exploration is filled with grim tales of men who took chances, of expeditions ill prepared, of leaders overzealous in the pursuit of unattainable goals. The Arctic doesn't allow many mistakes.

If you want to know about bears, ask an arctic pilot. He's seen more bears and bear tracks than anyone on the ice or on board a ship. He'll have stories to tell. "I never leave the chopper," a helicopter pilot told me, "while the scientists are on the ice and there's a bear nearby. And I always keep the rotor turning."

More than once he's had researchers diving into his aircraft's open door with a bear in pursuit. "One time, I thought we'd had it. The bear followed the men to the helo and reached up as we were taking off — like he wanted to grab the skid under my feet. When we lifted off, he was sure surprised. With one paw in the air, it looked like he was waving good-bye."

Nonchalant arctic fliers seem to relish their passengers' discomfort. I had my first such encounter on the way to Greenland, flying up Canada's northeastern shoreline. I know we were in for an exciting landing when the crew chief passed cheerily among us, saying, "Gentlemen, you may wish to loosen any tight clothing and remove sharp objects from your pockets" — words designed to inspire confidence in white-knuckle passengers. The huge C-130 lumbered toward a stretch of beach on Baffin Island's eastern shore where a runway had been bull-dozed smooth and outlined with 55-gallon drums — the ubiquitous totem of "civilized" man in the Arctic. Over the end of the runway, while we were still several feet in the air, the pilot reversed the pitch on the propeller blades. We fell like an immense rock. Our wheels plowed a furrow over a foot deep in the soft beach —the 'dozer had to smooth the sand again before we could take off. "Exact minimum length," the pilot said with considerable pride, relishing our anxious expressions. "We'll be off again as soon as I work up my nerve."

When I stepped out of the airplane, leaving a warm, familiar, high-tech world for the cold, alien, untamed habitat of the white bear, the Arctic hit me with a frontal assault on the senses. Brilliant sunlight caromed off blue-white ice and sprang in rainbow colors from a meadow full of blossoms. On other days the light seeped through a fog of such palpable density that I marveled at the pilot's skill in bringing the plane safely to earth.

In winter the arctic shock to the senses is felt rather than seen. Wind rips at my clothing and hammers hair across my face. The cold seeks entry through the slightest chink in my insulating armor. Like a knight preparing for battle, I check every detail, then check it again. I dash in street shoes, carrying my boots, to the lee of a Quonset hut — or forget the storm flap that covers my parka zipper —and I'm reminded of my folly in the first seconds of exposure. The enemy is the cold, and I underestimate it at my peril.

The most powerful sense, capable of stirring the deepest memories, is smell. It's also the hardest to put into words. The smell of the Arctic depends, like so many other sensations, on the season. Unfortunately, most visitors never get sufficiently far from the trappings of civilization to experience the smell of the Arctic. They'll tell you the overriding scent of the north country is the stink of diesel exhaust — the effusion from countless generators, Sno-Cats, heavy trucks, drilling rigs and ships' engines. Getting away from such contaminants may be as difficult as a day's hike or as simple as a few steps to windward.

Winter in the polar icepack, or on the Greenland icecap, brings an almost total absence of smell. Wrapped in multiple layers, hoods, face masks, and scarves, I've been far more aware of my own body odors than of any external scents. There are only two worlds that matter in the Arctic — inside and outside. This concept is portable: there's a very strong sense when cocooned in cold-weather gear that I'm sealed in a cozy room, and it's far more comfortable — and safer — to keep my nose "in here with me" than "out there." Because my nose is so confined, so swathed in clothing, the odor of the Arctic mimics the wintertime smell of elementary school classrooms: it's the odor of wet wool. However, icepack scents exist for those attuned to them — polar bears and Eskimo hunters are adept at sniffing out the *aglus*, or breathing holes, of seals (male seals, in particular emit a strong, unpleasant odor) — but overall the ice is the nearest approximation on earth to an absolutely odorless environment.

Summer in the Arctic brings smells of freshly thawed earth, or flowers, of swamp muck, of all the refuse and sewage strewn about native villages during the cold months. Archaeologists excavating ancient Eskimo sites suffer the odors of innumerable dog droppings, thawing for the first time in a thousand years. In Greenland near villages the summer odors are overwhelmed by the absolutely indescribable stench of fish, sun dried on wooden frames set high so the dogs can't get to the meat. Man's best friend must be content with the drippings that ooze from the oily split fish and fall to the ground below. Arctic travelers with a refined sense of smell are advised to visit during the colder months.

More immediate than smell is the sense of sound. Sound in the Arctic echoes a song title: it's the sound of silence. There are, to be sure, the cries of birds in summer, the rumble of icebergs calving from the fronts of glaciers, the shriek of the wind, the gurgle of waves against the small icebergs knows as growlers, and the continuous cracks and groans from the shifting icepack, but the silence of the Arctic is what finally gives dimensions to its immensity.

If you get far enough from man's engines, generators, and humming wires, the silence is loud enough to be heard — a physical impossibility: something from nothing. In summer the blue sky stretches endlessly overhead, the sun gilds every pinnacle, and the absence of sound brings peace. In winter all contrasts are studies in black and white, and the dry sounds echo the absence of color. Like the temperature, they are more harsh, more threatening, even in their silence. Nanook himself is silent. Silent as he comes, silent in his stalk. Silence is the sound of death approaching.

One sound in the Arctic that is, above all, reassuring is the whup-up-up-up of a helicopter returning to pick up our survey crew stranded ashore for several days by bad weather. The radio crackles to life. "I can make out the ridge you're camped on," the pilot calls, "but I can't see you. Try lighting a flare." A moment later the fire-spitting tube ignites. I wave it overhead, making giant sweeps. The pilot spots a moving, bright orange dot against the dark rocks. A smoke plume trails off downwind, to help him gauge the breezes at his landing site. "Tallyho!" the radio squawks, and the surveyors smile, the anxiety of our situation a thing of the past. No C rations tonight; we'll get a real meal aboard ship, followed by a hot shower and a soft mattress.

A friend who travels extensively by dogsled, far removed from the noises that most of us find familiar, reports satisfaction at becoming atuned to the rhythms of the Arctic: subtle changes in the wind's intensity, the exultant hiss of sled runners over smooth ice, the pleasing crunch of boots in the snow.

HOUSTON GEOLOGICAL SOCIETY 1923

The Arctic is a place of isolation: it has been called, with good reason, "the lonely land." Summer loneliness is pleasant, but winter isolation brings normal minds to the brink of insanity. In the arctic storm known as a whiteout, a man is as completely alone with himself as he will ever be: no sight, no smell, no sound — nothing, absolutely nothing, beyond the length of his mittened hand. Diffuse sunlight seeps through, seeming to come from all directions at once. No reference points. No shadows. No depth perception. Only in such a setting, divorced from reality, when all the senses stretch to desperate limits but are soon exhausted by the effort — each, in turn, sensing nothing — do you really *feel* the Arctic.

Written descriptions of science often seem dry and sterile — you'd think the research must have performed itself, without human interference. In the Arctic that's just not true. So much effort is expended every field day in satisfying basic human needs that the actual time devoted to science can be astonishingly small. *Food* assumes a high priority. Rations are increased to gluttonous proportions north of the Arctic Circle, because the body needs more calories to fuel its internal furnace. *Clothing* attains a monumental importance that it never acquires back in the southern world. Not fashion but function. Parkas, coveralls, sweaters, hoods, face masks, insulated long johns, wool socks, and inflatable "bunny boots" are carefully inspected for even the slightest gap that will allow entry of the cold air. Frostbite is a very real enemy.

