OFFICERS

President ......................... G. C. Richards ................ CA 4-6191
1st Vice President ................ A. S. Dickerson .................. CA 7-6306
2nd Vice President ............... Charles W. Stuckey, Jr. ....... RI 8-3576
Secretary .......................... Frank H. Hardin ................. CA 7-5323
Treasurer ........................... H. Grady Troxler ............. CA 8-8231

EXECUTIVE COMMITTEEMEN

W. Keasly Clark ................... Benjamin T. Brownson, Ex-Officio CA
Harry F. Fosler .................... Gentry Hild ................. Edith H. Powers

COMMITTEE CHAIRMEN

STANDING COMMITTEES

Finance ......................... Jesse George ...................... PA 3-6567
Distribution & Publication ..... Edward G. Lipp ................ CA 2-5285
Technical Program ............... Charles W. Stuckey, Jr. ....... RI 8-3576
Awards & Loans ................. George P. Walker ............. FA 3-5192
Research & Study ................ DeWitt T. Voikseh ................ CA 4-1681
HGS Membership ........ .......... A. H. Weikenheil .............. CA 7-5151
Personal Placement .............. George Body ....................... CA 1-3911
Remembrance ..................... Don F. Carlson ................ CA 5-9361
Public Relations .................. M. Stephen Kavan ............... CA 3-6454
Endowment ......................... James A. Heyes .............. CA 2-2453
AAPG Membership ................ Jack Cote ....................... CA 3-8566
Ballot ................................ D. C. Gilkinson ............... CA 3-9329
Advertising ....................... James A. Lucas, Jr. ........... CA 2-2039
Exhibits, G.C.A.G.S., A.A.P.G. W. E. White, Jr. ............... RI 2-2560
Transportation .................... Carlisle D. Speed, Jr. ........ CA 4-2533
Library ................................ Ralph E. Taylor .............. CA 1-3494
Boy Scout ......................... Albert R. Mercher .............. CA 1-3401

SPECIAL COMMITTEES

Engineers Council ................ J. C. Walter ...................... CA 7-1249
Academic Liaison .................. John J. W. Rogers .............. JA 6-8441
Advisor to Museum of ......... George E. Hardin, Jr. ........... CA 7-6323
Natural History .................... Harry Kilian ..................... CA 4-9711
Convention Policy ................ Harry Kilian ..................... CA 4-9711
Quarters ......................... Benjamin T. Simmons ............ FA 3-0492

REPRESENTATIVES

G.C.A.G.S. Representative ....... A. L. Warren ................. MA 3-3561
Alternate ......................... R. J. Chambers ................. JA 6-2469
MEETING NOTICE

EIGHTH REGULAR MEETING - APRIL 13, 1964

The eighth regular monthly meeting will be held Monday evening, April 13, 1964, on the 10th floor of the Houston Club Building. The social hour will begin at 5:15, dinner at 6:00, and the program at 7:00 p.m.

The speaker will be Mr. Hunter Yarborough, an AAPG Distinguished Lecturer, who will address the society on "The Geologic Framework of the Gulf Basin."

A 1940 graduate of the University of Texas with a B.S. degree in Physics and Geology and a Petroleum Engineering minor, Mr. Yarborough was pursuing graduate studies toward a Ph.D. degree when he entered World War II.

He served in Naval Aviation from 1941-1946, becoming a Command Pilot and serving in both the Atlantic and Pacific Theaters.

Since 1946 he has been a geologist with Humble Oil & Refining Co. His responsibilities there have ranged from surface and subsurface in Mississippi, Alabama, Georgia, Florida and New Mexico to Staff Geologist, Houston, California Area Geologist, Asst. Chief Geologist 1953-55, Coordinator of Regional Geologic and Geophysical Studies 1956-63, and Geologist, Houston Exploration Department 1964.

The Gulf Basin is the largest structural province of North America. Centering in the Gulf of Mexico and including the contiguous coastal plains of southeastern United States and Mexico this basin comprises an area of 1,200,000 square miles and contains more than 6 million cubic miles of unmetamorphosed sediments. Geophysical information suggests that its central part is an oceanic segment that has been covered by relatively deep waters, possibly since Precambrian time.

Geological evidence indicates that since Late Jurassic time the basin has been divided into two principal sedimentary provinces. The eastern province, making up one-third of the Gulf Basin and including southern Florida, the
western Florida shelf, the Campeche shelf, and the Yucatan Peninsula, has remained a slowly subsiding, relatively stable region of carbonate and evaporite deposition. In marked contrast, clastic deposition has dominated in the western province, a relatively unstable region with a number of structural depressions. Thick, early Mesozoic salt deposits occur beneath great thicknesses of younger sediments in most of the depressions, as well as in the central portion of the basin. Upward movement of salt from these deposits has created within the depressions hundreds of piercement domes and nonpiercement salt uplifts which are responsible for most of the structurally trapped oil and gas within the basin.

Deep drilling and geophysical information suggest that the carbonate and evaporite deposits in the eastern province may reach a maximum thickness of 25,000 feet in south Florida, whereas the dominantly clastic section of the western province in coastal Texas and Louisiana may exceed 35,000 feet in thickness.

SPECIAL ANNOUNCEMENT

A special Luncheon Meeting ($2.25) will be held in the Crystal Ballroom of the Rice Hotel at noon on Wednesday, April 8, 1964. James A. McCarthy will present his excellent paper on the "Vicksburg-Jackson Shale Ridge, Calhoun County, Texas."

If you have not already returned your reservation card, call FA 3-9309 for late reservations.

GALA SPRING COCKTAIL DANCE

THE FORREST CLUB
9950 Memorial Drive

$17.50 per couple (Includes everything!) Saturday, April 11 7 to 11 p.m.

Jimmy Simon's Orchestra

Delicious buffet Drinks!

Get tickets from the following:

Eddie Heider - CA 5-1607 Dusty Rhodes - RI 7-1300
Richard Winborn - CA 4-5251 Jim Hayes - CA 2-2453
Al Boatman - MA 3-4486 Curtis Franks - CA 7-5946
We appear to be entering into another up-cycle in the demand for geologists in this year 1964.

Geophysical companies are enjoying a strong demand for their services from the large companies as well as the smaller companies. This increased geophysical activity always precedes and is indicative of an accelerated exploration and drilling campaign in the near future.

The geophysical contractors say their big problem is finding qualified people to train for their work. In fact, they find it almost impossible to compete for the few geological-geophysical students who are graduating in the near future or who have recently graduated.

