Synthesis of seismic data, geologic mapping, and satellite imagery suggests a general 3-stage model of thrust and fold development in the Southern Appalachian belt. Essential to the model is the contrast in gross physical properties of the 2 basic rock packages present: (1) lower Paleozoic carbonates and chert, which behave competently, and (2) upper Paleozoic sandstones and shales, which behave incompetently. The individual structural development of each of the 2 rock packages differs but both are directly related to the development of a thrust structure.

Stage 1.—Initial displacement (0-3 mi) creates a large hanging-wall anticline (drag fold) in the lower Paleozoic.

Stage 2.—With greater displacement (2-5 mi), a J. L. Rich model anticline develops in the lower Paleozoic hanging wall. In the process, the upper Paleozoic was bulldozed by the lower Paleozoic, creating more internal folding and faulting.

Stage 3.—With further displacement (> 5 mi), the thrust will probably become a major overthrust. It develops by ramping of the lower Paleozoic through the highly deformed upper Paleozoic with intense penetrative deformation developing in areas of significant overthrusting.

From this 3-stage model, it may be possible to infer source rock and reservoir juxtapositions, relative timing of hydrocarbon generation, and fracture development. The regional distribution of structural types suggests that initiation of thrusting progressed westward with time. The model may have application in other orogenic belts (e.g., the Idaho and Wyoming Overthrust belt.

LOVE, KAREN M., and HENRY S. CHAFETZ, Univ. Houston, Houston, TX

Morphologic Variations of Calcite Crystals in Waterfall Travertine Deposits, Arbuckle Mountains, Oklahoma

A motley assortment of low-magnesian calcite morphologies occurs in travertine deposits in Oklahoma. These morphologic variations result from (1) precipitation, (2) dissolution, and/or (3) neomorphism in this nonmarine environment; analogous morphologic variations in both marine and nonmarine strata may likewise indicate nonmarine processes.

Commonly precipitated crystals include hexagonal prisms and rhombohedrons (2-150 μm long), and bladed to fibrous forms (0.02-2 mm long, many revealing triangular cross sections). Many of these crystals contain inclusion-defined growth layers that dissolve preferentially, leaving abundant intracrystalline porosity. This porosity parallels crystal outlines, imparting a nested appearance to the crystals. Partial dissolution also creates parallel "spikes" (4-30 μm long, 1-10 μm wide), and parallel "ribbon" crystals (30-150 μm long, 3-12 μm wide) that repeatedly narrow and widen, and occasionally twist. In addition to precipitational and dissolutional forms, aggradational neomorphism produces columnar crystals, commonly exceeding 8 mm in length. These crystals originated as elongate spar around filamentous cyanophyte tufts and were transformed subsequently into ragged-edged columnar crystals at the expense of overlying micritic crystals.

Morphologic variations in calcite crystals often have been attributed to ionic concentrations (particularly Mg and SO_4) of ambient waters. In this study, however, the low concentrations of both Mg (averaging 12 ppm) and SO_4 (approximately 16 ppm) may be interpreted as supporting theories relating precipitational morphologies to growth rates rather than to "poisoning" ions. In any case, recognition of similar morphologic suites resulting from precipitation, dissolution, and/or neomorphism may aid in the identification of nonmarine processes in marine and nonmarine strata.

LOWRIE, ALLEN, Geologist, Picayune, MS, and DONNA WELLS BLAKE, NORDA NSTL Station, MS