Arctic experiences are filed away as distinct memories, their sharp edges blurred little by the passage of time. The feeling of the summer-soft tundra sucking at my boots. Sharp stilettos of ice stabbing skyward on the tops of glaciers between depressions where dark specks of dust had melted their way into the surface — a hand-slashing menace. Majestic vistas: hundreds of miles containing absolutely no sign of human passage. The shared agony of my partner's frostbitten eyeballs. My feeling of vulnerability, set ashore with only a .45 pistol for protection. My first meeting with Greenland kayakers, paddling their sleek sealskin boats, clad in trousers sewn from polar bear fur. (It was at that moment that this book was conceived, though I didn't know it for years to come.) The incongruity of lifeboat drills on a ship surrounded by frozen ocean. Meltwater streams flowing beneath glaciers, carving blue ice caves with hidden waterfalls. My wonder at watching a 727 jet land on top of the sea, on a runway bulldozed smooth atop an ice floe. And more vivid, more painful than all the others, the cold. Biting stinging, slashing cold. Creeping, seeping cold. Deadly cold.

With the cold, and magnifying it to deadly dimensions, comes the wind. Wind so forceful that it wrenches measuring instruments off their mountings. Wind that pushed a nineteenth-century scientist back more than twenty times as he tried to crawl on hands and knees toward an observation hut atop an icy ridge. Wind that snatched away a twentieth-century meteorologist who became disoriented in a blizzard. He was staggering in near-zero visibility from one building to another nearby: his companions found his body weeks later, blown several miles away across the frozen surface.

Finally, the Arctic is a place of emptiness. In summer daylight with all its attendant colors, the open space is exhilarating. North country light brings forth — especially from photographers — descriptions rare in other settings: fabled, dazzling, unreal, biblical. In winter the darkness conceals the vistas but magnifies the emptiness. Every building, every rock, every snowbank assumes a grayish purple identity. Mercury-vapor lights dispel the gloom but enhance the ghostly color. Like stars come to earth, they perch atop tall poles — the only vertical features in the horizontal arctic landscape — and cast cones of blue-white light on the snow-swept scene below. One of the best descriptions of an arctic winter was penned by survivors of the Hall Expedition of 1871: "The face of the earth was in the last degree bleak and desolate."

Not everyone shares this grim view of northern winters though. Farley Mowat, who has a gift for description that transports you directly into the arctic scene, has written, "The northern people are happy when snow lies heavy on the land. They welcome the first snow in autumn, and often regret its passing in the spring. Snow is their friend. Without it they would have perished or — almost worse from their point of view — they would long since have been driven south to join us in our frenetic rush to wherever it is that we are bound."

Eskimos, Inuit, Greenlanders, Lapps, and all the northern peoples of Eurasia learned long ago that they can survive, and even prosper, in the arctic winter. They look forward to the coming of the cold, because it hardens the spongy earth and makes overland travel possible. After freeze-up the noxious clouds of mosquitoes no longer swarm about arms and faces. Light summer clothes made in Taiwan or Korea are discarded in favor of warm parkas made of caribou hide or trousers sewn with great skill from polar bear skin. Far from fearing the cold, the people of the Arctic are nourished by it. They thrive in the midst of ice and snow.

I write these words from the warmth of a temperate office. While I enjoy the changing colors of autumn, I know that in the treeless Arctic the rhythms of change are more intense but the colors are all variants of one: white. At the transmitting station that marked my introduction to the arctic world, the sun has already disappeared below the horizon. Its cheering rays won't be seen again for more than a hundred days. The huge Newfoundland dog lies curled beneath the building, wrapped in a deepening blanket of snow that shelters him from the icy blast of the polar winds.

"...the Arctic is a place of emptiness. In winter the darkness...magnifies the emptiness."

And in the gathering gloom, in the pack ice now frozen into solid sheets, there are bears. Hundreds of bears. Thousands of bears. Masters of darkness. White ghosts in the black night. No human, nothing in nature, challenges their supremacy: in the darkness of winter, the ice belongs to Nanook.

ABOUT THE AUTHOR

Charles T. "Chip" Feazel, a 1967 geology graduate of Ohio Wesleyan University, earned an M.A. from Johns Hopkins in 1969 and entered the U.S. Coast Guard, where he got his first taste of Arctic adventure while mapping glaciers in western Greenland in support of the International Ice Patrol. Following his military service, Feazel returned to Johns Hopkins for a Ph.D., and then joined Phillips Petroleum Company in 1975, where he performed and later supervised sedimentary research and was assigned to various exploration support groups. He currently directs development geology for Phillips' partner-operated offshore fields in the Gulf of Mexico. During a 1984 multi-company expedition to the Beaufort Sea north of Alaska, Feazel encountered polar bears as a daily hazard of scientific studies in the November icepack. Out of that experience — particularly the fear and uncertainty of knowing that a 1000-pound predator might be stalking geologists behind any ice ridge — and interviews with wildlife biologists, zookeepers, and Arctic veterans, he crafted his 1990 book, *White Bear: Encounters with the Master of the Arctic Ice* (Henry Holt & Co., $22.50).

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Caspian Sea, continued from page 18

are extremely shallow, everywhere less than 50m, owing to the heavy load of sediments contributed by the immense Volga, Ural, and Emba river drainage areas. A limited amount of seismic data has been acquired in areas exceeding 5m water depth. The Proterozoic basement is overlain by a thick sequence of Paleozoic-Mesozoic-Tertiary sediments, divided by a lower Permian salt. Onshore fields have large gas and condensate reserves in the pre-salt Carboniferous and Lower Permian anticlines and reef structures. The Permian salt is an effective seal over most of the surrounding area. The post-salt section is thought to be less prospective, but oil is produced from the Triassic and Cretaceous on the southeast.

Data Available

Professional Geophysics, Inc. (PGI) of Houston, representing the Caspian Sea authorities; Caspmorneftegeophyzrazvedka, Caspmorneft, Dagneft Production Association, Mangyshlakneft, and Chelekenneft, offers an extensive inventory of Caspian Sea seismic and well log data, and an Exploration Data Package to assist interested parties in the evaluation of the hydrocarbon potential of this vast inland sea. Some 36,000 km of seismic data and 37 well logs are immediately available at prices varying from US$30-$80/km, and US$1500-$4500/well, depending on the amount purchased and the depth of the wells. A set of shallow water seismic data from the northeast part of the sea is available at US$300/km. The Exploration Data Package, priced at US$40,000, includes seismic location and structure maps, a geologic and seismic cross section, 4 well velocity surveys, 6 regional seismic profiles, and 1600 km of seismic sections. The data covers areas of the Caspian Sea bordering on four Soviet Republics, Azerbaijan, Turkmenia, the Dagestan region of the Russian Republic, and western Kazakhstan.

For further details, contact:
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Geo-events continued from page 31

D. Wilson and J. McCartney, "United Salt Corp. Hockley Mine", Hockley, Texas, (two sessions 5:30 - 11:00 a.m. and 8:15 a.m. -1:30 p.m., Feb. 22.)
Rufus LeBlanc, "Recent Sediments of Southeast Texas", 7:30 a.m. - 6:00 p.m., Feb. 22.

GSA Short Courses, Rice University.
R. W. Bally, M. O. Withjack, K. E. Meisling and D. A. Fisher, "Geologic Interpretation of Seismic Profiles", Feb. 22-23.
J. E. Wright, P. Copeland and K. A. Hagerty, "Geochronology and Thermochronology", Feb. 23.

GSA Symposium, V. Sharpton, "Geology of Venus", Feb. 23.