Our own society’s placement committee reports that it has practically no men with five years or less experience listed on their roster as available for employment.

I have been advised by good authority that more geological graduates are being sought after this year than any year since 1957. The master's degree graduates will have a choice of job opportunities, the bachelor graduates with good grades will have no trouble finding jobs, the bachelor graduates with poor grades will have a little trouble finding jobs, while the Ph.D. graduates will find it difficult to find jobs to their liking because of their high specialization.

(It is interesting to note that once again the major companies have mis-directed our young students into (1) not studying geology because geologists are always going to be a "drug on the market," and (2) every geological student should acquire a doctor’s degree since there would always be a great demand for these advanced graduates.)

The demand for these young men is by both the major companies and large independents. These indicators normally will precede increased exploration activities by these groups, so we should be able to look forward to a good year for exploration in 1964, which will again increase the demand for all geologists and geological services.

I'm sure we are all ready for, and are willing to accept, this new challenge to carry on the search for new oil and gas reserves.

. . . Orville G. Lundstrom

ATTENTION, PLEASE!

An airmail letter from President Sproule of the A.A.P.G., enclosing a rebuttal argument against H. W. Hintze's article in our March Bulletin, was received too late for inclusion in its entirety in this issue, but the original is available at the Society's office. If there is sufficient demand, mimeographed copies will be run off and distributed to members requesting them. . . . . The Ed.
In this issue we are printing the first half of what I regard as a most valuable paper. The second half will appear in the May Bulletin. It is entitled "The Use of Photogeology and Geomorphic Criteria to Locate Subsurface Structures," by Walter W. Doeringsfeld, Jr. and John B. Ivey.

The paper in its entirety will, in effect, constitute an authoritative up-to-date manual on this advanced phase of the use of photogeology as applied to the search for oil. In fact, the firm of Doeringsfeld, Amuedo and Ivey has ordered 250 reprints for use primarily as instruction manuals in the training of foreign geologists.

This is how it came about. I had discussed the possibility of getting a condensed version of his verbal presentation of the subject with Walter Doeringsfeld the day after our January meeting. We had even gone over his illustrations and made tentative selections which we felt would at least give our absent members an accurate idea of the substance of the talk. However, as he subsequently advised me, they had felt the need of a formal written presentation for some time. So, when they got started on it, they simply went ahead and prepared a comprehensive treatment of the subject. Then they sent the whole thing to me, with carte blanche to utilize whatever I saw fit for an article for our Bulletin.

When I saw the thorough job they had done, I felt it would be a shame to print it in anything less than its entirety. So I called Walter and asked if we might print it all, but in two sections. That permission and the order for reprints were received promptly.

I feel that we are fortunate indeed to have the opportunity to present such an authoritative paper in this relatively new technique.

Houston Public Library

The Business and Technology Room of the Houston Public Library again has a supervisor, Charles Suessmuth. He is young, enthusiastic and anxious to make that division of the utmost possible service to its patrons. With the benefit of some guidance from Dr. Ralph Taylor and active assistance from Mrs. Taylor, who is compiling a list of the library's geological series holdings, it seems probable that he will succeed in substantially increasing its usefulness to the geologists of the community.

He is presently engaged in preparing a summary of the geological publications now available, for inclusion in their next quarterly bulletin. Also a project is now underway to get their more than 200 folios of the Geologic Atlas of the United States properly arranged, indexed and catalogued, so that it will be possible to determine whether a folio covering any particular area is on hand; and, if so, to gain access to it within a matter of minutes. That will make a great mass of geological information readily available for reference purposes which has in the past been practically unavailable because of the lack of any index or even any systematic arrangement of the folios.
REGISTRATION AND CERTIFICATION

A FINAL ROUND

Probably most of you are already surfeited with the arguments on this subject, so we will close the door on it with this issue.

I had hoped to be able to present a concise, yet clear cut and comprehensive, summary of the proposals that are to be laid before the Business Committee for action at the Toronto Convention.

(If I may digress for a moment, let me say that I feel that President Sproule and the other members of the present Executive Committee deserve some sort of an accolade for their strenuous and persistent efforts to bring the matter to a definite conclusion regardless of whether their proposals are adopted or rejected.)

However, any brief yet accurate summary seems virtually impossible since the final (February 29) draft of those proposals is a twenty-two page document winding up with thirteen conclusions and four recommendations, the latter covering two typewritten pages. Perhaps the best thing I can do is to refer you to the March A.A.P.G. Bulletin where I understand it is being published in full. Also, a few highlights of the overall situation may be recalled as an aid to an accurate perspective.

1. The A.G.I., which has become a big spending agency through the medium of Federal, Foundation and Industry grants for special projects, has definitely declared itself "out" as an agency for Registration and Certification, primarily on the grounds that it would jeopardize its tax free status and thus its eligibility for grants.

2. A new national organization, the American Institute of Professional Geologists, has been organized for the specific purpose of attending to the geologist's professional, as distinguished from his scientific, needs. That would include those functions such as certification and registration, which A.G.I. has declared itself unable to perform. Membership in a recognized scientific society such as G.S.A. or A.A.P.G. will be prerequisite to membership in A.I.P.G.

3. The present Executive Committee of the A.A.P.G., after intensive study of the subject, has concluded that Registration by the Association "is not only impracticable but undesirable."

Instead they propose a system of Certification, on a wholly voluntary basis, for those members who may desire it, or need it, as a basis for Registration with state or other governing bodies.

An applicant meeting the prescribed requirements would receive a paper designating him as a "Certified Professional Geologist" and a personal seal bearing that same designation.
This would be put in effect through the adoption of an amendment to the constitution to be submitted to a vote of the members, if the Business Committee approves the recommendations of the Executive Committee.

-----0-----

A brief communication from "Cliff" Bowles advises: "I have read with considerable interest the several expressions in the February and in the March issues of the Houston Geological Society Bulletins pertaining to registration and certification of petroleum geologists and have written a letter concerning it to President Elect of the A.A.P.G. Grover Murray with a copy of said letter going to outgoing President J. C. Sproule. An opinion was expressed in that letter that there are other problems seemingly more needful of the attention of the Executive Committee of our Society.

"The viewpoint expressed by William H. Hintze coincides with my thinking pertaining to Registration and Certification."

Bowles' letter goes on to say, however, that Hintze had failed to include Texas in the states having a registration conveyance available to petroleum geologists; that such a facility has been available to the 30 percent of the AAPG members in Texas, since the Texas State Board of Registration for Professional Engineers was formed in 1937; and that he and many other AAPG members are included in its roster of 18,605 Registered Professional Engineers.