Sedimentation Dynamics About Salt Features

Detailed side-scan sonar and gridded bathymetric surveys on continental margins reveal the existence of numerous submarine canyons. Recently published compilations of current velocities in submarine canyons indicate that alternating and undirectional flows often exceed 20-30 cm/sec with peak velocities ranging from 70 to 100 cm/sec. Current meters attached to the ocean floor have been lost at current velocities of 190 cm/sec. Such velocities are ample to transport sand-size sediments. The results of DSDP Leg 96 show the existence of massive sands and gravels on the Louisiana slope, deposited during the last glacial advance. Thus, present physical oceanographic data may be an analog to conditions during glacially induced lowered sea levels. Salt ridges and domes underlie much of the Louisiana slope, determining morphology. Submarine canyons lace the slope. Given a prograding shelf, the net sediment transport routes will be down the submarine canyons. Sediment deposition patterns around the salt ridges and domes include parallel-bedded foredrifts on the upslope side, lee drifts on the downslope side, and moats along the lateral flanks of the salt features. Major differences exist between the sedimentation patterns around a ridge and a dome. The size and shape of the flow pattern will determine whether there can be a flow over the salt feature with a resulting turbulent wave that may influence sedimentation. Sedimentation patterns about salt features on the present slope should be applicable to similar paleoenvironments.

LOWRIE, ALLEN, Geologist, Picayune, MS

Seismic Stratigraphy, Pleistocene Climate, and Tertiary Sea Level Changes

The Quaternary is characterized by 2 climatic signatures: that of the last 800,000 yr, the upper Pleistocene climatic signature (UPCS), and that of the period from 900,000 to 1,800,000 yr ago, the middle Pleistocene climatic signature (MPCS). Glacial cycles within the UPSC are about 100,000 yr long with interglacials of 10,000-12,000 yr duration and a "full" glacial period of 20,000-30,000 yr. The cycles of the MPSC range from 20,000 to 40,000 yr duration. Interaction between the 3 planetary orbital parameters of eccentricity, tilt, and precession are believed to cause the observed climatic signatures.

From DSDP cores, 8 major Miocene hiatuses have been described. There is a roughly equal duration of hiatuses and deposition, with periods ranging from 0.5 to 2 m.y. $\pm$0.5 m.y. The deep-ocean hiatuses correlate well with the seismically determined lowered sea levels of P. Vail. The hiatuses are interpreted to be caused by increased activity of ocean-bottom currents, in turn initiated by increased glacial activity. Thus, it is geologically reasonable that within each period of increased glacial activity there are 100,000-yr long UPSC-type cycles. The UPCS cycles have been tentatively identified in seismic data on the Louisiana, east Greenland, and Caribbean shelves and on the Indus Cone. Miocene glacial cycles should be sought in seismic data using innovative data processing techniques.

LU SONG NIAN, LI WEI MIN, GU HUI MIN, GAO PIN WEN, Beijing College of Geology, People's Republic of China

Effect of Biological Markers and Kerogens in Geochemical Exploration for Oil and Gas

The aliphatic hydrocarbons of 29 Tertiary argillaceous rock samples from eastern China have been examined by computerized gas chromatography-mass spectrometry. The steroid and triterpenoid components provide new information for the characterization of depositional environments, organic matter, and maturation of the source rocks. These samples contain gamaceranes, 8,14-open-hopanes, diterpenoid hydrocarbons, and diasteranes. The abundant gamaceranes correspond to the preference of even carbon atoms. The highest gamacerane occurs in the strongly reducing environment. The abundant diterpenoid hydrocarbons relate with the type III kerogen. These diterpenoid hydrocarbons are derived from higher plant forms. The threshold of oil formation can be correlated with the ratio of 20S (22S) and 20R (22R).

LUMSDEN, DAVID N., Memphis State Univ., Memphis, TN

Distribution of Dolomite in Deep Marine Sediments as Function of Time

The distribution of dolomite in deep marine sediments as a function of time was determined for the Cretaceous and Cenozoic, 150 Ma to present, using data from 1,142 DSDP samples. The general distribution patterns for the Atlantic and Indo-Pacific are similar. Their curves show a maximum in the Miocene, minimum in Paleogene, and 2 maxima in the Cretaceous separated by a Cenomanian low. The less time-extensive data of the Gulf-Caribbean and Mediterranean have a Miocene maximum. Red Sea data peak in late Miocene to early Pliocene. The general similar-