logs. From these data, sand percentage and net sand maps were constructed for the upper and lower Frio units.

Lower Frio sand values range from 2 feet to 1,600 feet. Maps tend to indicate that the center of deposition of the lower Frio unit is in Matagorda and Brazoria counties. Thick sequences of sand and shale occur in this area, particularly in the *Textularia seligi* (*mississippiensis*) and *Anomalina bilateralis* faunal zones. Wells here indicate as much as 1,600 feet of sand in a total interval of more than 2,600 feet.

The center of deposition of the upper Frio unit appears to be in Jefferson and Orange counties. This is accentuated by the occurrence of thick sands in the Hackberry zone, which results in more than 1,200 feet of sand in an interval exceeding 3,600 feet. Sand values range from 16 feet to 1,289 feet and sand percentages from 3% to 62%.

Efforts were made to minimize the effects of local structure and local lithologic variations. Nevertheless, such large subregional features as the western Jefferson County graben; the Red Fish Reef-South Mayes complex of Chambers County; the Chocolate Bayou complex, Danbury dome, and the Chenango complex of Brazoria County; and the Old Ocean complex of Matagorda County exhibit lithologic anomalies coincident with the area of their structural influence. These anomalies indicate that structural movement was taking place during deposition.

4. Upper Frio Lithofacies in Eastern Counties of Texas Gulf Coast, Thomas Branham, Socony-Vacuum, Bogota, Colombia, John Grayshon, Trunkline Gas Company, Houston, and Robert Johnson, Dahran, Saudi Arabia.

Maps showing the percentage and number of sands in several intervals of the upper Frio (Oligocene) were prepared from electric well logs to see how clearly such an analysis would reflect the depositional environments. Interpretations were based on a comparison with the sand-clay distribution occurring today in the eastern Texas Gulf Coast counties.

The position of the shore line during late Frio time was remarkably constant, as shown by the similarity in trend of the contours and in position of the maxima and minima on the sand percentage maps of all intervals. Subsidence and deposition must have been very evenly balanced throughout this time. Interfingering of sands and shales in the vertical section indicates numerous minor oscillations of sea-level which had only a transient effect on the position of the shore line.

A barrier island extended from northern Brazoria County northeastward to northern Orange County. North of the barrier island, in the barrier flat and lagoonal environments, evidence of ancient river channels is found. The Frio "hingeline," south of the barrier island, is marked by a pronounced thickening of section, particularly the shales.

5. *Nodosaria* Sand Environments in Eastern Counties of Texas Gulf Coast, James A. Mallory, University of Houston, Houston, Texas.

Lithofacies maps of the *Nodosaria blanpiedi* sand in the middle part of the Frio formation (Oligocene) in the eastern counties of the Upper Texas Gulf Coast were prepared from principally electric well-log correlations. These show a belt of maximum sand concentration extending from central Galveston County northeastward to northern Orange County, approximately paralleling the present coast line. This is interpreted to be a barrier island by comparison with present-day sand distribution along the Texas coast. Downdip from the belt of maximum sand concentration a marked increase in percentage of shale in the *Nodosaria* zone and in thickness of post-*Nodosaria* beds suggests the presence of a flexure or "hinge line."

Although the *Nodosaria* sand was deposited principally during a regression of the sea, local areas of thick sand occurring updip from the inferred barrier island indicate deposition in stream channels early in the subsequent transgression.

6. Effect of Structural Movement of Sedimentation in Pheasant-Francitas Area, Matagorda and Jackson Counties, Texas, John E. Walters, c/o Michel T. Halbouty, Houston, Texas.

The Pheasant-Francitas area of southwestern Matagorda County and southeastern Jackson County, in the central part of the Texas Gulf Coast, is typical of that part of the Frio trend in which deposition of the lower and middle Frio strata was controlled largely by faults along which movement was contemporaneous with sedimentation. Widespread structural movement beginning near the end of Vicksburg time resulted in regional down-to-the-coast faults in relatively shallow water near the ancient shore line. Both the alignment and displacement of these faults seem to have been affected by deep-seated structures which predate the faulting. These faults were active during deposition of the lower and middle Frio sediments, so that thick sections of mud and sand were deposited on the downthrown sides, while comparatively thin sections were being deposited on the upthrown sides of the faults. During early Frio time the fault movement formed miniature depositional basins on the downthrown blocks, centering in the areas of maximum displacement. These miniature basins are characterized by dip and thickening of the middle and lower Frio sediments toward the northwest into the controlling fault. Movement along the faults had diminished by late Frio time and its in-

fluence on deposition became minor. The upper Frio and overlying beds dip normally southeastward toward the Gulf of Mexico. The crests of structural closures within the miniature basins shift with depth due to the rather abrupt changes in the thickness of the middle and lower Frio sections.