HGS Environmental/Engineering Field Trip, Carl Norman & Saul Aronow, "Environmental/Engineering Geology in the Houston Metropolitan Area", 8:00 a.m. - 6:00 p.m., Feb. 23.

OTHER EVENTS

HGA Couples Party, "Valentine Dinner Dance", Lakeside Country Club, Feb. 14.

GSH Mardi Gras Party, Guest Quarters, 7:30-11:30 p.m., Feb. 15.

GSA South-Central Section, continued from page 17

the Eurasian and the African plate. The pre-Late Eocene basins typically lack evidence of a southern margin, which was obviously reworked, eroded, deeply buried under thrusts or metamorphosed(?).

The folds and thrusts with north vergence and a general E-W trend formed during the orogenic stages are oblique to the earlier extension and sedimentary paleoenvironments; it is very well expressed for the Early Jurassic-Early Cretaceous basin.

STRUCTURAL PROFILES OF THE WESTERN BALKAN—FOREBALKAN REGION, BULGARIA

EMERY, Martin, Maxus Energy Corporation, 717 N. Harwood St., Dallas, TX 75201

The Balkan Mountains and Fore-Balkan foothills of Bulgaria bisect the country laterally, separating the Moesian Platform in the north from the Srednagorian Plain and Rhodope Mountains in southern Bulgaria. The Balkan-Fore-Balkan thrust and fold belt evolved from a basin which begin with early Triassic intracratonic rifting. The basin was contracted by multiphase compression that propagated the Balkan-Fore-Balkan fold and thrust belt northward onto the southern edge of the Moesian Platform during the early Cretaceous (Aptian-Austrian phase), Paleocene (Laramian phase), and middle Eocene (Illyrian phase).

Two balanced cross sections of the western part of the Balkan-Fore-Balkan province of Bulgaria presented here illustrate the regional thrust-fold belt style of deformation. Well, seismic, and surface mapping data were used in construction of the cross sections. The Balkan-Fore-Balkan belt displays a narrow and thin foredeep. The foredeep sediments are involved in the external structuring of the belt. The northern limit of foreland deformation approximates the southern edge of shelf sediments of the stable Moesian Platform. North vergence of asymmetric anticlines and thrusts predominates but local backthrusts are inferred at Teteven Anticlinorium. Folded thrusts are indicated by the data. Illyrian phase compression often includes out-of-sequence thrusting and reactivation of pre-existing faults. Angular unconformities between stratigraphic units locally constrain the timing of deformation and can be projected along strike.

Palinspastic reconstruction of the cross sections provide a perception of the precursor basin. Previous investigations have implied that inversion of basin-forming normal faults was the predominate structural mechanism in the Balkan-Fore-Balkan region. However, the available data suggest low-angle thrust faulting is the prevalent style of deformation. Total shortening is estimated to be 25-40%.

STRUCTURAL ANALYSIS OF THE DINARIDE THRUST BELT, YUGOSLAVIA

WEIR, G. M., TASKER, D. R., and DALE, R. C., Amoco Production Company, Houston, Texas

The Dinaride thrust belt is divided into three major tectonic units defined by changes in stratigraphy, structural style and timing of deformation. Compressional shortening began as early as the Late Jurassic in the Internal Dinarides, a unit composed of several zones of Paleozoic metamorphics and Mesozoic ophiolites. A Mesozoic carbonate platform forms the core of the Central and External Dinarides, which are distinguished by distinct differences in structural style and timing of deformation. The Central Dinarides are characterized by at least two phases of deformation. Late Jurassic and Cretaceous unconformities suggest structural uplift prior to the onset of thrusting which began in the late Eocene. Deformation involves Paleozoic basement and includes a major decollement within a Late Permian-Early Triassic clastic and evaporite unit. Thrusting within the External Dinarides is restricted to Middle Triassic and younger age units, with decollements occurring within the Middle Triassic and Late Jurassic. The latter detachment occurs within the confines of an evaporite basin, whose importance has been largely ignored in previous structural interpretations.

GEOLOGY AND HYDROCARBONS OF THE ALBANIDES

SADEKAJ, I., BAKIA, H., CURI, P., Oil and Gas Geological Institute, Fier, Albania; BALLY, A. W., Department of Geology & Geophysics, Rice University, Houston, Texas USA

Albania offers a classical section across a folded belt. The Apulian platform (Sazani zone) with its Mesozoic platform carbonates form the foreland. Proceeding towards the east, the Ionian zone with its basinal Mesozoic-Paleogene sequence and a thick Neogene foredeep sequence was deformed during the Middle to late Miocene and the Pliocene. The main decollement level is at the base of the Upper Triassic evaporites. The Ionian zone is the center of the oil production of southern Albania. Much of the production is from structures involving Neogene clastics with minor production from Mesozoic carbonate reservoirs. Source beds in the Ionian zone occur in the Triassic, the Jurassic and the Cretaceous.

Farther east, the Kruja zone involves Cretaceous platform carbonates. Where folded during the Middle Oligocene, the Kruja zone is overlain by the complex west-vergent flysch nappes of the Krasta-Kucali zone. The flysch nappes extend underneath the great allochthonous lower Mesozoic ophiolite complexes of the Mirdita zone. The ophiolites were emplaced during the Upper Crateceous. Finally, the Korab zone to the east appears also to be underlying the great Mirdita complex. It consists of Paleozoic (Silurian-Permian) schists and carbonates, overlain by Permo-Triassic redbeds and evaporites, and Mesozoic carbonates. The Korab units may envelope part of the Mirdita ophiolites.

THE EXPRESSION OF CONVERGENCE RATE AND SLAB PULL IN FORELAND BASINS

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Cenozoic orogenic belts of the Mediterranean region display different structural and morphological characteristics that are predominantly controlled by the dynamic environment in which each belt evolved. Belts that formed in environments dominated by convergence due to external plate motions generally have high topography, marginal thrust belts consisting of shallow water passive margin sediments and molasse, cores of high-grade metamorphic rocks, significant involvement of crystalline basement, extensive post-collisional convergence, and commonly develop antithetic thrust belts. Those belts that form in environments dominated by slab pull generally have low topography, marginal thrust belts dominated by flysch, low-grade metamorphism, lack significant involvement of continental crystalline basement, lack antithetic thrust belts, lack significant post-collisional convergence, and commonly display extensional deformation in the back-arc to inter-arc region. The forces operating in these two different dynamic settings are clearly expressed in the deflection of the foreland lithosphere adjacent to the thrust belts. In settings where deformation is driven by large-scale plate convergence and where plate convergence is occurring more rapidly than subduction, flexural bending of the foreland lithosphere occurs primarily in response to loading of the lithosphere by thrust sheets; the depth and geometry of these foreland basins are roughly consistent with the size of the adjacent mountain belt. In settings where deformation is driven by forces acting on the subducted slab (probably largely related to the negative buoyancy of the subducted slab) and subduction is occurring more rapidly than large-scale plate convergence, flexural bending of the foreland lithosphere occurs primarily in response to forces transmitted to the foreland from the subduction zone. In these settings loading of the foreland lithosphere by thrust sheets contributes to the loading of the foreland in only a minor way (or in some cases not at all) and the foreland basin is typically much deeper and sits much farther in front of the adjacent mountain belt than would be expected from the size of the mountain belt itself. The systematic pairing of topographically high mountains with relatively shallow foreland basins in tectonic settings dominated by large-scale plate convergence is conducive to the protracted history of molasse deposition observed in these belts, as sufficient material is usually available to keep the foreland basins filled with coarse clastic material. In contrast, the systematic pairing of topographically low mountains with relatively deep foreland basins in tectonic settings dominated by slab-pull is conducive to the protracted history of flysch deposition observed in these belts, as the sediment source is commonly insufficient to fill the adjacent foreland basin, resulting in deposition of predominantly fine-grained material in deep water conditions via submarine fan development. The Late Paleozoic Ouachita thrust belt of the south-central US, and its associated foreland basin, displays most if not all of the characteristics of more recent thrust belts that formed in an evnironment dominated by slab pull.

