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INFLUENCE OF CLIMATE ON VARVES AND BEDDING

Varved sediments provide an imperfect record of changes in climate by means of variations in varve thickness. Erratic varve thickness pulsations with about 2 to 30 years between maxima agree with similar fluctuations in meteorologic records and show no strong periodicities according to power spectrum studies. However, weak rapidly changing climatic patterns are generally present with a slight favoritism for periodicities near 5 years.

Normally, varves form in quiet places that are relatively insensitive to the short climatic oscillations, but three sequences (Devonian Beaverhill Lake Formation, Oligocene Florissant lake beds, Miocene Monterey Formation) have yielded some information about them and about certain aspects of bedding. The short-term changes (2 to 30 years) are at least partially responsible for the timing of severe storms and floods that scour the bottom or shed coarse clastic layers into a basin.

Subtle varve thickness trends with a tendency toward quasiperiodicity near 90 and 180 years that may be related to solar activity have been observed, and varve calibration of bedding features formed in quiet low-energy situations suggests that low energy (Fondo) bedding couplets on the scale of 1 cm to 3 dcm are the result of 100–300-year climatic changes. Bedding features of the same and larger scale formed in higher energy environments are under the influence of the shorter, more erratically timed, climatic fluctuations.

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STRUCTURE OF PORTIONS OF THE NORTHERN CONTINENTAL SHELF, GULF OF MEXICO, AS DETERMINED BY SEISMIC REFRACTION MEASUREMENTS

The data from numerous seismic refraction profiles are presented in the form of five cross sections and three isopach maps. The specific areas covered are (1) the continental shelf south of Galveston, Texas, and (2) the continental shelf south of the Florida Panhandle. The area south of Galveston is represented by one cross section. This section shows the continuation seaward of the south-dipping sedimentary beds of the Texas Gulf Coast to a point approximately 60 km. south of Galveston where a reversal of dip is noted. At this point, presumably the axis of the Gulf Coast geosyncline, there are 13 km. of post-Cretaceous sediments. A broad ridge between the geosyncline and the Sigsbee scarp is shown. In the area south of the Florida Panhandle, four cross sections and three isopach maps show the relationship between the known onshore structure and the structure of the shelf. A continuation seaward of the Apalachicola embayment is noted and the great thickening of the Lower Cretaceous is shown to continue approximately 20 km. south of the present shoreline.

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GEOLOGIC RECORD OF HURRICANES

The passage of Hurricane Donna (September 9–10, 1960) across south Florida, an area where details of the pre-storm sea floor were well known, enabled the recognition of widespread storm effects. The recognition of these storm effects led to the conclusion that a significant part of marine sedimentation records the geologic work of large storms.

Specific storm effects were as follows: (1) formation of large quantities of boulder-size rubble by the action of surf on corals at the platform edge; (2) transportation of all sizes of material away from the open sea toward the platform interior; (3) stranding of layers of carbonate mud over wide areas on the supratidal flat (above the normal high tide line).

The amount of boulder-size rubble formed by hurricane surf on platform-edge reefs far exceeds the amount produced by day-to-day processes of death and deterioration. Each large storm adds an increment to the building of the rubble accumulations.

The large extent of supratidal flats is due to the ability of storm tides to strand sediment over large areas, the inaccessibility of the supratidal flats to processes that could rework its sediment into adjacent marine environments, and the supply of the supratidal flat sediments at the expense of adjacent marine sediments that compete with it for a place in the geologic record. These factors help explain the large amount of supratidal sediments in some ancient rocks.

Interesting negative aspects of hurricane's effects were that: (1) mound-type accumulations of muddy sediment were not eroded by storm wave or tidal currents, and (2) the sediment-laden waters resulting from the stirring of bottom sediments into suspension by the storm waves and currents did not give rise to effective turbidity currents.

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FORAMINIFERAL BIOFACIES IN SEDIMENTS OF THE GULF OF BATABANO, CUBA*

The Gulf of Batabano is about 180 miles long, 190 miles wide, and is located on the southwest coast of Cuba. The floor of the Gulf is a shallow submerged platform area with water depths ranging between 0 and 40 feet. The southern margin of the platform is bounded by a precipitous declivity resulting in deep-water facies on the south being separated from shoals of the platform by a narrow structural trend.

On the platform, foraminiferal abundance and diversity are greatest in the northern and western areas of Batabano Bay. Ostracodes are also most abundant in these areas. Foraminifera are from 10 to more than 50 times as abundant as ostracodes over most of the bay. General biofacies patterns include abundant miliolids in perimeter areas of the bay, an *Elphidium* facies in the central area of the bay, and an *Archaias* facies in the southeastern area of the bay. Areas of mud matrix characterize the first two biofacies whereas non-skeletal grains correlate with the *Archaias* facies.