Mr. Hintze's explanation is that his list was intended to include only those states where registration is required for the performance of certain geological services, rather than all in which registration is available.

-----0-----

A letter from E. W. Hard, President of the Dallas Geological Society, protests a sentence in our February issue reading as follows: "The Dallas Society, which is the only one among our exchangees to report official action thus far on the Certification and Registration recommendation of the AAPG Executive Committee, is flatly opposed to it, and has so advised President Sproule."

His stated reasons are: "The DGS Professional Standards Committee report was constructed and issued prior to the receipt of the AAPG Executive Committee's recommendations for voluntary certification and prior to AAPG President Sproule's presentation of these recommendations to the DGS members. It was primarily concerned with the licensing and registration of geologists in general, and not with the specific proposal of the AAPG Executive Committee. This proposal has not yet been considered in detail nor acted upon by the Dallas Geological Society."

The only comment I have is that the resolution to which the offending sentence referred was reprinted verbatim from the DGS Newsletter, as a newsworthy item because of the very positive attitude expressed. It contained no indication as to the specific communication from the AAPG to which it referred.
But it hardly seemed open to misinterpretation and the only possible assumption, at the time of writing, was that it referred to the Executive Committee's communications then extant. It is regrettable if the time lag between writing and publication, and a coincident change in the Society's attitude, made the statement inappropriate when published. But lacking clairvoyance, it is hard to see how a statement written in advance of a January 20 deadline, and an actual mailing date of February 3, is open to criticism for not having reference to a verbal advance discussion in Dallas on January 22 of the fourth draft of the Executive Committee's proposals, which was not mailed out to the affiliated societies until February 29.

...The Editor

NEWS ............................................... of members

DICK WINBORN has been promoted by North Central to Senior Geologist in the Upper Texas Gulf Coast District.

ED LIPP has been promoted to Division Manager of Exploration for Texas Gulf Coast and Louisiana for Crown Central Petroleum Corp. W. K. KERFOOT has been named Manager of Exploration also. Both will headquarter in Houston.

GEORGE MURPHY has been promoted to District Manager of South Louisiana for Colorado Oil and Gas. George's promotion has moved him to Lafayette where Colorado is opening a new office. Joining Colorado as an exploration geologist in Lafayette is RAY HAYWARD, formerly with Union Texas Petroleum.

WALTER H. ROSE left the Kilroy Company of Texas in January and has joined Coastal States Gas Producing Co. in Lafayette, Louisiana.

RAY A. BURKE, vice president of the Exploration and Production Department of Union Oil Company, had a narrow escape on December 21, 1963. As the company plane prepared to land at Midland-Odessa, the nose dipped and the plane crashed at the far end of the runway, two miles from the terminal. Ray and the first officer escaped, but the pilot and co-pilot were unable to leave the cockpit. The first officer suffered a fractured breastbone and was unable to be of assistance, but Ray managed to pull the co-pilot out. The pilot was beyond his reach. As they put the injured first officer and co-pilot in an ambulance, Ray yelled for an axe. He tried to break the reinforced cockpit window on the pilot's side with the axe, but the glass refused to shatter. By then, flames had engulfed the nose section, and Ray, his trousers soaked with kerosene, had to move back. By this time fire trucks had arrived, and while firemen sprayed a protective coating of fog over him, a highway patrolman strode to the plane and began trying to beat in the cockpit window. As flames were licking inside the cockpit, the pilot regained consciousness and crawled across the cockpit to the open window where he was pulled to safety. Although the plane was destroyed, everyone had been rescued alive.

Mr. Burke is a former resident member of this society, and although now living in Los Angeles, he still retains membership. His brother, Thomas M. Burke, is a resident member of HGS.
Personnel Placement

There are 46 geologists and geophysicists whose applications are on file with the HGS Placement Committee. Qualifications range from bachelor degrees with no experience to PhD degrees with 25 years experience. The areas of experience include most of North America, Africa, South America, and the Middle East. Of the 46, only 4 are without experience. The most numerous group consists of 27 geologists with BA degrees ranging from 25 to 55 years of age and who cumulatively represent a lot of talent. Should anyone be aware of any employment opportunity, please let me know.

...George Sealy - CA 1-3312

MEMORANDUM RE A.A.P.G. CONVENTION
Toronto, Canada - May 18-21, 1964

Mr. D. A. Zimmerman, P. O. Box 2880, Dallas 21, Texas, (telephone No. RI 7-1611), who works for Sun Oil Co. at their Richardson, Texas office is trying to get together a charter flight to the Toronto Convention.

Braniff is furnishing a DC 7-C propeller plane on this 4-1/2 hour non-stop flight from Love Field, Dallas, to Toronto International Airport. Normal meals and refreshments will be served on this flight. Mr. Zimmerman advises that the fare will vary from $102 to $125 round-trip, depending upon the number of people on this charter flight. Regular round-trip fares from Dallas to Toronto on jet are $174.20 for economy and $227.01 first class space on Braniff Jet. The charter flight is to depart Dallas on Sunday, May 17, at 1:30 p.m. The flight will return from Toronto on Thursday, May 21, at 5:00 p.m.

Connecting flights from Houston to Dallas can be arranged through Braniff District Sales Office of Houston at CA 8-4371. You must make your reservations through Mr. Zimmerman by mail or telephone as international air regulations do not permit Braniff to make the reservations for you in Houston. Braniff will, of course, help you to make connections with the charter flight to and from Dallas.

Mr. Zimmerman advises that a cash deposit of $60 is required with a reservation. The reservation may be cancelled any time prior to May 10th without penalty.

...Carleton D. Speed, Jr.
Transportation Chairman

A SUGGESTION

J. Y. Cousteau's recent book "The Living Sea" is an interesting narrative of his cruises to explore the life and bottom of seas around the world. A relaxing exposure to considerable oceanography and even an occasional outcrop.

...Shirley Mason
President Orville Lundstrom arranged a luncheon meeting at the Petroleum Club on Friday, March 13, to provide an opportunity for Norman C. Smith, Executive Director, and George C. Hardin, Jr., the Secretary-Treasurer elect, of the A.A.P.G. to discuss association affairs, particularly finances, with representatives of the Houston Geological Society and the A.A.P.G. District Representatives.

Those present were:


A.A.P.G. Administration: George C. Hardin, Jr., Secretary-Treasurer elect, and Norman C. Smith, Executive Director.