MARATHON-SOLITARIO OROGEN, TRANS-PECOS TEXAS

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The Ouachita orogen extends NE across southern Trans-Pecos Texas and is exposed in the Marathon basin, the Solitario, and smaller outcrops near Persimmon Gap, Big Bend National Park at the NE end, the subsurface continuation is offset 250 km to the SE along what probably marks a transform margin during the Iapetus opening that was reactivated during the Ouachita closing.

The fold/thrust belt in the Marathon basin is divisible into structural belts from NW to SE and internally into lower, middle and upper Paleozoic structural/stratigraphic packages separated by major shale units that acted as decollement zones. The thin lower package forms isoclinal folds. The thicker middle package forms asymmetrical folds in the NW outcrop belt and a spectacular tightly folded duplex framing the Dagger Flat Anticlinorium (DFA) with a shortening of 6.2:1. Farther south the middle package is involved in imbricate thrust slices with no cut-off lines so shortening estimates are not possible. The thinness of competent units and the numerous shale interbeds cause the usual flat/ramp geometry of thrust belts to be complicated by later folding or to allow folding between flats. Minimum overall shortening of the middle package is estimated to be 4:1. The thick upper package of foreland basin fill forms large, tight synclines with thrusts cutting through the anticlinal crests. Shortening in this package is less than 2:1.

Along strike, 35 miles to the SW, the Solitario, a 5-mi diameter uplift over a laccocaldera exposes structures of DFA style: lower package is in isoclinal folds with vertical stretching of about 2:1; the middle package shows folded thrusts, imbricate thrusts and a homocline of upper package rocks that marks the transition between DFA and southern domain style as seen in the Marathon basin.

Low-grade graphitic phyllites and metaquartzites of the interior zone are known only from two wells and one outcrop across the Rio Grande near the southeastern edge of Big Bend National Park.

THE APPALACHIAN-OUACHITA OROGEN, SOUTHEASTERN NORTH AMERICA

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The late Paleozoic Appalachian-Ouachita orogenic belt is exposed in the Appalachian and Ouachita Mountains, but large parts are covered by post-orogenic strata of the Gulf Coastal Plain. Large, sinuous curves of the orogenic belt (Alabama recess, Ouachita salient) mimic the shape of a late Precambrian-Cambrian rifted margin, along which the Alabama promontory and Ouachita embayment were framed by northeast-striking rift segments offset by a northwest-striking transform fault. Stratigraphy of the Appalachian-Ouachita foreland, as well as the Appalachian thrust belt in the Alabama recess, includes a Cambrian to Lower Mississippian shallow-marine, passive margin shelf succession and an Upper Mississippian and Pennsylvanian shallow-marine to deltaic, synorogenic clastic wedge derived from the Ouachita orogen. The Appalachian thrust belt consists of large-scale internally coherent thrust sheets, the structural style of which is controlled by a thick unit of Cambrian-Ordovician carbonate rocks of the passive-margin succession. In contrast, the Ouachita thrust belt consists of deep-water facies that record a Cambrian to Early Mississippian passive margin and a Late Mississippian to Pennsylvanian arc-continent collision orogen. Internally complex thrust sheets and disharmonic structures in the Ouachitas contrast with Appalachian structures, reflecting the lack of a stiff layer like that in the Appalachians. A north-to-south profile of the Ouachita orogen includes (1) a peripheral foreland basin, the southern part of which is deformed by north-directed thrust faults; (2) a subduction complex, including a forearc ridge; (3) a thrust-imbricated forearc basin, which has a late orogenic to post-orogenic fill of Desmoinesian to Permian age; and (4) remnants of an arc. Diachronous arc-continent collision began on the east in the Middle Mississippian and progressed westward to close a remnant ocean basin in the Ouachita embayment by Desmoinesian time. The subduction complex was emplaced over autochthonous passive-margin cover on North American continental crust. Northwest-directed Appalachian thrusting post-dated Ouachita thrusting, dismembered the southeastern part of the Ouachita foreland basin, and overrode the eastern part of the Ouachita thrust belt. A northwest-to-southeast profile of the Appalachian orogen includes (1) thrust-imbricated, passive-margin shelf facies and synorogenic clastic rocks of the Ouachita foreland basin; (2) accreted metamorphic terranes that tetonically replaced the passive-margin cover strata on North American continental crust; and (3) African crust and cover accreted to North America.

SOUTHERLY VERGENCE ASSOCIATED WITH NORTHERLY DIRECTED THRUSTS OF THE OUACHITA MOUNTAINS OF OKLAHOMA

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Regional stratigraphy, structure, and geophysical surveys outline large-scale northerly directed thrusts characterizing the late Carboniferous deformation of the Ouachita Mountains in Oklahoma. Yet within the oldest rocks of the Broken Bow uplift southerly verging structures dominate. The Broken Bow uplift has been subdivided into four structural domains: Hochatown Dome, Carter Mountain anticlinorium, Linson Creek synclinorium, and Cross Mountain anticlinorium. Detailed mapping indicates a history of progressive deformation in which four phases have been described. The earliest folds are tight, overturned, southerly verging and associated with a well-developed slaty cleavage. These folds are documented as far north as the Linson Creek synclinorium. Second generation folds are best preserved in the southern part of the uplift where the folded slaty cleavage is apparent. These folds are coaxial with the first generation, are open to tight, are inclined revealing southerly vergence. Faults are also associated with the second generation folds. In the south these faults dip toward the north and in the north they dip towards the south, forming a fan like distribution. Third phase structures are interpreted to be related to flattening of the succession, producing recumbent buckles, pencil structures, and a rough cleavage. The fourth phase is associated with a crenulation cleavage development and a family of open, nearly upright northeast-trending folds. A model involving initial basin shortening is proposed to explain the first generation folds. Subsequent detachment and translation of this deformed sequence is believed to have produced the second and third generation structures. The structural fan is interpreted to be associated with the emplacement of the Boktukola fault to the north and consequently associated with the regional northerly directed thrusting.

THE GEODYNAMIC MODEL OF THE DOUBLE BENDED CARPATHIAN-BALKAN ALPINE CHAIN

SANDULESCU, Mircea, Institute of Geology and Geophysics, Bucarest, Romania

The Carpathian-Balkan area is a Cretaceous-Tertiary folded belt incorporating: (1) in the Carpathian realm, the Main Tethyan Suture and both its European and Preapulian strongly deformed continental margins, while (2) the Balkan and Rhodope consist mostly of units belonging to the European deformed margin.

The Triassic and Jurassic periods were dominated by spreading (the Neotethys) and extension (rifts within the passive continental margins) processes. In that same time, a peculiar chain developed within the Carpathian-Balkan foreland: the North Dobrogea-Crimean Cimmerides.

Several compressional moments lead to the actual structure and shape of the chain. For the inner parts there are the mid-Cretaceous, intro-Turonian and end-Cretaceous deformations; for the outer ones, the end-Eocene (in the Balkan) and lower-middle Miocene (in the Carpathians).

Important crustal shortening occurred in the Carpathian-Balkan realm due to subduction of oceanic and/or thinned continental crust as well as imbricated continental crust shearing.

