turned beds, or other commonly recognized structural attributes of intrusive masses.

Diapiric shales produce negative gravity anomalies because of low densities. Density logs show densities to be almost as low as salt. Low velocities (indicated by sonic logs) cause shale-mass structures to be mapped seismically as "lows" instead of "highs," unless correct velocity functions are used.

A common clue to subsurface diapiric masses is 0.5-ohm resistivity (IES log) caused mainly by high water content of the shale. Few correlations, if any, can be made in the diapiric mass. An abnormal microfaunal sequence is found in nearly every case, as is high-pressure shale gas. Because of their greater magnitude and distinguishable direction, mudflow dips within an extrusive mass can be recognized commonly by a dipmeter survey. Dips recorded within an intrusive shale plug or a "shale sheath" should be random in both magnitude and direction. Sidewall cores within a diapiric mass contain churned shale pellets and gas bubbles in the shale units and also bear disrupted sand-grain frameworks in the sandstone bodies.

Sandy, water-filled, gas-churned mudflows are high-porosity, low-permeability masses that serve as barriers to hydrocarbon migration. Intrusive structures must have had a timely injection in order to trap migrating hydrocarbons whereas extrusive shale masses are unusual barriers because the barrier is present before or during deposition of the adjacent beds.

Systematic recognition and delineation of extrusive shale masses in the Gulf Goast by both conventional and improved exploration methods will open new frontiers to Gulf Coast petroleum exploration.

21. LEONARD L. LIMES, Consultant, New Orleans, La.

PALEOCLIMATOLOGY: A NEW DIMENSION IN OIL EXPLORATION

As the global search for oil continues, new dimensions are needed to define areas with maximum potential for the accumulation of hydrocarbons.

Oil and gas are formed by organic material deposited under highly selective conditions. Climate affects all living organisms today, as it has throughout the geologic past. The climate at the time of deposition affects both the supply of oil-forming organisms and the associated sediments.

The climate of the earth depends on the heat received from the sun. Because the earth is nearly spherical, a temperature gradient must exist from the equator to the poles. These climatic zones control the environment of deposition and also the resulting oil accumulation.

Paleoclimatology, by revealing the distribution in space and time of its climates of the past, when correlated with known oil accumulation, provides a new dimension in oil exploration.

22. JACK MORELOCK AND WILLIAM R. BRYANT, Texas A. & M. University, College Station, Tex.

PHYSICAL PROPERTIES AND STABILITY OF CONTINENTAL-SLOPE DEPOSITS, NORTHWEST GULF OF MEXICO

Sediments from the continental slope and shelf edge in the northwest Gulf of Mexico were tested to determine their strength, stability, and consolidation characteristics. Consolidation tests for Sabine River delta samples and abyssal-plain samples were used in the interpretation of the shelf and slope samples. To approximate *in situ* conditions, a direct shear-test machine was used to measure shear strength, and an Anteus Back Pressure Consolidometer was used to determine consolidation.

The topography of this area has been attributed to local slumping of unconsolidated and unstable marine sediments. Although the Sabine River delta samples were underconsolidated, the continental-shelf and slope samples all were overconsolidated. The overconsolidation of these samples and the high values of shear strength are assumed to be the results of low deposition rates and incipient cementation of the mineral grains. Analysis of the void ratio *versus* log pressure consolidation curves indicated that the sediments were "sensitive" and, therefore, relatively undisturbed by the sampling process.

The shear strength ranged from 0.05 TSF for the upper 1 m. of sediment to more than 0.5 TSF for a simulated depth of 20 m. The shear-strength tests indicate that the slope sediments should be stable to great thicknesses on even higher slopes than exist in this area.

23. ALAN R. FERGUSON, Humble Oil and Refining Company, Houston, Tex.

FINDING ANCIENT STREAMS MEANS FINDING NEW RESERVES

(No abstract)

24. F. P. C. M. VAN MORKHOVEN, Shell Oil Company, Houston, Tex.

CONCEPT OF PALEOECOLOGY AND ITS PRACTICAL APPLICATION

Economic micropaleontology contributes to the search for hydrocarbons in two equally important ways: it provides the petroleum geologist with correlations and age determinations, and it is instrumental in the delimitation of fossil environments of deposition. This latter function involves the study of paleoecology, which deals with the relations between fossil taxa and (or) assemblages and their environments. Paleoecological studies depend heavily on a thorough knowledge of the ecology of living organisms, but the methods and terminologies used in each field are distinctly different. Because erroneous paleoecological information may influence seriously the geological interpretation of an area, a thorough knowledge of correct procedures and methods in paleoecology is essential, and the limitations in paleoecology also must be realized fully. These procedures are discussed and summarized briefly. Definitions are presented of a necessary set of pertinent ecological and paleoecological terms, some of which are introduced here for the first time. Certain erroneous procedures and misinterpretations common in applied paleoecological studies include the indiscriminate use of well cuttings, the evaluation of poor faunas, and the taxonomic misidentification of fossils.

25. GARRETT BRIGGS, Tulane University, New Orleans, La.

PRIMARY SEDIMENTARY STRUCTURES IN SEARCH FOR PETROLEUM

Several types of primary sedimentary structures have been used in determining the source and direction of transport of sediments. In the last 15 years, much attention has been given to the description and measurement of the azimuthal directions of paleocurrent features and to the preparation of paleocurrent maps to illustrate ancient current patterns. Aside from

the purely academic interests in paleocurrent patterns, the establishment of paleocurrent trends can be of economic significance.