The meeting lasted until 3:00 p.m. and was highly informative. Mr. Smith discussed the general financial condition of the A.A.P.G. and outlined certain changes in the society's accounting procedures which will convey a more accurate picture of its condition in the future.

Incidentally, his report indicates that the society's condition during recent years has actually been much better than the previous reporting would suggest. For instance, the report in the Bulletin indicates a loss of approximately $25,000 for last year, whereas the actual overall net loss was approximately $1,400.

That sounds incredible, but it arises from the fact that the general statement covered the general operating fund only, whereas several publishing funds were also being maintained which were not being charged with their appropriate costs, nor being combined with the general operating fund in one overall statement. So while the operating fund has been showing relatively heavy losses, revenue accruing in the publishing funds has actually reduced the net deficits to about the magnitude of that of last year.

Methods were also discussed for keeping the representatives better informed as to matters to be taken up at the annual business meeting, so as to give them an opportunity to get a better feeling as to the local membership's attitude concerning them before having to vote on them.

...Frank R. Hardin
LATE PUBLISHED RE-CAPS DESCRIBING CONTINENTAL SHELVES

Not only off the coast of Louisiana, but in far-distant shores, wildcatting has resulted in additions to oil and gas reserves on the continental shelf, which is the part of the continental margin adjacent to the shore. Continental slope and continental rise are the other divisions of the margin.

As to this shelf, its geology has been described as follows:

"The continental shelves are a simple underwater continuation of the adjacent land, and, as would be expected, their geology is merely an extension of the geology of the bordering land area." (James Trumbull in U.S.G.S. Bull. 1067, p. 12)

Two recent books* include descriptions of continental shelves around the world, and present data as to departure of some shelf areas from the simple form given above. The two views in the books are as follows:

Shepard, pages 276-6: "The importance of low stands of sea level during glacial stages is undeniable ... Most of the wide shelves, however, must have a history that is only partly explained by the glacial sea levels."

Guilcher's statement as to origin of the shelves and the rest of the continental margin is: "The continental margins appear to have a mainly diastrophic or constructional origin ... Warping, faulting and long continued sedimentation are probably the essential forces which have built this outstanding feature off the continents." (Pages 306-7)

Particularly vivid is Figure 10 of Guilcher (page 300) showing the ways warping, etc., has resulted in a number of different continental-margin profiles. Manifestly, Guilcher views the continental margins as more mobile in many places than the adjoining land - a view expressed by this reviewer also (AAPG Bull., vol. 34, p. 351-360, 1950).

References listed in both books are numerous; however, Guilcher lists only to 1960. African Coast data from Liberia to Angola have important recent additions (e.g., Gulf's shelf discovery off Nigeria).

To the petroleum geologist evidence of greater mobility on parts of the continental shelf than inland from it is, of course, an argument for shelf oil and gas possibilities. Similar optimism was expressed by Pratt (AAPG Bull., vol. 31, p. 657-692, 1947).

...Paul Weaver

Marjory Allin was hostess to the Geological Auxiliary board of directors on Wednesday, March 25, at ten in the morning at her home on Lanark Lane. Chairmen of the various social functions were present as special guests for lunch.

Bob Souther has been transferred to an assignment in Italy. He and Laura-beth will make their home in Rome for a year or so. If all the friends who are planning to visit the Southers in Italy do so, they will never know they left Houston!

Louise and Sam Dunnam are actively engaged in overseeing the repair of their home which was recently damaged by fire. Annie Hedley has just been able to move back to her home which was almost totally destroyed by fire earlier this year.

Faye and Ray Lewis are Spring vacationing in Mexico with their children, Lisa and Chuck. The youngsters were happy that the family vacation this year coincided with the Kinkaid School spring recess instead of with the annual AAPG Convention as in the past.

We distaff understand that the following members of the Houston Geological fraternity are planning to attend the 1964 AAPG Convention in Toronto, Canada: Virginia and George Hardin, the Larry Vittrups, Ben and Robbie Simmons, Jack and Alene Williams, Marge and Chuck Edwards, Lil and Bob Moehlman, the Wayne Bowmans and the Ben Curtis'.

Mary Folk has returned from Seattle, Washington where she met Stewart, who has been on an assignment in Anchorage, Alaska. At Ft. Lewis, in Seattle, they visited with their son, Lt. Harry Folk and his family.

Home again - Virginia Edgecomb after a visit with her father in Florida. Happy to know Barbara Hanson and Clara Smith are on the mend after their sojourns in the hospital. Elsie and Roy Bennett are new grandparents. Young Roy and his wife have a baby girl. Jean and Royce Woodard have a new home in Briargrove Park. They are expecting something else new any day. The Philip Allins spent Easter in Durant, Oklahoma, with Marjory's mother, Mrs. Marjory Rushing. B and Hillord Hinson are new members of the Champions group - golf, that is. They recently moved into their new home abutting the golf course in the Champions residential section.

The Houston Geological Society Cocktail Dance will be held on Saturday, April 11, 1964, at the Forrest Club, 9950 Memorial Drive, from 7 to 11. A delicious buffet will be served, as well as any type of mixed drink you desire. Jimmy Simon will furnish the music for dancing and a Spring flower theme will be carried out. Several members of the HGS will be selling tickets before the dance, as tickets cannot be sold at the door. Reservations must be made by Thursday, April 9th, as a limited number of tickets will be available.

...E. P. Smith
PROFESSIONAL DIRECTORY
Space for Professional Cards of Members

JOSEPH L. ADLER
Geologist & Geophysicist
Chamber of Commerce Bldg.
CA 2-7925
Houston 2, Texas

ALLEN & GILKISON
Oil and Gas Consultants
Harris H. Allen and D. C. Gilkison
963 San Jacinto Bldg. CA 8-9329
Houston 2, Texas

E. J. BARRAGY
Independent Geologist
3005 Allen Parkway
Houston, Texas JA 2-4644

A. L. BARTOW
Geophysical Consultant
2315 Watts Road
Phone: MA 3-3306

R. M. BEATTY
Consulting Geologist
816 Esperson Bldg.
FA 3-8884

JOHN L. BIBLE
BIBLE GEOPHYSICAL CO., INC.
Gravity - Magnetic Surveys
Interpretations
236 Esperson Bldg. CA 2-6266
Houston 2, Texas

LESLEI BOWLING
Oil and Gas Consultant
536 California Bldg. JA 2-0432
New Orleans, Louisiana

