served events, respectively. The average vertical separation during episodes of normal and reverse faulting was 1.90 and 0.24 mm, respectively. The cumulative vertical separation recorded during episodes of reverse faulting was 20% of that recorded during episodes of normal faulting.

Events occurred at different times along the same fault. This suggests that faults that have not been demonstrated to be active still must be considered to be capable of moving at any time at possibly damaging rates.

The events appear to be caused primarily by differential compaction and expansion of the Chicot aquifer in response to changes of its piezometric surface. Lesser causes may be the release of tectonic extensional strain energy, the depressuring of hydrocarbon reservoirs, and the movement of salt domes.

REINSON, GERALD E., and PETER S. ROSEN, Geol. Survey Canada, Dartmouth, Nova Scotia

Depositional Sequence in Subarctic Sandy Beach Face, Central Labrador

Beach-face deposits on the strand-plain coast near Michael River, Labrador, contain four distinct units. The basal unit 1 (60 cm thick) is a graded sequence of well-mixed sand and gravel near the bottom and medium-grained laminated sand at the top. It is disconformably overlain by unit 2 (20 cm thick) which consists of fine to medium-grained sand with contorted and disrupted laminations and small pods of loosely packed sand. Unit 3 (25 cm thick) is a chaotic gravel and sand sequence devoid of sedimentary structures, whereas the uppermost unit 4 (20 cm thick) consists of well-laminated, fine to medium-grained sand.

The stratigraphic sequence is interpreted as follows. Unit 1 represents the normal berm accretionary phase of late summer 1977, and unit 2, the foreshore accretionary phase during early winter. In early winter, the wetted beach surface begins to freeze and a deposit of interlaminated sand and ice forms under the continuous action of swash-backwash. This deposit is later deformed, owing to volume reduction and loading, during thawing. Small sediment-laden ice blocks, which are washed up and incorporated into the accreting laminated sequence, are represented by porous sand pods when the ice medium melts. Unit 3 is the remnant of ice-rafting and ice-push deposits which accumulated during ice breakup in spring 1978, whereas unit 4 records the normal foreshore swash-backwash accretionary phase of early summer 1978. The fact that freeze and breakup events are recorded within a complete yearly cycle of beach-face accretion indicates that such events could be preserved in the rock record under rapidly aggrading summer-beach conditions similar to those at Michael River.

REYNAUD, R., P. R. LOUIS, and J. LACAZE, SNEA(P), Chambourcy, France

Deltaic Facies Recognition on Seismic Data

Seismic sections relating to shelf facies generally display parallel or slightly divergent reflections. An analysis of internal parameters (such as continuity amplitude, frequency, and phase), areal associations, and external geometry of each unit allows a direct prediction of the nature of the deposits.

In the Niger delta, diagnostic seismic facies relate to each environment (marine, littoral marine, littoral, sea marginal, and fluvial). These seismic facies are also closely related to the electrofacies. Seismic models have been computed for several types of environment and comparison to the real section supports the interpretation.

REYNOLDS, RICHARD A., and RICHARD E. CASEY, Rice University, Houston, Tex.

Neogene Radiolarian Biostratigraphy and Paleo-Oceanography of North Boundary Currents

Deep Sea Drilling Project (DSDP) cores from offshore Japan and California, land-based sections from California, and Holocene sediment samples from surrounding areas have been used to develop radiolarian biostratigraphies and to interpret paleo-oceanographic conditions for the Neogene of the Japan Current (a western boundary current) and the California Current (an eastern boundary current). Our studies suggest that (1) the present-day characteristics of boundary currents (western being deeper, narrower, swifter, and less productive than eastern boundary currents) have varied greatly throughout the Neogene, but are tied one to another; and (2) both mid-latitude regions can be correlated biostratigraphically to low latitudes. The Japan region is most correlative to low-latitude radiolarian biostratigraphic zones. The developed biostratigraphy of the region and inferred paleo-oceanographic trends aid in correlation of the California region to low-latitude radiolarian biostratigraphies. Comparison of material from boundary-current regions with equatorial and subpolar North Pacific DSDP material suggests that tectonic events such as the uplift of Panama may be tied to the observed Neogene changes in these boundary-current regions. These studies have also been instrumental in indicating radiolarian taxa that may be used to suggest relative paleodepth of deposition and eutrophic conditions in these boundary-current regions.

REYNOLDS, RICHARD L., and MARTIN B. GOLDHABER, Texaco Inc., Houston, Tex.

