interpretation indicated the crest of a deep closure had not been penetrated. The Sun 27 G. T. Brooking, drilled in December 1972, found new deep production. New reservoirs also were discovered in the previously drilled upper part of the Frio section.

The improved logging techniques used in the wells allowed a more quantitative look at all the sandstones. Combination logging tools providing a simultaneous recording of induction resistivity, acoustic velocity, and computed Rwa curve were used exclusively. Using the Rwa curve as a hydrocarbon indicator, low resistivity sandstones that appeared wet from casual examination were tested and found productive. Other sandstones which appeared to have no vertical separation from overlying water sandstones were tested and found productive.

Twelve new wells were drilled from 1972 through 1974. The drilling program resulted in a significant increase in the daily gas and oil production. Multiple recompletion opportunities also were recognized.

COLEMAN, J. M., and L. D. WRIGHT, Coastal Studies Inst., Louisiana State Univ., Baton Rouge, La.

Deformational Processes in Delta-Front Deposits

River-mouth depositional patterns are modified by sediment deformational processes of sufficient magnitude to endanger severely bottom-supported structures. Several types of deformations are present and include (a) peripheral slumping, (b) differential weighting and diapirism, (c) graben faulting, (d) mass wasting by sediment degassing, and (e) deep-seated flowage. High depositional rates are present near the river mouth and decrease seaward; with time, the bar front oversteepens and rotational slump planes form peripheral to the bar front, moving sediment into deeper water. These blocks have longitudinal dimensions of approximately 200 to 2,000 ft and lateral dimensions of 600 to greater than 2,000 ft. Differential loading by denser bar sands overlying low-density clays results in vertical and seaward flowage of the clays contemporaneously with seaward bar progradation. Diapiric folds and spines (mudlumps) intrude into delta-front sediments on the seaward side of the deforming load, vertical movement affecting sediments to depths in excess of 500 ft. The seaward extrusion and continued movement of clays arch the overlying delta-front sediments, and this stress is relieved by small graben faults oriented radially to the deforming load or delta lobe. The grabens have widths from 150 to 1,500 ft and lengths of several miles. The finer grained river-mouth sediments contain high percentages of methane and CO_2 gases, formed by bacterial decomposition of organics. Passage of hurricane waves produces bottom-pressure perturbations, forcing the entrapped gas upward, causing loss of sediment strength and allowing mass movement. The weight of the modern delta has depressed underlying Pleistocene sands about 400 ft, causing squeezing and flowage of clays onto the continental shelf at water depths greater than 300 ft. Large-scale slumping and faulting near the continental shelf result from this clay flowage. These processes are contemporaneous with deposition and play an important role in initiating a depocenter.

EMMERLING, M. D., and W. F. TANNER, Dept. of Geology, Florida State Univ., Tallahassee, Fla.

Sand Leakage around Rocky Headland at Niteroi, Brazil

A statistical study of foreshore sediments from two adjacent open-ocean pocket beaches near Niteroi, state of Rio de Janeiro, Brazil, was undertaken to investigate sand leakage around the rocky headland separating the beaches. According to May and Tanner, the rocky headland theoretically could act as a cell boundary. A statistical analysis should reveal whether or not the rocky headland is a cell boundary.

Three samples collected from beach 1 (NE of headland) and seven samples collected from beach 2 (SW of headland) were sieved and the four moment measures were determined for each of the samples. The moment-measure analysis was marked by the following pertinent points: (1) mean phi size increases in both directions away from the headland; (2) mean phi size for beach 1 (1.577 phi) is significantly different from the mean phi size for beach 2 (1.297 phi); (3) sorting for both beaches appears to improve weakly toward the headland (0.370 ± 0.020 to 0.450 ± 0.020); (4) skewness increases from a negative minimum (-0.150 ± 0.020) away from the headland to a positive maximum (0.100 ± 0.020) at the headland; (5) kurtosis decreases away from the headland (1.000 ± 0.020 to 0.200 ± 0.020); (6) two-factor regression analysis of the four moment measures (y) versus linear distance (x) away from the headland revealed a weak positive linear trend for mean phi size, a weak negative linear trend for sorting, and strong negative linear trends for skewness and kurtosis; (7) analysis of variance indicated that the variation in mean phi size is significantly different between the two beaches.

Interpretation of the statistical analysis forces one to conclude that the rocky headland is a cell boundary (*e.g.*, little or no leakage) separating two pocket beaches, each of which is in dynamic equilibrium.

FELDHAUSEN, P. H., Dames and Moore, Park Ridge, Ill., and S. A. ALI, Rensselaer Polytech. Inst., Troy, N.Y.

Multivariate Statistical Approach to Sedimentary Environmental Analysis

A multivariate statistical strategy employing cluster analysis, ordination, and gradient analysis was used to determine the depositional environment of Barataria Bay, Louisiana. Cluster analysis of sediments suggests the existence of five sedimentary facies: (1) beach sand, (2) foreshore sand, (3) silty channel sand, (4) silty channel-margin sand, and (5) organic silt and mud. Ordination was used to depict the gradational relations among individual samples and among facies defined by cluster analysis. Gradient analysis suggests a wide range of environmental conditions operating within the bay and substantiates Klovan's factor analysis.

Gradient analysis shows that ordination extracts, successively with each axis, the most variable combination of the original variates. The ordination coordinates become new objectively created variables which are efficient measures of the original grain-size curve.

This multivariate statistical approach to sedimentary environmental analysis may prove useful for partitioning other sediment samples into facies and for examining the interaction between these facies and their environment of deposition.

FEREBEE, T. W., JR., A. H. BOUMA, and G. L. HUEBNER, JR., Texas A&M Univ., Dept. of Oceanography, College Station, Tex.

Towed Horizontal Resistance and Spontaneous Potential Survey off Sabine Pass, Texas

A program of electrical measurements on unconsolidated marine sediments was started by the geologic oceanographers at Texas A&M University in 1968. It consisted of measuring resistance and spontaneous potential on extruded cores and *in situ* in the field, and correlating the electrical values with various sediment and geotechnical properties. The present phase of research concentrates on delimiting and defining sediment lithologies using a towed horizontal array. Several combinations and electrode spacings were tried across Heald Bank, off Sabine Pass, Texas. Bottom-water and sediment samples were collected from well-defined submarine lithologies.

Preliminary results indicate that the spontaneous potential is uniformly highest in mud and clay areas. Large variations occur over shelly sands and shell debris. Resistance is largely uniform across Heald Bank, with relative values depending on electrode