WAYNE F. BOWMAN, SR.
Independent Geologist
1713 Niels Esperson Bldg.
CA 2-0279
Houston 2, Texas

ORVAL L. BRACE
Geologist
1810 South Coast Bldg. CA 8-5404
Houston 2, Texas

IRA BRINKERHOFF
Petroleum Consultant
901 San Jacinto Bldg. CA 4-2656

RALPH B. CANTRELL
Petroleum Geologist and Engineer
4005 Bellaire Boulevard
Houston 25, Texas MA 3-0471

GEORGE H. CLARK
Petroleum Geologist
404 First City National Bank
FA 3-1187
Houston, Texas

STUART K. CLARK
Consulting Petroleum Geologist
2310 Esperson Bldg. CA 8-5174
Houston 2, Texas

JACK COLLE
Consulting Geologist and Paleontologist
911 San Jacinto Bldg. CA 7-6266
Houston 2, Texas SU 2-4555
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Address</th>
<th>Phone</th>
<th>City, State</th>
</tr>
</thead>
<tbody>
<tr>
<td>RALPH E. DAVIS ASSOCIATES, Inc.</td>
<td>Consultants - Oil and Natural Gas</td>
<td>1216 Niels Esperson Bldg. CA 4-7576 Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MICHEL T. HALBOUTY</td>
<td>Consulting Geologist</td>
<td>Independent Producer and Operator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERNEST A. ELWOOD, JR.</td>
<td>Prudential Drilling Company</td>
<td>1418 Bank of the Southwest Bldg. CA 4-7741 Houston 27, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED J. HAMNER</td>
<td>Consulting Geologist</td>
<td>5060 Navarro Lane SU 2-0732 CA 8-8278</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAUL FARREN</td>
<td>Geophysical Consultant</td>
<td>1528 Bank of the Southwest Houston (2) and Geodata Building MO 7-3317 5603 S. Rice Ave. (36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEORGE C. HARDIN, JR.</td>
<td>Petroleum Geologists</td>
<td>711 First City National Bank Bldg.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HERSHAL C. FERGUSON</td>
<td>Consulting Geologist</td>
<td>1424 Esperson Bldg. CA 8-8444 Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEBERT AND SURBER</td>
<td>Geophysical, Geological Consultants Seismic Review and Subsurface 2422 Bank of the Southwest Bldg. Houston 2, Texas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAROLD L. GEIS</td>
<td>Consulting Geologist</td>
<td>1238 Bank of the Southwest Bldg. CA 5-1396 Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. B. HOHLT</td>
<td>Geological Consultant</td>
<td>Exploration · Exploitation · Valuation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KENNETH L. GOW</td>
<td>Geologist and Engineer</td>
<td>531 Texas National Bank Bldg. CA 4-6584 Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOWARD HOUCHER</td>
<td>Consultant</td>
<td>1005-A First City National Bank Bldg.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CECIL V. HAGEN</td>
<td>Petroleum Geology &amp; Engineering</td>
<td>5650 Kirby Drive El Ranchito Route s3 - Gonzales, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GENTRY KIDD</td>
<td>and SHIRLEY L. MASON Geologists</td>
<td>813 Esperson Bldg. CA 7-8231</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Address</td>
<td>Phone</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------</td>
<td>----------------------------------------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>L. A. KIMES</td>
<td>Geophysical Consultant</td>
<td>422 San Jacinto Bldg. CA 8-1012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORVIL M. LUNDSTROM</td>
<td>Exploration and Production</td>
<td>603 Bank of the Southwest Bldg. Houston 2, Texas</td>
<td>CA 4-6191</td>
<td></td>
</tr>
<tr>
<td>C. T. MacALLISTER</td>
<td>Geophysical Consultant</td>
<td>6327 Vanderbilt, Houston 5, Texas MA 3-4181</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHIL F. MARTYN</td>
<td>Petroleum Geologist</td>
<td>1404 First City National Bank Bldg. Houston 2, Texas CA 7-5447</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEORGE N. MAY &amp; ASSOCIATES</td>
<td>Consulting Geologists and Paleontologists</td>
<td>P. O. Box 2052 Nat Mouton Bldg. Lafayette, Louisiana CE 4-3379</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W. B. McCARTER</td>
<td>Independents</td>
<td>2522 Hazard JA 9-1881  Houston 19, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEORGE I. McFERRON</td>
<td>Consulting Geologist</td>
<td>Room 5, 1973 W. Gray  Houston, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAYMOND E. MING</td>
<td>Geologist</td>
<td>750 San Jacinto Bldg. CA 8-1916 Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. B. MITCHELL</td>
<td>Geologist</td>
<td>2801 First City National Bank Bldg. Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JOHN C. MYERS</td>
<td>Consultant in Oil, Gas and Sulphur</td>
<td>1207 Bank of the Southwest Bldg. CA 5-4133 and CA 5-4559 Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WALTER J. OSTERHOUDT</td>
<td>Consulting Geophysicist and Geologist</td>
<td>P. O. Box 3182 303-247-3769 Durango, Colorado 81302</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KENNETH DALE OWEN</td>
<td>Geologist</td>
<td>Esperson Building Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAYMOND D. REYNOLDS</td>
<td>Geologist</td>
<td>436 Bankers Mortgage Bldg.  Houston 2, Texas CA 7-5309</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. L. SELIG</td>
<td>Geologist</td>
<td>1907 Bank of the Southwest Bldg.  Houston 2, Texas CA 4-9774</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Address</td>
<td>Phone</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------</td>
<td>----------------------------------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>Benjamin T. Simmons</td>
<td>Consulting Geologist</td>
<td>601 C &amp; I Life Bldg.</td>
<td>FA 3-0493</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fred L. Smith, Jr.</td>
<td>Consulting Geologists</td>
<td>1226 Bank of the Southwest Bldg.</td>
<td>CA 5-6656</td>
<td></td>
</tr>
<tr>
<td>J. T. Goodwyn, Jr.</td>
<td></td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbert C. Smith</td>
<td>Consulting Geophysicist and Geologist</td>
<td>320 Pinehaven Dr.</td>
<td>OV 6-5153</td>
<td></td>
</tr>
<tr>
<td>Carleton D. Speed, Jr.</td>
<td>Geologist - Oil Producer</td>
<td>711 Houston Club Bldg.</td>
<td>CA 4-2523</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. C. Spoor, Jr.</td>
<td></td>
<td>2130 Chamber of Commerce Bldg.</td>
<td>CA 4-9624</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Geologists</td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. C. Stallworth, Inc.</td>
<td>Engineering and Geological Drafting</td>
<td>1210 Bank of the Southwest Bldg.</td>
<td>FA 3-7343</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surveying and Mapping</td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planimetering and Acreage Calculations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Brooks Stewart</td>
<td>Geophysical Consultant</td>
<td>320 Bankers Mortgage Bldg.</td>
<td>FA 3-4966</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edward B. Stiles</td>
<td>Consulting Geologist</td>
<td>10401 Memorial Drive</td>
<td>CA 5-4005</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HO 5-8568</td>
<td>Houston 24, Texas</td>
<td></td>
</tr>
<tr>
<td>Gene Van Dyke</td>
<td>Van Dyke Oil Company</td>
<td>Bank of the Southwest Bldg.</td>
<td>CA 8-8174</td>
<td></td>
</tr>
<tr>
<td>A. H. Wadsworth, Jr.</td>
<td>Bank of the Southwest Building</td>
<td>CA 7-8151</td>
<td>Houston 2, Texas</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. C. Walter, Jr.</td>
<td>Geologist and Petroleum Engineer</td>
<td>2202 Esperson Bldg.</td>
<td>CA 7-1246</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houston 2, Texas</td>
<td>Home Phone: HO 5-9773</td>
<td></td>
</tr>
<tr>
<td>George F. Watford</td>
<td>Consulting Geologist</td>
<td>1420 Bank of the Southwest</td>
<td>CA 7-6935</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>James A. Wheeler</td>
<td>Consultant</td>
<td>1910 Esperson Bldg.</td>
<td>FA 3-1618</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houston 2, Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frank A. Nice, Jr.</td>
<td>Consulting Petroleum Engineer</td>
<td>1606 Bank of Southwest Bldg.</td>
<td>CA 7-3938</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Completion - Property Mgmt. - Valuation</td>
<td></td>
<td>YR 8-6070</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>JA 9-6442</td>
<td></td>
</tr>
</tbody>
</table>
USE OF PHOTOGEOLOGY AND GEOMORPHIC CRITERIA TO LOCATE SUBSURFACE STRUCTURES*