The double bended shape of the folded area is the result of differential (in time and amount) driftings of foreland sectors as well as of Preapulian continental bloc. Transcurrent and tear faulting accompanied and facilitated these events.

A POSSIBLE DELAMINATION ORIGIN FOR HINTERLAND BASINS TO THE RIF-BETIC CORDILLERA AND CARPATHIANS

MORLEY, Christopher K., Amoco Production Co., Houston, TX 77253-3092

The hinterland basins of the Rif-Betic cordillera (Western Alboran Sea) and the Carpathians (Pannonian Basin) are in part composed of a thick (in excess of 3-4 km) thermal sag basin sequence. The underlying crust has been thinned to 25 km in parts of the Pannonian Basin and to 15 km in parts of the Alboran Sea. Modern tectonic models for these areas envision tectonic collision and thickening of the crust followed by gravitational collapse and crustal thinning by extension contemporaneous with thrusting. Basin and Range-type extension has been envisioned for parts of these extensional collapse systems. While such features may exist locally, they do not fit the structural style of the entire region and fail to explain the great thickness of the sag basins, and details of the timing and geometry of structures within the basins and the thrust belts. Consequently, it is suggested that delamination of the mantle lithosphere and perhaps parts of the lower crust by subduction roll-back is an important factor in the evolution of these basins. Roll-back of the mantle lithosphere permits hot asthenopheric mantle to upwell and lie close to the base of the crust. Initially, uplift and erosion of the crust overlying the asthenosphere occurs. As the thermal perturbation cools, the crust thermally subsides to produce a large sag basin.

HYDROCARBON POTENTIAL OF THE WEST CARPATHIAN THRUST BELT AND THE UNDERLYING EUROPEAN PLATFORM, CZECHOSLOVAKIA

PICHA, Frank J., Chevron Overseas Petroleum, San Ramon, CA 94583-0946, USA; STRANIK, Z., MENCIK, E., and MULLER, P., Geological Survey, 65869 Brno, Czechoslovakia

Oil was first discovered in what is now Czechoslovakia in 1914. Most of the production to date has come from the Neogene Vienna basin. During the past few decades, exploration has expanded into more complex terrains. Of these, the broad suture zone between the North European platform and the West Carpathian thrust belt has proven to be the most promising.

The external zone of the Carpathians is represented by highly deformed Jurassic to Lower Miocene flysch deposits thrust over a relatively shallow Neogene foredeep. Based upon drilling estimates and reflection seismic data, the length of the overthrusting ranges from 10 to 50 km, but the actual shortening is probably much larger. The Carpathian flysch belt is a thin-skinned thrust belt consisting of several rootless tectonostratigraphic units. Superimposed on the Carpathian belt is the successor Vienna basin of Neogene age.

Buried below the allochthonous flysch belt and the Neogene foredeep are various formations of the European platform. These include Paleogene, Cretaceous, and Jurassic sequences of the Tethyan margins; Variscan-consolidated Carboniferous and Devonian carbonate and clastic deposits; and the Cadomian crystalline basement.

The structure of the European platform is complex. It involves Late Paleozoic Variscan compression, Jurassic rift-related extension and Late Cretaceous/Early Paleogene Laramide uplifting. Some of the anticlinal features evident in the deeper part of the platform may have formed during the Alpine orogeny. These structures may represent a deeper structural level of the Carpathian belt which evolved below the thin-skinned structure.

Sedimentary sequences of the European platform represent the main exploration target in the region. Several oil and gas fields have been found in the shallower part of the platform down to depths of 3 km. Reservoirs consist of Neogene and Paleogene clastics, Devonian carbonates, and the weathered surface of the crystalline basement. Organic-rich source rocks are present in Neogene, Paleogene, Jurassic and Devonian sequences.

The deeper part of the platform has been little explored. Regional seismic sections show a continuation of sedimentary sequences of the platform down to 10 km below the Carpathian thrust belt.

TERTIARY KINEMATICS OF THE INTRA-CARPATHIAN AREA

CSONTOS, Laszlo, NAGYMAROSY, Andras, HORVATH, Ferenc, Eotvos University, 1088 Budapest, Muzeum korut 4/A, Hungary, KOVAC, Michal, Slovakian Academy of Sciences, 81473 Bratislava, Czech and Slovakian Republics, TARI, Gabor, Rice University, Houston, Texas 77251-1892, USA.

The extensional Pannonian basin of the intra-Carpathian area formed synchronously with the compression along the Carpathian loop during the Neogene (middle to late Miocene). Recent reconstructions of the original position of flysch nappes in the Western Carpathians indicate that the magnitude of shortening in this thrust-fold belt is much higher than it was previously thought. Based on this estimate we restored the pre-Neogene geometry of the intra-Carpathian area. The resulting kinematic picture assumes significant strike-slip and extensional displacements on major transtensional structural features in the Pannonian basin.

The Neogene back-arc basin is superimposed on a set of dissected Paleogene (middle Eocene to lowermost Miocene) basins of apparently different origin. Indeed, these basins do not form a single basin in the reconstructed middle Miocene kinematic picture. The same holds for Mesozoic facies successions showing a peculiar inverted paleogeography. This controversy can be resolved by a further step in the kinematic reconstruction, namely by a late Oligocene-early Miocene episode of eastward directed continental escape of the present-day northwestern part of the Pannonian basin from the Alpine realm. The escaping unit was bordered by the Pieniny Klippen Belt in the north and the Mid-Hungarian Line in the south. The latter shear zone has accommodated roughly 400 km of right-lateral displacement, using the offset between the Paleogene basins of Hungary and Slovenia, as kinematic markers. In the restored pre-escape kinematic picture, the Paleogene basins of the intra-Carpathian area line up in a single basin and the Mesozoic facies distribution also ends up in a consistent pattern.

COMPARISON OF THE OUACHITA AND CARPATHIAN THRUST-FOLD BELTS AND THEIR BACK-ARC BASINS: GULF OF MEXICO AND PANNONIAN BASIN

TARI, Gabor, PEREZ-CRUZ, Guillermo, BALLY, Albert, W., Department of Geology and Geophysics, Rice University, Houston, Texas 77251-1892.

The Late Paleozoic Ouachita orogenic belt is a north-vergent thrust-fold belt, related to a A-type subduction of the passive margin of North America. The thin-skinned Ouachitas and their deep foredeep basins were formed during this southward directed subduction. Synchronously with compression in the thrust-fold belt, thick Pennsylvanian to Permian marine sediments were deposited to the south of the Ouachita belt, in the Paleozoic Gulf of Mexico. Although this sedimentary succession typically lacks apparent extensional features, its position on the concave side of an orogen associated with A-subduction points to its back-arc origin. The Pannonian basin of Hungary provides a well-documented analogy for this specific basin setting.

The Pannonian basin of Central Europe is one of the Mediterranean, extensional back-arc basins, characterized distinctly by attenuated continental crust. Very thick (locally >8 km) sedimentary successions formed during the syn-rift (middle Miocene) and post-rift (late Miocene to Recent) period. The style and magnitude of extension is well documented based on reflection seismic and well log data. The loop of the Carpathians surrounds the Pannonian basin and forms a continuous, thin-skinned thrust-fold belt which is coeval with the extension on its concave side. The Neogene evolution of the Carpathians is dominated by the formation of thick flysch nappes toward the foreland and a deep foredeep basin.

Beyond these broad similarities between these thrust-fold belt and back-arc basin couples (Ouachita-Gulf of Mexico and the Carpathians-Pannonian basin, respectively), other specific details, such as foreland basement promontories of comparable size and kinematic role, such as the Llano Uplift and the Bohemian Massif make this comparison even more viable.

