proceed confidently to use all the energy needed to promote economic progress throughout the world so that all mankind may enjoy a better and richer life.

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STRATIGRAPHY OF THE VICKSBURG EQUIVALENT OF LOUISIANA

A study, extending from western Mississippi across Louisiana and into East Texas, of the surface stratigraphy of the Vicksburg (Oligocene) equivalent in Louisiana reveals that five units comprise the sequence from upper Jackson (Eocene) to lower Catahoula (Miocene): (5) massive quartzose sandstone; Cassels Hill Member of the Catahoula Formation (20–50 feet); (4) clays and silts, fossiliferous and calcareous; east of Sabine Parish designated Rosefield Formation and in Sabine Parish and farther westward called Nash Creek Formation (25–70 feet); (3) well sorted quartzose sand; Sandel Formation (20 feet); (2) chocolate clays and lenticular quartzose sands; Mosley Hill Formation (80 feet); (1) khaki-colored fossiliferous clays; Danville Landing Beds (100+feet).

These units remain consistent and persistent along strike across Louisiana. The three middle units represent the original Mosley Hill group thought to be Oligocene by Murray, but in this paper the Mosely Hill is restricted to the lower unit which is present at the type locality. The names Sandel and Rosefield are new. The maximum thickness of the total sequence is 180 feet in Catahoula Parish. The Cassels Hill Formation is separated from the Rosefield Formation by a disconformity beneath which the Rosefield decreases in thickness from 70 feet in Catahoula Parish to 7 feet in western Louisiana and East Texas.

The Mint Spring Marl of the lower Vicksburg sequence in Mississippi is subdivided into the underlying marl facies which extends westward and the overlying carbonate facies which extends eastward. The Rosefield Formation of Louisiana is thought to correlate with the entire Vicksburg sequence at Vicksburg plus the uppermost 15 feet of the Forest Hill of Mississippi. The Sandel and upper Mosley Hill represent the Forest Hill (restricted) of Mississippi and the Danville Landing is upper Yazoo equivalent. The Sandel pinches out westward into Texas so that there is no separation between the Mosley Hill and Rosefield clay and silt sequences, both of which are represented in the type Manning of Texas.

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EVOLUTION OF THE CONTINENTAL SHELF AND SLOPE

Further explanations of the origin of the continental slope, such as ascribing it to catastrophism, normal faulting, a wave-built terrace, or marginal downwarping, appear to be unsatisfactory. Instead, the writer considers continental slopes to have been constructed by the folding of the continental rise against the continental block, forming a eugeosynclinal orogen. Accordingly, continental slopes would be the flanks of such orogens; a secondary cause for some continental slopes may be the modified scarp left after a rifting-apart of a continental mass by continental drifting. Once formed, initial continental slopes undergo modification by erosion and sedimentation. A proposed mode for such geomorphic evolution is presented. Continental shelf formation is a part of this evolution.

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BIAS FACTORS IN LOOSE-GRAIN DATA

In loose-grain studies, sampling of grains by point-count or other conventional methods is never equivalent to sampling of the sediment by volume. This causes severe difficulties in comparison of Recent sediments, in which loose-grain data are frequently used, with older sediments, in which thin-section or chemical data are used. Even sieve data are not directly comparable. Correction of loose-grain data to a "volumetric" basis is surprisingly complex and uncertain.

Where a sediment must be described in terms of its volume, all loose-grain point-count data are systematically biased in favor of the finest grains present on any area. Given equal volumes, the frequency of encounter of any grain-size category is cut in half every time the grain diameter is doubled. This can be demonstrated with assorted spheres, by chopping a potato into successively smaller cubes, or by simple algebraic derivations. Shape factors may contribute an additional bias which is not considered here.

After transformation of the raw data to "volumetric" ratios by multiplication, a certain amount of bias is still present, or "uncorrectible," unless *every grain* in a sediment is counted. In statistical terms.

$\bar{\bar{X}} = \mu$ only if $n = \infty$ (where μ is the un-biased, "parent," "volumetric" model mean)

The "uncorrectible" portion of the original bias is a function of: (1) sorting or "Variance"; (2) the number of points counted, or "sample size"; and (3) Gaussian normality of the un-biased natural property with respect to volume. Bias (1) increases dramatically as the sorting gets poorer, (2) decreases asymptotically toward zero as the number of points is increased, and (3) becomes highly erratic for properties which are not "normal." The effect of this bias on polymodal properties is catastrophic.

Estimation of the "uncorrectible" portion of the bias, from the behavior of mathematical models, is a haphazard procedure at best. Only a few models have been worked out, due to the number of calculations which become necessary. In the model shown here, the "uncorrectible" bias is more than half of the total bias.

Until good methods of bias-correction can be developed, statistical comparisons of loose-grain properties must be considered either: (1) unrelated to sediment volumes, or (2) confounded with sorting and (or) normality. Hence, comparisons of size, and any property dependent upon ("interacting with" or "correlated with") size, must be accompanied by tests demonstrating complete uniformity of sorting ("Homogeneity of Variance", at the "point" or "error" level). Where this is impossible, interpretation of the test results becomes frustrating and virtually futile.

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ATLANTIC MARGIN OF NORTH AMERICA

Recent investigations in previously poorly covered areas and with new techniques have extended our knowledge of the structure of the continental margin of eastern North America. The sedimentary trough under the continental rise has been better defined by seismic profile data and structural trends have been followed by magnetic measurements. Among the features recently identified is a structural offset at 40° North Latitude which appears to be a transcurrent fault offshore 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