Detailed and specific dominant foraminiferal faunas include: (1) a brackish *Ammonia beccarii tepida* assem-

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blage in the Ensenada de la Broa; (2) a transitional miliolid-*Elphidium* facies over much of the inner bay area; (3) an *Archaias* high-energy biofacies in the eastern part of the bay associated with coarse sediment, relatively stable salinity values, and a rather high oxygen content; (4) a *Discorbis-Vertebralina* low-energy biofacies in the western part of the bay in areas of mostly mud matrix; and (5) a reef-front facies composed of *Amphistegina lessonii, Asterigerina carinata,* and *Rotorbinella rosea* which are associated with coarse well-sorted sediments, strong currents, and a high oxygen content. Planktonic Foraminifera do not occur in the platform biofacies.

Deep-water cores off the Batabano platform show high percentages of displaced platform Foraminifera within the benthic faunas, more than 80 per cent planktonic Foraminifera in deeper-water cores, foraminiferal numbers of several thousand, and rare reworked Miocene Foraminifera.

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VELA UNIFORM AS OF EARLY 1963

For the past three years, VELA UNIFORM has been underway as a major national effort directed toward achieving a reliable system for detecting, locating, and identifying nuclear explosions underground. A brief review is made of the more interesting technical developments of importance to the practicing earth scientist. Such developments include improved knowledge of variations in the earth's crust and upper mantle, distribution of seismic noise near and below the earth's surface, ocean-bottom seismometry, advanced seismic array processing, and on-site inspection techniques, both aerial and surface. A brief film of some of the major physical facilities sponsored by VELA UNIFORM is also shown.

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RECENT MEANDER BELT DEPOSITS OF THE BRAZOS RIVER: AN ALLUVIAL "SAND" MODEL

Point bar deposits of the Brazos River near Richmond, Texas, appear to be typical of an alluvial meandering stream of this size. They are the principal meander belt deposits and consist of a sequence of silt and fine sand grading downward to coarse sand and gravel. A typical section may be subdivided into four generalized zones, each characterized by a particular class of sedimentary structure: (1) small ripple (or small scale) cross-bedding, (2) horizontal lamination, (3) giant ripple (or medium scale) cross-bedding, and (4) poor bedding. The section is an offlap sequence deposited within the channel or the depositional (convex) bank area as the stream meandered laterally toward the erosional or caving (concave) bank. The average thickness of the total section is 55 feet, which is equal to the average maximum depths of the river during flood stages.

Natural levee sediments deposited along the flood stage bank are 5 feet or less in thickness and are difficult to distinguish from the uppermost point bar sediments.

As the stream meanders within its belt, it produces a suite of deposits, consisting of sediments characteristic of point bars, natural levees, and fills of abandoned channels and oxbow lakes. The widths of the belts and related deposits, which are approximately 1.5 miles and 18–20 times the width of the stream, appear to be controlled primarily by the radius of curvature (600–2,400 feet) of the meanders.

Abandoned channel fills consist principally of laminated and bedded clay and silt. They are tortuous or arcuate in ground plan, a few hundred feet wide, and their cross sections are roughly U-shape. The deposits range from a few feet to approximately 40 feet thick and usually occupy positions within the upper two-thirds of the compounded point bar sections.

Flood basins within the alluvial plain of the Brazos are adjacent to the meander belts and are topographically lower, approximately 5 feet, than the uppermost point bar and natural levee sediments. The flood basin deposits are laminated and poorly stratified sandy clay and silt containing numerous soil zones and calcareous and ferruginous nodules.

During the Late Recent standing sea-level stage, approximately the past 3,500–5,000 years, the Brazos has developed and abandoned several meander belts within its alluvial plain, which is approximately 7 miles wide near Richmond. Most belt trends are approximately at right angles to the regional depositional strike. Cross-bedding directions and grain orientation conform with various river current directions, and most are aligned closely with the trends of the depositional banks of the individual point bar deposits.

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INTRODUCTION: WHY A SYMPOSIUM ON CONTINENTAL SHELVES AND SLOPES?

Criticism of two kinds often is leveled at research symposia held in conjunction with annual meetings—lack of timeliness and lack of substance. Our premise in organizing this Research Symposium has been that its topic should be of current interest and be concerned with fundamental geologic problems; likewise, new data should be presented and interpreted.

An informal summary of fourteen alternative topics for this Research Symposium was circulated among a large number of geologists with a representative range of practical to theoretical interests. The topic being discussed was favored by the majority in a ratio of two to one. Every effort has been made to locate and invite the participation of all those workers who currently are investigating facets of these problems. All of the speakers are from the various oceanographic institutes. The absence of representatives from the petroleum industry as participants in this Symposium is not due to any lack of invitations.

Off-shore petroleum exploration is one of the most important and competitive spheres of petroleum exploration today. The importance of such marine exploration promises to become even greater in the future. The major part of this exploration will be confined to continental shelves and slopes. Likewise, the major part of land-based petroleum exploration occurs within sediments that were deposited in so-called shelf or slope environments. Any better understanding of the entire geologic framework of continental shelves and slopes will assist materially in petroleum exploration.

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PATTERNED SEDIMENTATION OF PENNSYLVANIAN AND PERMIAN MARINE STRATA IN PART OF THE CORDILLERAN AREA

Repetitive to cyclic sedimentary patterns characterize many sequences of marine rocks of Pennsylvanian and Permian age in parts of eastern Nevada and western Utah. The assemblages accumulated in different (at