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Superfund Status continued from page 27

LIFT Endowment has withdrawn its letter of intent to apply for a Technical Assistance Grant (TAG). For information on the $50,000 grant available to a citizens group, please call (214) 655-6715 or 1-800-533-3508.

SIKES DISPOSAL PITS

Location: Harris County; 2 miles southwest of Crosby

National Priorities Listing History: Proposed Date: 10/23/81; Final Date: 09/08/83

Current Project Phase: Remedial Design

Contacts: Alan Etherage, TWC, at (512) 463-0729; or Earl Hendrick, EPA, at (214) 655-6715

Information Available at: Crosby Library

Sikes Disposal Pits accepted chemical wastes from area petrochemical companies. TWC signed a construction contract on July 27, 1990, and field activities started in early fall 1990. Incineration of the estimated 215,000 cubic yards of waste is expected to begin in 1992 and be completed in 1996.

The Barrett-Crosby Civic League submitted an application for a technical assistance grant on March 11, 1991. Please call (214) 655-6715 or 1-800-533-3508 for information.

SOUTH CAVALCADE STREET

Also Known As: Koppers Co., Inc.

Location: Harris County; 2 miles southwest of intersection of Loop 610 North and U.S. Hwy. 59 in northeast Houston

National Priorities Listing History: Proposed Date: 10/15/84; Final Date: 06/10/86

Current Project Phase: Remedial Design

Contacts: Mark Fite, EPA, at (214) 655-6715

Information Available at: Houston Central Library

This facility is a 66-acre site currently used by three trucking firms. Previously, the property was used as a wood treating facility which caused surface and ground water contamination. The contaminants, which include creosote compounds and heavy metals will be removed by soil washing and *in situ* soil flushing methods. The ground water will be pumped to the surface and cleansed by carbon adsorption and filtration. Negotiations with the Potentially Responsible Parties (PRPs) were successfully completed in June 1990. The Consent Decree requires the PRPs to design and implement the remedy in a timely manner, to operate and maintain remedial facilities for 30 years, and to reimburse EPA for the past response costs and future oversight costs. The public comment period on the Proposed Consent Decree ended on September 28, 1990, during which no comments were received. The PRPs are currently preparing workplans for conducting pilot studies of the Remedial Design.

LIFT Endowment has withdrawn its letter of intent to apply for a Technical Assistance Grant (TAG). For information on the $50,000 grant available to a citizens group, please call (214) 655-6715 or 1-800-533-3508.

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EXPLORATION ACTIVITY REVIEW

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

National Rig Count: December 14—802; Year Ago—1,179
Gulf of Mexico Rig Count: 98

GULF COAST

Texas

Murphy H. Baxter will drill a 5200′ **Yegua/Cook Mountain** wildcat about midway between the old Jackson-productive Salinas and Sixto fields in west-central **Starr** County. The #1 Guerra is several miles east and southeast of nearest Yegua production, and about 8 ½ miles southwest of the closest good Cook Mountain control at San Roman and San Roman West fields (Jackson and Yegua production) where the lower Yegua and Cook Mountain sections consist of massive sands grading downward to thin sands underlain by predominantly shale. Yegua structure at the new location is regional east dip with local nosing.

In southeastern **Starr** County, Great Western Onshore has staked its #1 Vela about a mile southeast of the small, Frio-productive Garcia West Field. The 12,500′ wildcat, which should reach the **Queen City,** is located in a narrow zone along the Vicksburg flexure between primarily Jackson/Yegua production (updip) and predominantly Frio/Vicksburg production (downdip). Nearest Queen City production is about 18 miles northwest. At the Yegua horizon the wildcat spots on the distal southeast flank of a subtle east plunging nose, upthrown to the first major growth fault of the Vicksburg flexure.

Sandia Energy will evaluate the **Olmos** at its #1 Vivion, a projected 6200′ wildcat 3 ¼ miles east of Olmos production at Shepard Field in east-central **Dimmit** County. The dry Belco #1 Coffield, 2 ½ miles north, logged several Olmos sands between 4700-5050′. At the top Olmos horizon the new venture spots on southeast dip, approximately 300′ low to Shepard and Shepard North fields.

Farther southeast, in extreme southern **LaSalle** County, Petroleum Management has opened River Run Field at its #1 Alexander & State, a new **Wilcox** gas discovery 4 miles east of the operator's Riva Ridge Field (lower Wilcox gas), discovered in October 1990. Flow rate was 686 MCFGPD and 4 BCPD through perfs 5239-52′. Lower Wilcox structure here appears to be regional southeast dip.

A 12,000′ **Frio/Vicksburg** test is scheduled for southern **Aransas** County 1 ½ miles southeast of the recently completed discovery for McCampbell North Field (Frio). The Wagner & Brown #1 Bishop will evaluate the Frio, productive in the large, nearby McCampbell Field, and may test the upper Vicksburg, not presently productive in the area. Several deep Frio sands were logged in a pair of 11,000′+ dry holes a mile north and south of the new venture. At the middle Frio horizon the wildcat spots on fairly steep west dip, upthrown to a large regional down-to-the-coast fault.

Anadarko Petroleum will drill an 11,500′ **Yegua** test about midway between Frio-productive Arroyo Rojo and Ganado East fields in eastern **Jackson** County. The #1-A Knudsen is about a mile south of an 11,240′ dry hole (Energy Development #1 Smith) which logged several thin Yegua sands between 10,250-810′. Nearest Yegua production is at Black Owl Field, 9 miles northeast in adjoining Wharton County. At the Vicksburg horizon the wildcat spots on irregular southeast dip, upthrown to a down-to-the-basin fault.

A 16,000′ **Wilcox** test has been scheduled by Gus Edwards in extreme northern **Harris** County, ½ mile northeast of Yegua oil production at Indian Hills Field. The #1 Bartle is 2 ¾ miles north of the 14,015′ Enserch #1 Boone which tested a small amount of gas from Wilcox perfs at 10,856-870′ before abandonment. At the top Wilcox horizon the new venture spots on the distal northeast flank of a small structural closure bounded on the north and south by regional down-to-the-coast faults.

Farther southeast, in east-central **Harris** County, McGuire Oil has staked a 9700′ **Cook Mountain** wildcat, the #2 Dooley, 1 ½ miles west of Yegua gas production at Victor Blanco and Victor Blanco West fields. The discovery well for Victor Blanco Field (Houston Oil Co. of Texas #1 Swilley) flowed 45 BOPD through Yegua perfs 8130-40′, and 11,000 MCFGPD from 8244-47′. At the Cook Mountain horizon the new test spots on local southwest dip near the interpreted western terminus of the small down-to-the-coast fault responsible for entrapment at Victor Blanco Field.

South Louisiana

Hallwood Petroleum will drill a 15,000′ directional wildcat, the #1 Arnould, to the ***Bol mex V* (middle Frio)** one mile southeast of Scott Field in central **Lafayette** Parish. Production in the nearby fields of Scott, Judice and North Maurice has come predominantly from *Bol mex*, *Marg tex* and *Cam A* sands. At the *Marg tex* horizon the new test spots on southeast dip upthrown to a local down-to-the-south fault, but more complex structure is anticipated at the deeper *Bol mex* level.

In western **Terrebonne** Parish, Great River Oil & Gas has scheduled a directional **upper Middle Miocene** test 1 ¼ miles east of Upper and Middle Miocene production at Bayou Penchant Field. The #1 Continental Land & Fur, projected to 12,057′ MD (11,500′ TVD), should evaluate some of the *Big 2/Cib carstensi* section. At the *Big 2* horizon the wildcat spots on local south dip, immediately downthrown to the northern of the two main east-west faults traversing Bayou Penchant Field.