7. REVIEW OF HITCHCOCK FIELD, GALVESTON COUNTY, TEXAS, Jesse O. Reiter, c/o Hershal C. Ferguson, Houston, Texas.

The stratigraphy and structure of Hitchcock field, located about 40 miles southeast of Houston, are discussed in light of the 27 wells drilled there since Halbouty and Simmons' original study in 1941. The producing structure appears to be an east-west anticline, the crest of which has been down-faulted to form a graben. Maximum stratigraphic throw of the faults in the field is 280 feet. The large regional strike fault that passes north of the field has a stratigraphic throw of 830 feet. The greatest structural growth seems to have occurred during late Miocene or early Pliocene time.

The sand in which oil was first discovered (5,100-foot sand) is still the most important reservoir in the field. It is absent over the crest of the anticline, but is present on the west, south, and east flanks.

Cumulative production from Hitchcock field through 1957 was 4,115,421 barrels of oil, 1,889 barrels of condensate, and 1,180,919 MCF of gas. All of the oil and most of the gas come from the Miocene. Some gas is produced from the Pliocene. Three wells drilled to the Oligocene Frio sands failed to find production in that section.

8. TURTLE BAY FIELD, CHAMBERS COUNTY, TEXAS, R. P. Akkerman, Gulf Oil Corporation, retired.

Turtle Bay field, about 40 miles due east of Houston, produces oil and gas from upper Frio and *Marginulina* sands (Oligocene). Structurally, the field is an anticline formed not by uplift but by subsidence of its north flank into rim synclines around the Moss Bluff, Lost Lake, and Hankamer salt domes, plus regional tilting toward the southeast. The area of the field remained stable as the southerly regional dip was reversed by subsidence into the rim synclines on the north. A thicker than normal *Heterostegina* limestone is observed on the electric logs of wells drilled in the area, showing reversal of regional dip, and may be used as a criterion to localize the search for more such fields in the district.

9. *Heterostegina* REEF ON PIERCEMENT SALT DOMES, WITH SPECIAL REFERENCE TO NASH AND OTHERS IN NORTHWESTERN BRAZORIA COUNTY, TEXAS, Ralph B. Cantrell, J. C. Montgomery, and A. E. Woodard, Houston, Texas.

Reef limestone as much as 300 feet thick occurs in the *Heterostegina* zone in part of northwestern Brazoria County about 40 miles south-southwest of Houston, between Damon Mound, Nash, and West Columbia piercement salt domes. This locally developed limestone is completely surrounded by normal *Heterostegina* calcareous shale or shale with one or more very thin limestone beds.

At Nash dome the upper part of the limestone is porous, consisting chiefly of "honeycomb" corals, and the lower part is more dense. Indications are that the *Heterostegina* reef developed in a near-shore, shallow-water environment, and that its growth did not stop at the end of Anahuac time but continued even into the early Miocene.

Large-diameter conventional cores are recommended for evaluating the production potential of the *Heterostegina* limestone. Although the best porosity is found in the top of the limestone, it may develop also in other intervals. The limestone production at Nash field does not have a common oil-water contact.

Substantial oil production has been obtained from the *Heterostegina* limestone and more may be expected at Nash, Damon Mound, and West Columbia fields, at depths ranging from approximately 2,000 feet at Damon to 4,350 feet at Nash.

10. LOG INTERPRETATION IN BRACKISH-WATER FRIO TREND, Terry Walker, Welex, Inc., Houston, Texas.

The interpretation of logs in the Frio trend of the Texas Gulf Coast is complicated by thin sands laminated with numerous shale and dense streaks. Such conditions require measurements of Rxo and porosity over very short vertical intervals. Coupled with the higher-resistivity formation water, these conditions, however, offer the ideal application for the FoRxo-Guard combination in that fluid content can be resolved in stringers as thin as 1½ feet. The combination of logs offers rapid formation fluid determination in addition to reliable saturation and porosity calculations.

Correlation between the Guard Log and conventional logs in the area can be made without difficulty. In addition, correlations between Guard Logs from well to well are such that stratigraphic changes can be located closely.

11. STRUCTURE OF KARNES COUNTY AREA, TEXAS, AND ITS RELATION TO JACKSON SEDIMENTATION, D. Hoye Eargle, United States Geological Survey, Austin, Texas.

12. EROSIONAL CHANNEL IN MIDDLE WILCOX NEAR YOAKUM, LAVACA COUNTY, TEXAS, William V. Hoyt, consulting geologist, Yoakum, Texas.