western hemisphere bounded by latitudes 40°N and 14°S and longitudes 60°W and 108°W, it is concluded that this part of the earth's crust has been segmented into major blocks bounded by wrench fault zones. The absence of "island arcs" in this area is noted. Four occurrences of triangular crustal "building blocks" bounded on two sides by wrench-fault zones and on the third by autochthonous fold belts are pointed out, as are other recurring crustal components.

An interpretation of basement faulting based on the application of the principles of wrench-fault tectonics to observed tectonic features leads to the conclusion that the observed tectonic pattern of Middle America can have resulted from the interplay of essentially meridional crustal compression and equatorial compression, both of which are thought to have been active throughout geological time.

There is a clear relation between the distribution of oil and gas provinces and the basement tectonic pattern.

MOORE, DAVID G., U. S. Navy Electronics Laboratory, San Diego, California
CURRAY, JOSEPH R., Scripps Institution of Oceanography, LaJolla, California

Sedimentary Framework of Continental Margins

The sedimentary framework of selected continental margins of North and Central America has been investigated by means of non-explosive, continuous-reflection seismic systems. These records have been interpreted in the light of present knowledge of distribution of sedimentary facies and the processes of transgression and regression on modern continental shelves.

As a result of these studies, it is concluded that there is no typical continental margin. Fundamental differences exist in regional tectonism, rates of supply of sediments, and oceanographic agents of transportation, deposition, and erosion. Predominantly tectonic-erosional versus depositional types can be recognized, but are not necessarily related by evolutionary sequence. Submerged Pleistocene deltas are important in shaping present continental shelves and slopes. All types of shelves and slopes recognized today, existed prior to the Quaternary, but without the depth uniformity and abruptness of shelf break.

MOUNTJOY, ERIC W., Geological Survey of Canada, Ottawa, Ontario, Canada

Miette Reef Complex (Devonian), Jasper National Park, Alberta*

A small limestone reef complex occurs in the Front Ranges of eastern Jasper Park. From exposures in three thrust sheets, reconstruction indicates a sub-rectangular outline with an area of about 30 square miles. The main reef sequence is in the order of 1,400 feet thick, circumscribed by a slightly thinner succession of shales and argillaceous carbonates. This reef is comparable to the moderate sized biostromal reef complexes of the Alberta basin.

The depositional history of the reef can be interpreted from the reef geometry and stratigraphy, well exposed reef margins, and carbonate petrology. The basal transgressive sediments are represented by a widespread, thin, argillaceous, fine calcarenitic, stromatoporoidal and *Amphipora* limestone (Flume) deposited over a flat erosion surface on Cambrian strata. Due to increasing rates of subsidence the deposition of organic, biostromal carbonates (upper Cairn) was restricted to the areas underlain by a thicker development in the basal limestone of stromatoporoidal carbonates, presumably shoals. Stromatoporoid reefs with thin interbeds of *Amphipora* limestone and calcarenite form the main constituents of the Cairn biostromes. Fine calcarenites (Maligne) deposited adjacent to the biostromes probably represent detritus eroded from their margins. Further increase in the rate of subsidence induced growth of bioherms around the margins of the stromatoporoid biostromes. These bioherms enclosed a central lagoon. In the central part of the Miette reef this resulted in a gradual change from dark-colored, stromatoporoidal carbonates (upper Cairn) to light-colored, fine, non-skeletal, granular limestone (lower Southesk). Black, pyritic shales (Perdrix) deposited during this period in the adjacent basin indicate stagnant, poorly circulated waters. More rapid subsidence appears to have drowned the reefs, and terrigenous muds reduced basin relief (lower Mount Hawk). Gradual emergence of the reef produced a small platform or bank above which non-skeletal lime sands (main part of Southesk) were deposited in the restricted and agitated waters. Carbonate muds derived from the bank were added to the terrigenous muds (middle and upper Mount Hawk), further reducing basin relief. Lime sands (upper Southesk) gradually spread over adjacent Mount Hawk muds. Scattered small coral reefs developed near the edges of the bank. During this final stage of slow sedimentation interspersed with periods of non-deposition, quartz silts were deposited over the region.