SEQUENCE STRATIGRAPHIC GRID
(DIP & STRIKE SECTIONS)
OFFSHORE GULF OF MEXICO

PHASE II

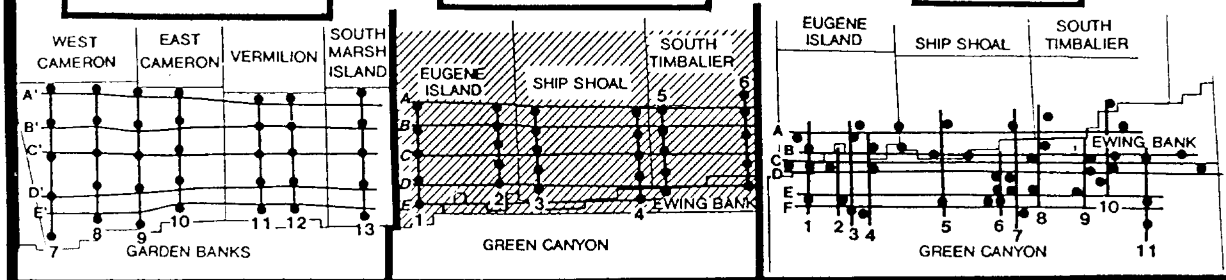
In Progress
$15,900 per dip line
$15,900 per strike line
$24,900 for dip & strike line

PHASE I

Completed
$17,900 per dip line
$17,900 per strike line
$24,900 for dip & strike line

PHASE III

In Progress
$3,500 per well



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For further information, please contact:

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Sequence Stratigraphy Analysis
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WELL LOG SEISMIC SEQUENCE STRATIGRAPHY COURSE

Peter R. Vail, Ph.D., Maurice Ewing Chair, Rice University
Walter W. Wornardt, Ph.D., Adjunct Prof., Rice Univ.; President, MICRO-STRAT INC.

Friday & Saturday, March 13-14, 1992   8:00 am to 12:00 1:00-5:00 pm
Mariott Hotel, 1750 West Loop South 77027 713-960-0111

Course Description:
- Identification of sequence boundaries, system tracts, condensed sections, geologic age, paleoenvironments, etc. on well logs from Gulf of Mexico data sets.
- Utility of high resolution micropaleontology in the determination of geologic age, paleoenvironments, condensed sections, system tracts, etc.
- Interpretation of paleoenvironments and lithofacies from well log patterns.
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Price: $445.00 (Includes refreshments, three well-log data packages and 320 page course note book.)
The course will be limited to 50 participants from oil companies and independent geological and geophysical consultants.

A portion of your registration fee will be donated to the Rice University Sequence Stratigraphy and Micropaleontology Research Fund.

For additional information, or to register, contact: MICRO-STRAT INC., 5755 Bonhomme, Suite 406 Houston, TX 77036, (713) 977-2120

Energy Development Corp. has staked a 12,500′ wildcat in extreme western **Jefferson** Parish, about two miles northeast of Middle Miocene production at Little Temple Field in adjoining LaFourche Parish. The #1 SL 14024 is about 3000′ east of a pair of dry Miocene tests, the Woods #1 and #2 Bricker (TD 12,001′ and 11,419′). At the *Tex W* horizon the new venture spots on southeast dip, upthrown to the down-to-the-south fault bisecting Little Temple Field.

Farther southeast, in central Plaquemines Parish, Louisiana Land & Exploration will drill the #1 Johnson one mile west of Potash Field. The projected 15,000′ TD should be sufficient to penetrate the **upper Middle Miocene.** *Tex W-Big 2* sands in the upper Middle Miocene account for most of the production in the area. At the *Big 2* horizon the wildcat spots on the distal southwest flank of the Potash salt dome.

MESOZOIC TREND

East Texas

Marinex Exploration will drill a 7000′ **Smackover** wildcat in northern **Limestone** County, 3 ½ miles southwest of Woodbine production at Christmas Creek Field. The #1 Woolverton is about 3 ¼ miles northeast of the Wrather (Miller) #1 Rogers, a 6173′ dry hole which recovered slight gas odor in Smackover cores at 5953-58′. A subsequent DST yielded only mud. Top Smackover structure here is regional east dip into the Mexia-Talco fault system.

Pegasus Energy is drilling below 6000′ at its #1 Newsome, a 9500′ **Travis Peak** test 5 miles north of James production at Aventura Ranch Field in southern **Van Zandt** County. The new wildcat is one mile southwest of a 14,030′ Smackover dry hole (Inexco #1 Strange, *et al)* which tested an unspecified interval with undisclosed results. Structure at the base Massive Anhydrite is regional east dip with subtle local nosing.

In south-central **Smith** County, C W Resources has staked four wildcat locations on the north flank of the Bullard salt dome.The #1 Jackson is located high on the northwest flank and the #1 Reames high on the northeast flank, while the #1 Broad and #1 Loftin spot lower on the northwest and north flanks, respectively. All are projected to 16,000′ TD. This is the first attempt in several years to drill a deep test around Bullard Dome, and there are currently no known commercial shows in the shallower tests drilled around the dome. Nearest success is approximately 4 ½ miles north on the west flank of Whitehouse Dome, where Wisenbaker recently completed a Glen Rose discovery (28 BOPD and 7,145 MCFGPD from 8110-8257′).

South Arkansas

Goldsberry Operating will drill a 7000′ **Rodessa** wildcat in extreme southeastern **Miller** County, 3 miles northwest of Gloyd Lime and Hill Sand production at West Bradley Field. The #1 Harrington will primarily target the Jeter, a porous limestone within the Lower Anhydrite Stringer in this area, which is well developed and oil productive at Kelly Bayou Field, 3 ½ miles southwest. Structure at the base Massive Anhydrite is gentle, irregular northwest dip.

Farther east, in western **Columbia** County, Jack T. Everett has scheduled a 9500′ **Smackover** wildcat about 1 ¾ miles southeast of Rodessa, Cotton Valley and Smackover production at McKamie-Patton Field. The #1 Hodnett-Layman Heirs is about 4000′ east of the dry Atlas #1 Longino (TD 9313′) which recovered 570′ of salty sulfur water on a DST in the upper Smackover. At the top Smackover horizon the new venture spots on the east flank of a small structural closure on the southeast flank of the large McKamie-Patton anticline.

Mississippi - Alabama

Howell Petroleum is drilling below 9000′ at the #1 Paramount-Ducksworth, a 15,800′ **Cotton Valley** test about 3 miles northwest of the large, multipay Soso Field in southeastern **Smith** County. About 3000′ south of the new wildcat the Pruet & Hughes #1 Taylorsville Unit, an 18,778′ dry hole, recovered 150′ of gas and oil an a DST in the Cotton Valley at 15,519-554′. Subsequent testing proved noncommercial. At the base Massive Anhydrite horizon the new test spots near the crest of a broad nonproductive structure upthrown to a regional fault system.

In **Escambia** County, Alabama, Fina Oil & Chemical has completed the #1 ATIC 15-1 as a new **Smackover** oil discovery 1 ½ miles west of Smackover oil production at Wallace Field. Flow rate was 144 BOPD and 24 MCFGPD through perfs 13,400-417′. At the top Smackover horizon the discovery appears to spot on regional southwest dip, but is probably situated on a pre-Jurassic basement high, similar to other Smackover fields in the area.

