shore and is represented by a change in trend of Triassic and older rocks ashore. The implications of this and other newly established features are discussed.

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EARLY VADOSE SILT IN TOWNSEND MOUND (REEF), NEW MEXICO

Vugs, fractures, interstices, and other voids in the Townsend carbonate mound (reef) are floored with internal sediment composed of well sorted calcite silt. Internal sedimentation predates precipitation of blocky cement, and post-dates both precipitation of early drusy cement and early internal erosion. The crystal silt differs from associated marine sediment in its scarcity of clay-size particles, sand-size particles, and recognizable skeletal debris.

The age relationships and texture of crystal silt seem best explained by sedimentation inside pre-existing crumbly rock in the vadose zone during early emergence. If the explanation is valid, similar internal sediment might be a valuable clue to previously unrecognized subaerial stages in other carbonate mounds.

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CONCEPTS OF THE ATOKA

The Atoka was named and defined as the formation between the Hartshorne Sandstone above and the Wapanucka Limestone below (1900, 1901).

The basal part of the Atoka is considered by some to correspond with the Kessler Member of the Morrow.

Minute fusiform fusulinids are known from the basal Atoka at Clarita, Oklahoma; and it is commonly believed that *Fusulina* is entirely a post-Atokan genus.

However, "Fusulina" was already described from beds assigned an Atokan age (in New Mexico and Wyoming); and now prolific *Fusulina* was found about 400 feet below the Hartshorne northwest of Clarita.

It would be logical not to expect lithologic boundaries, no matter how locally persistent, to coincide with major steps in evolution of embedded fossils, no matter how seemingly rapid. Hence, biostratigraphic boundaries postulated on the evidence of evolution of fusulinids need not correspond with lithologic boundaries, although they may do so at places. The first appearance of the fusiform fusulinid *Fusulinella* appears to coincide roughly with the basal sediments of the Atoka, at least in the type area of the Atoka; but the first appearance of *Fusulina* is undoubtedly well within the upper and perhaps even middle part of the original Atoka.

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CHARACTERISTICS OF CONTINENTAL SHELVES AND SLOPES

One of the most important and interesting geological questions awaiting solution is that of the origin of continental shelves and slopes. Just as for other geological features, more than a single origin is involved for different areas or for different times. Data on structure, composition, and topography provide the clues for interpretation of geological history and thus of origin, but such clues are presently so incomplete that interpretations are uncertain. Common to many areas is the presence of a downwarped basement under the slope and(or) a topographic depression beyond the slope—but is this cause or effect? Also common is the composition: marine sediment—but what can we infer about the precise environment of deposition of these sediments? Are they neritic under the inner part of the shelves and bathyal beneath the slopes? How important are turbidites for the continental rise beyond? How similar are the Mesozoic and Tertiary sediments to those of the Pleistocene and Recent? The present topography is reasonably well known—but is it similar to ancient topography? In many areas the present shelf has been shaped by processes unique to the Pleistocene—does this mean that continental shelves did not exist before the Pleistocene? New data will be presented by the different speakers, all of whom have been active in field studies. We, perhaps, will find that a comparison of the results of their field work in large, but widely separated, areas will provide a much needed fresh approach to the question of the origin of continental shelves and slopes.

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SEDIMENT AND STRUCTURE IN THE DEEP BASIN OF THE GULF OF MEXICO

Underway seismic reflection measurements have been made almost continuously since January, 1961, on expeditions of Columbia University's Research Vessel VEMA. Reflection profiles reveal the sedimentary layers down to a strong, rough-surfaced reflector which is assumed to be basement. These profiles display, in the deep basin of the Gulf of Mexico, buried structures which are believed to be salt domes. The sedimentary layers revealed in the Gulf of Mexico are discussed and hypotheses are offered about the geological history of the region and the possible means by which salt domes could emerge in deep oceanic basins.

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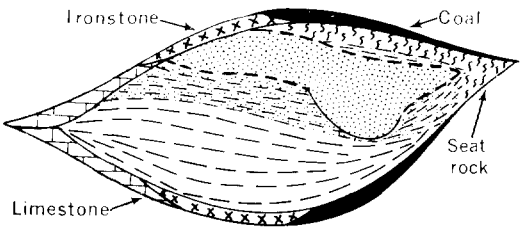
MODEL FOR CYCLIC SEDIMENTATION IN THE APPALACHIAN PENNSYLVANIAN

The basic elements of an idealized or model cyclic deposit in the Pennsylvanian strata of the Appalachian region are the commonly occurring rock types—siltstone, shale, sandstone, coal and associated "seat rock," ironstone, and limestone. These rocks can be considered as members of genetic classes which reflect dominance of either "physical" or "chemical" depositional processes. Siltstone, shale, and sandstone are mainly the product of physical deposition of solid particles from suspension, whereas coal, "seat rocks," ironstone, and limestone wholly or in part originate from biochemical or physical-chemical processes. Pennsylvanian sequences consist of alternating layers of these "physical" and "chemical" deposits of varying thicknesses and such alternations comprise, perhaps, the only completely unequivocal manifestation of cyclic sedimentation: Specific differentiation of lithologic types beyond this simple "physical"-"chemical" dichotomy leads to increasing complexity in describing the cyclic deposits. Stratigraphic sections commonly show "chemical" units which may include only one or all three of the common chemical rocks. Likewise, physical units may include one or more rock types and the sequence of these rock types differs from cycle to cycle.