Marcasite in Roll-Type Uranium Deposits

Iron disulfide minerals occur in anomalously high concentrations in uranium-bearing zones of roll-type uranium deposits and are thus important components of the geochemical system that governs formation of these uranium orebodies. These high concentrations have been interpreted by previous workers as resulting from an ore-stage generation of sulfide superimposed upon a pre-ore generation. We have examined petrographically over 500 polished sections from five roll-type deposits, three from Texas and two in Wyoming, and have recognized both pre-ore and ore-stage generations of iron disulfides in each deposit. The two generations may be distinguished by textural relations. In each deposit, marcasite is present as an ore-stage sulfide; in

two Texas deposits (one in Webb County, the other in Live Oak County), it is the dominant ore-stage sulfide. This ore-stage marcasite occurs as intergrowths within and overgrowths on uranium-bearing phases and in close association with ferroselite near the redox boundary. Ore-stage marcasite occurs commonly as overgrowths on pre-ore sulfides that are dominantly pyrite both in ore and in a more extensive halo around the altered tongue. In two of the Texas deposits, ore-stage marcasite is present as much as 200 m (Webb County) and 400 m (Live Oak County) downdip from the roll front. Because of the close association of marcasite and uranium mineralization, understanding the conditions that lead to marcasite precipitation enables clearer determination of the geochemical environment of ore deposition. Kinetic factors are shown to favor marcasite over pyrite and we suggest that undersaturation with "monosulfide"-type phases such as mackinaurite and greigite are a prerequisite for marcasite formation.

RICART Y MENENDEZ, FERNANDO O., Museo Nacional Historia Natural, Santo Domingo, Dominican Republic

Subaerial Diagenesis of Axial Corallite of *Acropora Cervicornis*

In the subaerial environment the axial corallite of *Acropora cervicornis* is micritized. The micritization starts in the biologically secreted aragonite; later, the pore-infilling cement (recrystallized or not) is micritized. If the micritized fibers are leached out, the nonmicritized fibers are left without support and the corallite becomes crumbly (chalky). As more fibers are micritized, the corallite may be leached out entirely. If the pores of the corallite are infilled with minerals resistant to leaching, a reticular three-dimensional frame will be left in the space occupied by the corallite. If the new voids are infilled by drusy calcite a cast of the corallite will be created. The aragonitic fossil corals located in the splash zone may be replaced by calcite crystals, with much of the texture of the original cement, septa, septothecae, and costae reappearing and being preserved as ghosts in the calcitic crystals. The spherulitic texture of septa, septothecae, and costae produced by a submarine recrystallization process is not preserved.

RICE, DUDLEY D., RICHARD B. POWERS, an EDWARD W. SCOTT, U.S. Geol. Survey, Denver, Colo.

Relation of Sedimentary History and Tectonics to Natural Gas Accumulations, Western Gulf of Mexico

The western Gulf of Mexico province, which lies offshore from the states of Louisiana and Texas, is estimated to contain large resources of natural gas in Miocene, Pliocene, and Pleistocene rocks.

Interpretation of chemical and isotopic analyses of natural gases from 47 fields suggests that the province is important as a gas-producing region for three reasons. (1) Several shallow Pleistocene accumulations are of apparent biogenic origin; this gas is characterized by enrichment of the light isotope C^{12} in methane (δC^{13} lighter than -55 parts per thousand) and by large amounts of methane ($C_1/C_{1\text{-}5} > 0.99$). (2) Many of the Miocene accumulations were generated during the early stages of thermal cracking of liquid hydrocarbons. This type of gas is wetter than biogenic gas ($C_1/C_{1\text{-}5} > 0.92$) and isotopically heavier (δC^{13} heavier than -43 parts per thousand). (3) Numerous accumulations occur in thermally immature (with respect to oil generation) rocks in which hydrocarbons, particularly gases, have migrated vertically from deeper, more mature rocks. These gases are relatively dry ($C_1/C_{1\text{-}5}$ generally > 0.90), and have a wide range of carbon isotope values.

The gas occurrences can be related to the sedimentary history and tectonics of the area. The location, areal extent, and thickness of sediments in late Tertiary and Quaternary depocenters controlled the distribution of reservoir and source rocks and the depth of the maturity level for each rock series. Movement of a thick Mesozoic salt section, in conjunction with concurrent subsidence of the Gulf basin and the influx of sediments, resulted in folding and faulting of Cenozoic rocks and the formation of structural traps. Regional growth faults, plus radial faults associated with salt diapirism, provided pathways for the migration of hydrocarbons.

RICE, G. W., M. L. BAKKER, and D. M. WEINBERG, Continental Oil Co., Ponca City, Okla.

Geoseismic Modeling—An Interactive Computer Approach to Stratigraphic and Structural Interpretation

The solution of complex structural and stratigraphic problems often requires a merging of geologic, geophysical, and computer science principles. Geoseismic modeling is one such multidisciplined approach that allows the geoscientist to test geologic concepts to see if they can be confirmed seismically. Often, many iterations are required to formulate a geologic model that adequately matches the measured seismic response. To do this effectively, the geoscientist must have easy access to accurate theoretical principles and be able to interact with the computer in a real time environment. This leads to the following important considerations in making the computer an effective tool for geoseismic interpretation: (1) the geoscientist must be able to interact with the computer using his own language and terminology; (2) good human engineering principles, including graphic input and output devices, are necessary for describing the geologic model to the computer; (3) the system must be interactive to allow the geoscientist to test various geologic configurations quickly and to adapt these to the measured seismic response, because long turnaround time associated with batch processing interrupts the thought process and usually leads to an incomplete analysis; and (4) the system must be flexible enough to describe accurately both the seismic characteristics and the geologic configuration.

RICE, G. W., and B. M. BRANDT, Continental Oil Co., Ponca City, Okla.

Wave-Form Factor Analysis—Quantitative Approach to Seismic Stratigraphy