By
Walter W. Doeringsfeld, Jr. and John B. Ivey
Denver, Colorado

Photogeology is literally the interpretation of a e r i a l photography for geological purposes, and in the strictest sense, photogeology includes geomorphology. Most domestic photogeology, until the mid-1950’s, was done in areas where bedrock exposures were relatively easily mapped, structurally and stratigraphically. About this time, oil companies began to search for surface data which might give clues to subsurface structural features not distinctly expressed at the surface by bedrock exposures. Coincidence of geomorphic criteria with known subsurface structure has provided the key for photogeologic and geomorphic studies.

In most areas, geomorphology should be used in addition to conventional photogeology when mapping the surface for oil and gas exploration. Geomorphology, as applied in the oil industry, is a science, and should not carry the old connotation and stigma of "creekology." The logical application of geomorphic principles is proving to be a valuable exploration tool. This paper discusses practical applications of geomorphic principles, and is not meant to be a discussion of theoretical geomorphology.

Basic principles which are well documented in the published literature are necessary to the comprehensive application of geomorphology. Many prominent geologists and geomorphologists have published articles and books containing these principles, but few have attempted to organize their material specifically for oil exploration. Thornbury (1954), although he devotes only a few pages to oil exploration, does state a number of fundamental concepts (p. 16-30), the more important of which are quoted as follows:

1. "Geologic structure is a dominant control factor in the evolution of land forms and is reflected in them." (p. 17)

2. "Geomorphologic processes leave their distinctive imprint upon land forms, and each geomorphic process develops its own characteristic assemblage of land forms." (p. 19)

3. "Complexity of geomorphic evolution is more common than simplicity." (p. 21)

4. "Little of the earth's topography is older than Tertiary and most of it no older than Pleistocene." (p. 26)

(Sequential numbers above are the present authors.)

*This paper was presented before the Houston Geological Society on January 13, 1964, by Mr. Walter W. Doeringsfeld, Jr., of Doeringsfeld, Amuedo and Ivey, Denver, Colorado.
Geomorphic analysis is concerned primarily with determining the degree of influence which the structure and lithology of the surface rocks have had on the morphological development of an area. The four basic categories of analysis, generally in order of their importance, are:

1. Drainage analysis
2. Land form analysis
3. Fracture pattern analysis, and
4. Tonal characteristic analysis.

Although more or less stress may be placed on one of the above categories in a given area, a comprehensive analysis includes consideration of all of them.

Drainage analysis is usually the most important step in a geomorphic study, and certain drainage terminology usually has a structural connotation as well as the more commonly used morphologic connotation. The terms consequent, resequent, subsequent, and obsequent, which describe drainage, can be used in a structural sense, and can be related to the original consequent surface, which is the initial slope of the land upon regression of a sea. Although it is technically improper to ascribe human qualities to physical processes, all streams are "lazy" and take the direction of least resistance; thus, streams controlled by folding tend to migrate down dip and streams controlled by faulting usually adopt a course coincident, or nearly so, with the fault trace. The greatest deterrent to the structural analysis of drainage is the homogeneity of surface rocks.

DRAINAGE ANALYSIS

Drainage analysis is the term applied to the study of drainage patterns with respect to their genesis, orientation, texture, uniformity, and plan. The term also describes the study of individual stream characteristics, and may be used in the study of entire drainage basin systems. In many areas drainage basins and structural basins have the same general outlines and it is desirable to study entire basin systems to make comprehensive geomorphic analyses.

The regional drainage patterns can be determined, and anomalous drainage patterns can be outlined by more detailed analyses in restricted areas. Geologists working in the Rocky Mountain area will recall many classic examples of each type of drainage mentioned here. It is important to note, however, that in most other areas of the country, drainage types may not be classic in expression. In practice, this means that the interpreter works with more subtle drainage features and in some areas more interpretation must be applied than in others. This paper is intended to concentrate on areas having more subtle than classic forms of drainage expression.