The paleocurrent trends are indicative of the orientation of elongate sandstone bodies in which they commonly occur because their orientations typically parallel those of the sandstone bodies. Paleocurrent patterns, therefore, may be of assistance in depicting more accurately sandstone trends on isopachous maps. Current trends may be determined by, or reflect, grain orientation and thus yield information regarding the fabric and preferential permeability directions of sandstone beds. A marked departure in the paleocurrent pattern of one fault block relative to the pattern in adjacent blocks can be indicative of the relative amount and direction of movement of the block.

Measurements of the orientation of paleocurrent features are obtained readily from outcrops. In the subsurface of the Gulf Coast, the recognition and measurement of current trends must be made through the use of oriented conventional cores and (or) the high-resolution dipmeter. From oriented cores, paleocurrent directions may be determined from cross-bedding or from the orientation of elongate particles.

Advancements in the instrumentation of dipmeters and improvements in the computation of dipmeter data have made possible the recognition of dip directions of cross-bedding in the subsurface. It is recommended that attention be given to paleocurrent features in the subsurface as an aid in the determination of sandstone, permeability, and structural trends.

26. HUBERT C. SKINNER, Tulane University, New Orleans, La.

PALEOECOLOGY OF LATE NEOGENE DEPOSITS AT BELLE GLADE, FLORIDA

About 30 ft. of gray shell marl is exposed along Florida Highway 80, 1 mi. south of Belle Glade and 3 mi. east of South Bay, Palm Beach County, Florida. The fauna from these deposits includes at least 115 species of Mollusca and 36 species of Foraminiferida. Twenty-six extinct molluscan species (20 pelecypods and 6 gastropods) were recovered; 4 fresh-water gastropods were recognized. The molluscan and foraminiferal faunas were identified and counted, and paleoecological data were compiled.

The Foraminiferida are benthonic forms characteristic of nearshore marine environments. The association of genera compares with modern assemblages from the nearshore turbulent zone or coastal lagoon. The species of Mollusca identified range from fresh-water forms (in rare occurrence) through shallow-water marginal-marine to normal-marine forms. However, approximately 40% of the molluscan fauna is composed of *Chione cancellata* (275 specimens), *Anomia simplex* (147 specimens), and *Macrocallista maculata* (110 specimens). The abundance of these shoal-water species suggests an environment with a water depth of less than 10 fm. in an open-sound or open-lagoon margin with a mud bottom. The age of the Belle Glade deposits is interpreted to be Plio-Pleistocene.

27. JACKSON E. LEWIS, Tulane University, New Orleans, La.

PALEOECOLOGICAL STUDY OF PLEISTOCENE MARINE FAUNA, FLAGLER COUNTY, FLORIDA

Selected techniques of biofacies analysis were applied to an unconsolidated sedimentary deposit in the Pamlico Formation of Pleistocene age in Flagler County, Florida. An oriented sample containing 0.61 cu. ft. of concentrated shells and sand yielded data which were subjected to analyses of taxonomic diversity, texture, abundance, and incomplete specimens. Of the mollusk shells present, 80% are pelecypods (39 species) and 20% are gastropods (37 species). Faunal elements indigenous to the depositional site could not be discerned, but the 19 species comprising 93% of all mollusk specimens suggest a depositional environment of shallow-water, high salinity bays with sand or sand-mud substrate, weak currents, considerable wave action, and a minimum water temperature of 50°–55°F.

28. KATHERINE M. KAMP, Tulane University, New Orleans, La.

CLASSIFICATION OF NEOGENE CONES (MOLLUSCA, GASTROPODA, GENUS *Conus*) FROM SOUTHEASTERN UNITED STATES AND CARIBBEAN

Fossil species of *Conus* from the southeastern United States and Caribbean areas never before have been studied systematically. Previously recorded *Conus* occurrences have appeared only as parts of faunal lists from certain localities. Thus, the resulting number of synonyms and inaccurate identifications have increased through the years.

Because no study of the relations between described species, horizontally or vertically, has been made, this study was undertaken to evaluate and to revise the nomenclature of fossil cones from numerous localities in the southeastern United States and Caribbean regions. The extensive collections of Cenozoic mollusks at Tulane University provided much of the material studied, supplementing field collections made by the writer. Several institutions, including the United States National Museum, the Academy of Natural Sciences at Philadelphia, and the Paleontological Research Institution, kindly have loaned type specimens.

More detailed study of this genus reveals that some forms designated as different species actually are variations of the same species. Morphological variability studies for the shells of each locality are being made. Ecology, where appropriate, is correlated with the morphological data. A new technique, the relation of color patterns on fossil shells to the morphological features, is used. The method for partly restoring color to fossils has been developed recently by Axel A. Olsson. Shells oxidized either artificially or by exposure to the sun exhibit their definitive color patterns clearly under ultraviolet light. Although the color of a shell may vary within a population, depending on its environment or diet, the basic patterns of dots in spiral rows, tent shapes, bands, or reticulations are fixed for a given species. The color pattern is produced by the arrangement of excretory glands in the mantle, and as such is a physiological feature and, therefore, a record of the soft parts of the animal.

Intensive study of one genus, with regard to its position in time and its distribution in space, helps resolve some of the taxonomic problems. Because *Conus* has a wide distribution (tropical Atlantic, Pacific, and Indian Oceans, and their associated seas), an efficient study must be limited geographically. With the several techniques discussed, and the large collections and many references at hand, the more accurate classification of this genus is achieved.