The Miette reef was localized above the positive pre-Devonian arch which parallels the eastern Front Ranges and Foothills. Growth of the Miette reef appears to have been largely controlled by continued differential subsidence above this arch and by shoals and stromatoporoid reefs in the upper part of the Flume.

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MURRAY, GROVER E., Louisiana State University, Baton Rouge, Louisiana

Geologic History and Framework of Gulf-Atlantic Geosyncline

A coastal geosyncline (paraliageosyncline) extends more than 4,000 miles along the eastern margin of North America from Newfoundland to British Honduras. About half of this element, which ranges from less than 100 to more than 500 miles in width, is covered by waters of the Atlantic Ocean and Gulf of Mexico. In the uncovered part, some Jurassic—but mostly Cretaceous and Cenozoic—strata crop out in belts which are progressively younger seaward. Rocks and features which have been considered to be inherent features of either miogeosynclines or eugeosynclines are found in the province.

The geosynclinal sedimentary mass, lithically variable, roughly lenticular in cross section, and built on a basement of differing Precambrian and Paleozoic rocks, is relatively linear in plan between Newfoundland and Florida. Between the latter and British Honduras, it constitutes a great irregular arc which almost encircles the Gulf of Mexico. Maximum thicknesses of the sedimentary materials are on the order of 25,000 feet in the Atlantic segment and 50,000 feet in both the northern and southern Gulf of Mexico. These occur generally near the margin of continental (sialic) material. Notable landward deviations (embayments) exist in the vicinity of the Mississippi River and Rio Grande, whereas significant seaward extensions form the Florida and Yucatan platforms. The thick sedimentary depocenter of the northern Gulf of Mexico region, frequently called the Gulf or Gulf Coast geosyncline, is in reality only a segment of the larger feature.

Character and degree of deformation vary appreciably but they appear to be principally due to vertical stresses resulting from isostatic and gravity adjustments, density differentials, igneous emplacements, sedimentary loading, subsidence—whatever the cause, crustal thickening and flow, bulging around the perimeter of depocenters, or combinations of these. Segments of the geosynclinal mass, involved in orogenic activity which created the Sierra Madre Oriental of Mexico, constitute the Coahuila and Chiapas marginal folded provinces. Here, structural types normally attributed to compressional stresses, or to large-scale gravity sliding, predominate. Elsewhere, the presence of intrusions, volcanic flows, and tuffaceous materials discloses episodes of Triassic, late Cretaceous, and Tertiary igneous activity.

Large structural features, such as the Ocala, Sabine, Tamaulipas, and Teziutlán uplifts, and the Mississippi and Rio Grande embayments, are mobile "sags and swells" or "welts and furrows" in the developing geosynclinal province. Certain of these appear to have been positioned, possibly effected, by landward and seaward deviations (salients and recesses) in the late Paleozoic orogenic belts.

Major systems of normal, strike faults, or of pronounced monoclinal flexures are common. They are closely related to (1) fracturing of the continental margins in the early stages of the geosynclinal development, and (2) subsidence associated with rapid sedimentation. Other normal faults of divergent orientations are also numerous. Reverse and thrust faults predominate in the more deformed areas of Mexico and Guatemala.

Salt structures, many of them diapiric, are common in the salt basins of Mississippi, Arkansas, Louisiana, Texas, Tamaulipas, Veracruz, and Tabasco. Clusters of them reflect a close association of thick salt and superjacent thick sediments and, to less degree, zones of faulting and flexing.

Many of the structural features—positive or negative, large or small—have not always maintained the same form and position. As entities, they have tended to persist in a general area but the apex of maximum uplift or downwarp of a particular feature frequently has shifted in space and time. In all cases, however, the different structural features have exerted their own individual influence on the form, character, thickness, or pattern of adjacent sedimentary materials.