The following terms are necessary to the understanding of stream classification, particularly as applied to petroleum geomorphology; the terms refer to morphologic as well as drainage features: a consequent stream is one whose course was determined by the initial slope of a land surface. The stream usually flows in the direction of the dip of the strata, but not necessarily on
bedding planes or surfaces. A consequent stream will develop on a consequent surface, remaining consequent in form until a later erosion cycle modifies the original surface. A consequent stream flows in the direction of the initial land surface, but at a lower level and is usually referred to (informally) as a dip stream. Consequent streams are sometimes mistakenly referred to as consequent and, in practice, differentiation between the two types can be difficult. A subsequent stream develops a valley along a belt of relatively weak rock, usually between more resistant beds on either side and is commonly referred to as a strike stream. Obsequent streams low in a direction opposite to the initial consequent slope, and to the dip of the strata, and opposite to the consequent streams of the area. The subsequent streams are usually shorter than the consequent streams. An antecedent stream cuts through a geologic structure younger than itself and is able to keep pace with the uplift by rapidly cutting into the uplifted area. A superimposed or superposed stream is one which has cut down through a cover mass or mantle onto a buried structure. An insequent stream is a stream that has no apparent relation to structure. Various textbooks on geomorphology show examples of the drainage types referred to above. Inverted topography is a term applied to an area where the topographically low land forms are structurally high, or where topographically high land forms are structurally low.

FIGURE 1
Stream development on various slopes.
Figure 1 diagrammatically portrays the types of streams that develop on inclined and folded surfaces, and the resultant land forms that appear after the consequent surface is eroded. Upon regression of a sea the slope of the surface, depicted by (A), is seaward and normally the underlying beds also dip in the same direction. The initial surface slope is called the consequent slope and the resultant drainage on this initial surface is also called consequent. With erosion the monoclinal feature (B) would be dissected into a series of cuesas. The long slopes and down-dip drainage would be resequent; the shorter slopes and up-dip drainage would be obsequent. The drainage that has met a lithologic barrier

Fig. 2. Stream development on monoclinal slopes, McMullen County, Texas.
at the base of a cuesta and has adjusted to strike would be subsequent. An upwarped area (C) also has an initial consequent surface; however, the first completely eroded surface may also look like the consequent surface because erosion would cut to the first resistant bed. By definition the drainage would be resequent because it has developed at a lower level than the initial consequent surface. Further erosion of the upwarped area (D) would produce steep infacing escarpments with consequent slopes and drainage, and gentle, long, out-facing slopes with resequent drainage. The comparison of synclinal drainage and land forms can be observed by examining (E) and (F). The first surface existing after morphologic and structural adjustment is consequent; however, the slope of the surface after erosion would be in the same direction and would be called resequent, because erosion is at a lower level than on the initial consequent surface. Further erosion breaches the land forms and finally when the land form is base-leveled, anticlines and synclines can be differentiated only by identifying infacing or out-facing escarpments.

Many areas exist where monoclinal features similar to the one in Figure 1 B can be examined. An excellent example is Figure 2, an index mosaic of a portion of McMullen County, Texas.

Figure 3 is an excellent example of drainage and land forms resulting after erosion has cut through the initial consequent slopes of an anticline. This example is the Preston anticline that trends through Fannin County, Texas. The subsequent or strike drainage is particularly well expressed as noted by the general parallelism of drainage and structure contours (Sellards, 1939). Although it is self-evident that lithology is the most important factor which controls streams during development, structure does have an important part in the adjustment of streams to genetic types. Drainage apparently is very sensitive to even small changes in lithology and structure, and in many areas buried structure is revealed at the surface through mantle rock and alluvium as a result of differential compaction of overlying sediments or rejuvenation of structural movement along zones of weakness. The surface manifestation of subsurface structure does not always correspond directly with the latter. Other factors, apparently due to migration with depth, the thickness of mantle rock, and effects of erosion on structure, are also important. Surface expression of less than five feet, apparently caused by vertical movement and recompaction, has been detected by the writers in mantled and alluviated areas such as the San Joaquin and Sacramento Valleys of California. Other areas, such as the glaciated basins of Alaska, have geomorphic features similar to those already described; however, the amount of vertical movement or depth of underlying rocks is, as yet, an unknown quantity.

An important element of drainage analysis is the study of texture. Texture indicates the relative spacing of all drainage lines, and might be referred to as drainage density or stream frequency. Permeability of the surface rock is the most important factor influencing the drainage texture, although other factors may be involved, one of them being the amount of rainfall in the area. Texture of drainage patterns is referred to in relative terms as fine, medium, and coarse. The classifying terms will vary from one area to another, because they...
Fig. 3. Stream development on anticlinal fold, Preston anticline, Fannin County, Texas.
FIG.-4 COARSE TEXTURED DENDRITIC DRAINAGE PATTERN

FIG.-5 FINE TEXTURED DENDRITIC DRAINAGE PATTERN
are relative and only have meaning with regard to local conditions. Figure 4 is an example of fine textured pattern developed in shale. Relative impermeability of the shale, general lack of vegetation, and brief, violent rain showers forced the development of the surface drainage at the expense of the subsurface drainage. In areas where there is more vegetation and prolonged general, rather than quick, heavy rainfall, the stream density in shale would be less.

Figure 5 is an example of coarse textured pattern developed on sandstone. Larger amounts of surface water drained downward into the relatively permeable sandstones leaving a reduced amount of water available at the surface for the development of streams.

Texture is important in determining gross lithologic changes and in some cases can be very helpful in defining details of lithology. Figure 6 is the drainage pattern coinciding with a northward-plunging anticline genetically related to the Contamana trend in the Ucayali basin in eastern Peru. The surface rocks are the Capas Rojas of Tertiary Age. The relief is relatively slight and the entire area is mantled with alluvium; vegetation was observed to be continuous across the entire feature.
Figure 7 shows the annotation that was possible after a thorough geomorphic analysis had been made. Stream texture was the key to determining stratigraphic units and discerning structure.

Structure has the dominant role in controlling the form of most drainage patterns. The nine basic land forms that indicate structural control are termed; Dendritic, trellis, rectangular, parallel, centripetal, annular, barbed, radial, and deflected. These examples are illustrated in Figures 4 through 15.

Dendritic, Figures 4 and 5, is the most common pattern, and is characterized by irregular branching and re-branching of tributary streams in all directions and at any angle, but normally at less than a right angle. It implies a generally uniform or homogeneous lithologic character of the underlying rocks and a general lack of structural control. Modification of normal dendritic patterns by an increase in angularity, parallelism, and angle of confluence, usually indicates a greater degree of structural control; and, the modifications should not be overlooked.
Trellis drainage, Figure 8, displays a system of subparallel streams, usually aligned along the strike of the sedimentary rocks or between parallel or nearly parallel topographic features such as ridges. It indicates strongly folded or dipping rocks, and is common in the folded Appalachian Mountains of the Valley and Ridge physiographic province.