INTERNATIONAL HIGHLIGHTS

Provided by PETROCONSULTANTS, Foreign Scouting Division, Geneva, Switzerland

LATIN AMERICA

Argentina

San Jorge has discovered more oil on its Huantraico Block in the **Neuquen Basin.** Testing at wildcat Chinquin Trapial x-1 produced a maximum of 818 BOPD from the **Troncoso** Member **(Neocomian),** while completion operations were under way at wildcat Punon Trapial x-1 after recovering 553 BOPD (37° API) from the **Upper Agrio** Member **(Barremian).**

Bolivia

Mobil has made the first oil discovery in the **Madre de Dios Basin** at its wildcat Pando 1, originally operated by Occidental. Two drill stem tests at 1266-69m (4154-64′) and 1224-27m (4016-26′) in the **Upper Devonian Tomachi** Formation recovered undisclosed amounts of 34° API oil and associated gas.

Colombia

Recent information indicates that Lasmo's Purificacion 1, located in the Espinal Block in the eastern sector of the **Giradot Sub-basin** of the **Upper Magdalena Basin,** is a significant oil discovery. The 6427′ wildcat flowed an aggregate in excess of 2,500 BOPD (32° API) from two separate zones in **Upper Cretaceous** sandstones reported as the '**Guadalupe** Formation'. The Lasmo-Sun partnership is planning to test a larger structure in the Espinal Block with their Venganza 1 wildcat before beginning appraisal drilling on the Purificacion structure.

Ecuador

Oryx's horizontal well Gacela 1, located in **Napo Basin** Block 7 about 3 miles west of the Coca Field, is an oil discovery. Production tests yielded 1,000 BOPD on natural flow, while further testing with a down-hole jet pump increased the flow rate to 2,500 BOPD. The wildcat was drilled to the Barremian Hollin Formation and encountered four hydrocarbon-bearing zones, reportedly with a net thickness of 121′, most of which was in the **Hollin** Formation. This is Ecuador's first horizontal well and the company's first exploratory test in Napo Basin Block 7.

Peru

In October, Mobil spudded wildcat Ponasillo 1 in Block 30, the first well on its **Huallaga Basin** acreage. Planned TD is 5000m (16,405′) to test a series of **Aptian** to **Campanian** sandstones in the Ponasillo North anticline.

EUROPE

Italy

Agip's wildcat Mirazzano 1, located about 7 miles east of Milano and 3 miles east of the company's Settala gas field in the ENI Exclusive Zone, is a gas discovery. It was drilled to 2007m (6585′), with the reservoir assumed to be in the basal section of the **Porto Garibaldi** sands.

Turkey

Shell has made another discovery on its exploitation lease 1492 in the **Southeast Turkey Thrust Zone.** Wildcat Leylek 1, located between Shell's Beykan and Kurkan oil fields, was drilled to TD 2630m (8629′) and is believed to be an oil discovery. No further details were disclosed.

Czechoslovakia

In October, Nafta Gbely completed wildcat Lieskova-1 in the **East Slovak Sub-basin** as a gas discovery after drilling to TD 2600m (8531′) in 75 days. That same month, MND Hondonin, the Moravian Oil Company, spudded wildcat Poddvorov-87 in the Czech part of the **Vienna Basin,** and wildcat Zdanice-169 on the southeast slope of the **Bohemian Massif.**

AFRICA

Algeria

BHP announced an oil and gas discovery in its **Ghadames Basin** Block 402A. Wildcat Rhourde Debdaba 1 (RDB 1) flowed 1,533 BOPD (36° API) and 4,500 MCFGPD from 2980.5-86m (9779-97′) in the **Trias Argileux Greseux Inferieur.** The tested interval was part of a 39′ oil-bearing sand.

Nigeria (Offshore)

In October, Mobil made two significant oil discoveries for a combined expected reserve potential of 450 million bbls. In OML 70, wildcat Omon 1 encountered 197m (646′) of net oil sand between 1520-2440m (4987-8006′) and flowed an aggregate of 7,500 BOPD (44° API). In OPL 94, wildcat Yoho 1 tested an aggregate of 8,400 BOPD (38° API) from 345′ of net oil sand between 1675-2440m (5496-8006′).

NEAR EAST

Oman (Onshore)

PDO's Tuhfah 1, in the **Eastern Flank Sub-basin** of southern Oman, was suspended as an oil well after reaching TD 2934m (9626′). The wildcat, located about 5 ½ miles northeast of the Hadh 1 oil well, represents the northernmost discovery in the Eastern Flank Sub-basin.

In central Oman, PDO discovered oil at its wildcat Hazar 1st, located 25 km (15.5 miles) north of the Zauliyah NE Field in the **Rub' Al Khali Sub-basin (Arabian Basin).** TD was 4017m (13,180′).

Oman (Offshore)

In September, PDO spudded its first offshore well, wildcat Sawqirah Bay South 1, projected to a TD of 3000m (9843′). Location is in Sawqirah Bay Block (23), about 65 km (40 miles) off the coast. No discovery has been made so far in the area. In 1979, Amoco abandoned Sawqirah Bay 1 as a dry hole after reaching TD 3313m (10,870′) in the Paleozoic.

FAR EAST

Indonesia (Onshore)

On South Sumatra, Pertamina/Canada NW tested oil and gas at wildcat Guruh 1 in the Ogan Komering Block. Five DST's were run in the early **Miocene Batu Raja**

Formation, with DST #5 flowing 640 BOPD and 200 MCFGPD from 1572-79m (5158-81′). Location is 2 ½ miles ESE of Air Serdang JOB 1 which yielded an aggregate 1,131 BOPD and 9,418 MCFGPD in November 1989.

Pertamina/Elf's wildcat Sukajaya 1 in the Jambi-Merang Block and 10 ½ miles southeast of the Tempino Field, tested 1,400 MCFGPD on a DST of the interval 1031-37m (3383-3402′) in the **Air Benakat** Formation **(Middle/Upper Miocene).** The discovery was drilled to TD 2767m (9079′) in the basement.

Indonesia (Offshore)

Arco has suspended wildcat PSI MML 1 as an oil and gas well in the Offshore NW Java Block, West Java Sea. DST #3 flowed 878 BOPD and 385 MCFGPD from 1146-49m (3760-70′) in the **Massive** Formation, while DST #5 yielded 6,100 MCFGPD from 990-1004m (3248-94′) in the **Main** Formation, both of **Middle Miocene** age.

Malaysia (Offshore)

Hamilton Oil Corp., owned by Australian BHP Petroleum, made a third discovery in the PM-3 permit off Trengganu in East Malaya. Wildcat Bunga Raya 1 tested a cumulative 5,719 BPD oil and condensate plus 41,600 MCFD gas from **Tertiary** sandstones between 1890-2350m (6201-7710′).

Papua New Guinea

Barracuda/Command's outpost well, Gobe SE 2, in PPL-56 in the **Papuan Fold Belt** about 500 km (310 miles) northwest of Port Moresby, was suspended at TD 2350m (7710′) after testing 8,907 BOPD and 10,600 MCFGPD from the **late Jurassic** to **early Cretaceous Iagifu Sandstone.** Logs indicated a gross vertical oil column of 75m (246′). The sustained flow rates were reportedly the highest ever achieved in Papua New Guinea. Primary objective of the test was to ascertain the lateral and vertical extent of the Iagifu Sandstone oil reservoir, which flowed 4,250 BOPD at the discovery well Gobe SE 1.

AUSTRALIA

South Australia

In PEL 5&6, Patchawarra East sub-block, Santos suspended wildcat Keleary 1 at TD 2634m (8642′) after testing 518 BOPD in the **Tinchoo** Formation and being cased as a future oil producer. Location is 15 miles NNE of the 1980 gas discovery, Beanbush 1.

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