The oldest strata which can be considered an integral part of the geosyncline are thick, probable Triassic redbeds. Superjacent strata consist of widespread evaporites, notably halite, and redbeds which may be Triassic, Jurassic, or both, in age. Younger Jurassic, Coahuilan, Comanchean, and early Gulfian rocks vary lithically from coarse, marginal, or continental clastics to basin and platform or shelf carbonates. Thick evaporites, predominantly anhydrite, are present in the late Jurassic, Coahuilan, and Comanchean of the Gulf region in Mississippi, Louisiana, Arkansas, Texas, Tamaulipas, Nuevo Leon, Coahuila, Campeche, Yucatán, Guatemala, and probably Chiapas. Extensive, calcareous-argillaceous, marine Cretaceous beds constitute evidence of the maximum spread of oceanic waters upon North America during the Mesozoic and Cenozoic. Subsequently, in the Tertiary, waves of clastic sediments progressed into the geosynclinal province. Paleogene sedimentation centered in the Rio Grande delta region of southern coastal Texas whereas Neogene deposition was concentrated in southern Louisiana and adjacent offshore area. Tertiary thicknesses in each area exceed 25,000 feet. In the Florida and Yucatán platforms, on the other hand, deposition of carbonates predominated during the entire Mesozoic and Cenozoic.

Major sedimentary units of the geosynclinal mass are arranged in belts roughly concordant with the general trend of the modern shore. In gross form, they resemble flattened link sausages, the thick portions corresponding with centers or loci of deposition (depocenters) of particular sedimentational epochs. Several depocenters of the same age constitute a regional axis of deposition (depoaxis), the locations of which have gradually shifted gulfward since the Jurassic. Major reversals of this gulfward migration occurred in the Cretaceous and Tertiary and resulted in widespread cyclic sedimentary sequences (cyclothems).

The major source of sedimentary supply for the Atlantic segment of the geosyncline was eastern United States and Canada, particularly the Appalachian Mountains. In the northern Gulf region, Mesozoic materials were also apparently derived mainly from eastern United States but great quantities of Cenozoic detritals came from western United States. Some local land areas supplied sediment in Mexico, Guatemala, and British Honduras during the Triassic, Jurassic, and early Cretaceous but, throughout most of the Cretaceous and Cenozoic, the principal supply sources for these areas were lands at the west or south.

Thick redbeds, of Triassic or probable Triassic age, within or adjacent to the province, suggest that the geosyncline was initiated by fracturing of the continental margins when the continent generally was elevated following late Paleozoic orogenies. A major system of perimetrical faults, so remarkably accordant with structural trends in the Ouachita structural belt as probably to be related to or controlled by them, effected an almost closed, more or less starved, Gulf basin. Great quantities of NaCl and $CaSO_4$ were precipitated by an as yet unproven mechanism. Deposition of evaporites was followed by clastics and carbonates. Filling of the Gulf basin by seaward building (prograding) of sedimentary masses occurred for long periods, creating widespread conditions ideal for the generation and entrapment of hydrocarbons.

With progradation, depression of the continental edges continued; the sedimentary masses increased generally in thickness, possibly because of concentration in belts of less width; and tilting and uplift of the landward margins of the older rocks of the geosyncline occurred. Sags, swells, faults, salt structures and so on, measurably deformed and affected the sedimentary materials. These processes of accretion and deformation continue today, gradually adding girth and natural resources to the continental area.

NOLAN, THOMAS B., United States Geological Survey, Washington, D. C.

Current Research of the U. S. Geological Survey

The research program of the U. S. Geological Survey comprises a multitude of investigations within two broad categories: research related to the appraisal, development, and utilization of our mineral resources—minerals, mineral fuels, and water—and research whose primary aim is to advance geologic and hydrologic knowledge. Within these two extremely broad fields, the concept of "target areas," including topical "targets" as well as geographic ones, enables us to develop our research program through concerted attacks on broad problems of regional or topical importance.

The principal targets in our research on natural re-