In a rectangular pattern, Figure 9, the main stream and its tributaries characteristically display right-angled bends. This pattern is most notably the result of structural control by faults or fractures. Many areas throughout the western United States exhibit this type of drainage; the San Rafael swell in Utah has excellent examples of this form.

A parallel pattern, Figure 10, is one in which the streams flow parallel to one another in the direction of the regional slope of land. This type of drainage may indicate structural control as in the Piceance and Uinta basins, Colorado and Utah, or it may be related more to land form as exhibited by parallel streams developed on some large alluvial fans.

Centripetal drainage, Figure 11, is characterized by streams converging into a central depression. The depression may be structural as well as topographic, in which case tributary streams probably would be resequent. Breached anticlinal features may exhibit centripetal drainage, in which case tributary streams would be obsequent.

An annular pattern, Figure 12, exhibits arcuate-shaped subsequent streams which tend to encircle an area of uplift. This pattern is typical of breached domes, or broad structural highs where alternate resistant and non-resistant strata are exposed. Some of the best known examples of this form are the so-called "racetrack" features associated with domal upwarps such as the Black Hills, South Dakota. These patterns also have been found with direct relation to structures buried by alluvial mantle.

A barbed pattern is one in which some tributaries to the main streams point upstream. Barbed patterns may indicate initial adjustments to an annular pattern, but are more commonly the result of stream piracy. The upper left quadrant of Figure 13 shows barbed streams in relation to normal dendritic drainage. The angle of confluence of normal dendritic drainage is less than 90 degrees and of barbed drainage is greater than 90 degrees.

Radial patterns, Figure 14, look like the spokes in a wheel, and are commonly developed around a topographic high where the bedding is horizontal, or very nearly horizontal. Also this type of pattern is noted around volcanic cones, plugs, and other near-circular features. This pattern can be developed over young domes, and local structural highs, but it should be noted that most radial drainage is the result of headward erosion.

A deflected drainage pattern, Figure 15, displays an abrupt change in the direction of the stream, and might indicate uplift or fault control. Frequently, alignments of stream deflections give important indications of structural control.
ANNULAR DRAINAGE PATTERN

BARBED AND NORMAL
DENDRITIC DRAINAGE PATTERN
RADIAL DRAINAGE PATTERN  FIG-14  DEFLECTED DRAINAGE PATTERN  FIG-15

Cont'd next month
GEOPHYSICAL SERVICES

APACHE EXPLORATION CO., INC.
C & I Life Bldg.
Houston, Texas 77002
A. L. Ladner CA 2-9649

CAMBE GRAVITY SERVICE
"Gravity for the Geologist"
235 Esperson Bldg.
Houston 2, Texas
Leo Pugh CA 2-6266

NATIONAL GEOPHYSICAL COMPANY, INC.
2345 Mockingbird Lane, Dallas, Texas 75235
2425 Brun St., Houston, Texas 77019
H. L. Johnson, Houston W. R. Mitchell, Dallas
JA 6-1721 FL 2-2671

SIDNEY SCHAFER AND COMPANY
2200 Welch Avenue
Houston, Texas 77019
Sidney Schafer JA 9-8789

SEISMOGRAPH SERVICE CORP.
1229 Texas National Bank Bldg.
Houston, Texas 77002
Robert B. Baum CA 2-9071

WELL LOGGING

BAROID DIVISION, NATIONAL LEAD COMPANY
P. O. Box 1675
Well Logging and Mud Company
B. O. Pixler JA 4-6381

LANE WELLS COMPANY
1412 Chamber of Commerce Building
J. L. P. Campbell CA 2.9771
W. D. Bishop or
L. I. Bates WA 8-3331
Division Sales Engineers

PAN GEO ATLAS CORPORATION
P. O. Box 14524
Houston, Texas 77021
Ross B. Smith RI 7-1300

SCHLUMBERGER WELL SURVEYING
CORPORATION
P. O. Box 2175
Houston, Texas 77001
E. H. Heider
Kenneth S. Howell CA 5-1605

CORE ANALYSIS

CORE LABORATORIES, INC.
3615 Gulf Freeway
Core Analysis and Mud Logging
John E. Furen CA 3-4193

EMRACO PRODUCTION LABORATORIES, INC.
4928 Griggs Road
Houston, Texas 77021
E. R. Cockrell, Jr. RI 7-9300

GEOPHYSICAL INSTRUMENTS

DRESSER SIE
10201 Westheimer Road
P. O. Box 2928, Houston, Texas 77001
E. A. Pratt SU 2-2000
OIL PRODUCERS

J. RAY McDERMOTT & CO., INC.
1400 Houston Club Bldg.
Houston, Texas 77002
J. Ray McDermott CA 5-0631

U. S. OIL OF LOUISIANA, INC.
1500 Gray Street P. O. Box 2566
Houston, Texas 77001
John W. Mecom
Aubrey H. Rabensburg CA 5-0331

GEORGE MITCHELL & ASSOCIATES, INC.
12th Floor, Houston Club Bldg.
Houston, Texas 77002
George Mitchell CA 5-0161

RAYMOND D. REYNOLDS, Geologist
436 Bankers Mortgage Bldg.
Houston, Texas 77001
Raymond D. Reynolds CA 7-5309

SOUTHERN NATURAL GAS COMPANY
Esperson Bldg. P. O. Box 1513
Houston, Texas 77001
Roger W. Stoneburner CA 8-9681

OIL FINANCING

BANK OF THE SOUTHWEST, N.A.
P. O. Box 2629
Houston, Texas 77001
Harold Vance, Vice President CA 5-1551
Manager, Oil & Gas Department Ext. 481

DRILLING COMPANIES

BIG "6" DRILLING COMPANY
225 Oil & Gas Bldg.
Houston, Texas 77002
Weldon Smith CA 5-6576

OTIS RUSSELL DRILLING COMPANY
2916 27th Street
Bay City, Texas
Otis Russell CA 8-7919

ELECTRIC LOGGING

CAMBE LOG LIBRARY
718 Milam Street
Houston, Texas 77002
John Todd
B. W. Bown CA 8-3494

REPRODUCTION COMPANIES

CARDINAL PRINTING & LETTER SERVICE, INC.
234 Esperson Bldg.
Houston, Texas 77002
Mrs. Helen C. Bandy
Mrs. Pollyann Howe FA 3-9309

HOUSTON BLUE PRINT & STATIONERY CO.
700 Walker
Houston, Texas 77002
H. H. Yarberry
H. H. Yarberry, Jr. CA 3-4358