Detailed studies at lateral variation of completely exposed small cyclic deposits and of larger cycles with a small rate of lateral variability suggest the generalized model shown diagrammatically. This diagram, shown



with "chemical" rocks as limiting members, represents a cross section of a Pennsylvanian cycle extending from seaward to landward (left to right) extremities. Examples show that this simple model is modified by local as well as regional conditions.

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RECENT CARBONATES OF ISLA MUJERES? QUINTANA ROO

Isla Mujeres, off the northeast tip of Yucatan, consists of oölitic dunerock. The Caribbean coast is subjected to heavy waves, and the sediments are coarse, well sorted, highly polished and rounded; coralline algae, carbonate rock fragments, *Halimeda* and coral are abundant. The lee (western) beach is protected; sands are finer, well sorted, dull, and angular with *Halimeda* greatly predominant. Straits separating Isla Mujeres from Yucatan are swept by strong northerly currents: sediments are poorly sorted, negative-skewed, and consist of a bimodal mixture of (1) dominant small, polished oölites, and (2) subordinate coarse oölitic rock fragments with some skeletal grains.

Sorting of beach sediments is a sinusoidal function of mean grain size; best sorting is at 2ϕ, -3ϕ, and -8ϕ. Sorting values (σ) of 0.3–0.6ϕ are characteristic of all beaches regardless of grain size, from fine sand to coral boulders, regardless of composition and regardless of wave energy of the coast. Protected bay sediments are muddy and poorly sorted (immature); sediments from current-swept straits are winnowed, but poorly sorted (submature); sediments of lee beaches are well sorted but dull and angular (mature); and sediments of beaches exposed to high waves are well sorted, rounded and highly polished (super-mature).

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RESEARCH AND THE PETROLEUM INDUSTRY

If research were to be considered as an industry in itself, it would rank among the largest in the United States. Ever since the beginning of World War II, the amount of money invested in research and development has been increasing much more rapidly than the Gross National Product (GNP); growing from a few tenths of a per cent of GNP in 1939 to about 3 per cent of GNP in 1961. Although research by and for the U. S. Government is now more than half of the total, the expansion of research in the petroleum industry has been almost entirely financed by that industry. Research in the earth sciences has become a large part of the petroleum industry effort. It is, however, different in many ways from research on processes and products. For many years, a lack of appreciation of the true nature and role of geological and geophysical research inhibited effective integration of the results of research into the operations of the industry. By now, research is widely recognized as an important and valuable ally of the exploration geologist and geophysicist.

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DETAILED STRATIGRAPHIC CONTROL THROUGH DIP COMPUTATIONS

Recent dip interpretation techniques utilize high-density computations to define depositional and structural features. The definition of stratigraphic patterns is accomplished in both shallow and deep horizons. The method is of increased importance in the deeper provinces, where seismographic techniques lack resolution.

Faults may be recognized and defined, both as to direction of dip and to strike. Characteristic dip patterns delineate channels, bars, and unconformities. Definition of complex channeling has provided the necessary control for more efficient development of some deep South Louisiana fields. Patterns of deltaic depositions, with definition of foreset beds, are also apparent from dip computation results.

Reef structures can be located and defined by interpretation of dips resulting from deposition on the irregular reef surface, from talus slopes, and from differentially compacted formations.

In several instances, the presence of shale diapirs has been confirmed.

Machine computations of Dipmeter surveys, with dips computed as frequently as one per foot of hole, are particularly suited to these problems.

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ANALYSIS TECHNIQUES AND SIGNAL ENHANCEMENT METHODS APPLIED TO THE BELLSHILL LAKE STRATIGRAPHIC TRAP PROGRAM

A test program was conducted in the Bellshill Lake field to investigate the application of seismic techniques to finding the stratigraphic trap formed by the irregular sand bar type build-up within the Basal Quartz section controlling production in the field.

The seismic interpretative criteria were postulated from synthetic seismograms.

Controlled field tests were conducted to find the factors which influenced record quality, to examine the effect of each factor on the signal-to-noise ratio, and to evaluate the field techniques developed from the test results. Critical field techniques were the selection of charge sizes and hole depths yielding both suitable shot wave forms and a means for attacking the ghost reflection problem, the attenuation of shot generated boundary waves through wave length filtering with arrays of multiple seismometers, and the preservation of true amplitude information in the recording procedure. Special data processing techniques included the application of a velocity filter, the "pie slice" process to improve the signal-to-noise ratio without signal distortion, and the stacking of vertically distributed charges with a process designed to eliminate the ghost over a broad frequency range without signal distortion.

The emphasis in the experimental survey was in the methods of investigation and the particular balance in techniques which must be struck to solve an explora-