

suggested previously. Similar evidence indicates that the late Paleozoic Ouachita and Marathon orogenies were arc-continent collisions. Correlative periods of deformation for both of these orogenies have been documented from many places in northern and northwestern South America.

The early Paleozoic history of the Cordilleran mobile belt appears to have been independent from that of the eastern mobile belt. In the late Paleozoic, however, these mobile belts seem to have become coupled tectonically to produce regional stresses that were released along several major megashears. In southern and southwestern North America these include the Wichita and Texas megashears; a third megashear is probably present in northern Mexico. Late Paleozoic movement on these fault zones produced numerous basins and uplifts throughout these regions.

Modifications of the model proposed by Malfait and Dinkelman for the origin of the Caribbean region include the opening of a sphenochasm in the Gulf of Honduras, and regional tensional and compressional stresses resulting from the clockwise rotation of North America. The Gulf of Mexico and the present dislocated positions of the Ouachita and Marathon fold belts are the result of an opening sphenochasm under the present Mississippi embayment and the westward displacement of the Ouachita and Marathon fold belts by left lateral movement on the Wichita and Texas megashears.

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CERTIFICATION PHENOMENA IN ANTARCTIC AND PACIFIC DEEP-SEA SEDIMENTS—A SCANNING ELECTRON MICROSCOPE AND X-RAY DIFFRACTION STUDY

Diagenetic sequences leading to the formation of deep-sea chert have been studied in drill and piston core samples taken in the Antarctic and Pacific Oceans. A pure white chert cored at the base of a Neogene diatom-radiolarian ooze sequence on the Kerguelan Plateau (Southern Ocean) contains no volcanic alteration products and was derived solely from the solution and reprecipitation of biogenous opaline silica. The chert consists entirely of alpha-cristobalite spherules (5-10 microns in diameter) with some strongly etched fragments of siliceous microfossils.

Cristobalite spherules identical with those reported from the Antarctic, as well as the Atlantic and Caribbean Ocean basins, are present in Upper Cretaceous and Tertiary cherts and silicified limestones of the equatorial Pacific Ocean basin. Diagenetic sequences involving the replacement of carbonate microfossils and ooze matrix have been traced via scanning electron microscopy. A typical replacement sequence is: (1) cristobalite spherules are deposited within the interstices of coccolith oozes and chalks; (2) concomitantly, calcareous nannofossils begin to dissolve, thereby producing additional pore space (some calcite is lost to the rock, but some is reprecipitated within the interstices as euhedral crystals up to 10 microns in diameter); and (3) more cristobalite is precipitated while more calcite is dissolved. The process continues until the calcite matrix is completely replaced by cristobalite.

Foraminifera tests in the calcareous ooze apparently recrystallize or are dissolved outright. Cristobalite spherules are deposited within molds or within the recrystallized test. Finally, the recrystallized tests are dissolved leaving a cast of cristobalite.

In all samples studied, cristobalite was deposited as an authigenic mineral by means of inorganic chemical precipitation. In no place was a gel phase observed, and none is thought to exist in the formation of deep-sea chert.

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LATE CRETACEOUS DEPOSITIONAL SYSTEMS IN NORTHEASTERN MEXICO

The Parras and Sabinas basins in Coahuila and Nuevo León and the Ojinaga basin in northeastern Chihuahua were the principal sites of Late Cretaceous sedimentation in northeastern Mexico. Comparative study of these basins provides insight into the Late Cretaceous geologic history of the area. Inter-basin similarities suggest first-order regional patterns; whereas, differences are the product of second-order local causes.

The three basins contain a similar sequence of deltaic deposits that show the same sense of progradation (west to east). The deltaic sequence is older (Campanian) in the Ojinaga basin and younger in the Parras and Sabinas basins (Campanian and Maestrichtian). Regional uplift, continuous sediment input, and shifting depositional sites from Campanian through Maestrichtian time produced these eastward shifting deposits.

The deltaic sequence differs from basin to basin. It is 1,000 ft thick in the Ojinaga basin, 3,000 ft thick in the Sabinas basin, and 10,000 ft thick in the Parras basin. Coal deposits are part of the sequence in the Ojinaga and Sabinas basins, but are absent in the Parras basin. Sediments in the Ojinaga and Sabinas basins were deposited during a single major progradational event; whereas the sediments in the Parras basin were deposited during multiple progradational and retrogradational cycles. These differences in the anatomy and thickness of the depositional sequences were produced by local tectonic events. The relatively thin, deltaic sequence with associated coal deposits of the Ojinaga and Sabinas basins suggests low subsidence rates together with low sediment input rate in these areas. The thick, cyclic, noncoal-bearing, progradational-retrogradational sequence of the Parras basin suggests a high rate of subsidence and sediment input concomitant with tectonic instability south and west of the depositional area.

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PALEOSTRUCTURAL ANALYSIS OF OLD OCEAN FIELD

The petroleum geologists' search for energy sources leads him to prospective areas where he conceives structural or stratigraphic traps. This is only the beginning, however, for in order to understand and delineate the potential of an area one needs a clear and concise concept of the depth-burial-migration sequence of the prospect. In an effort to clarify and relate this concept to future prospects, the Old Ocean field has been analyzed.

Significant hydrocarbons are absent in pre-F-21 sands. The F-21 is local nomenclature for a producing sand body found approximately 300 ft below the top of the lower Frio.

One gas-condensate reservoir (F-21) and one oil reservoir (F-12) with a sizeable gas cap were analyzed by following their structural development from the time of earliest closure to the completion time of hydrocarbon migration.

In the F-21 reservoir, a small anticlinal trap was available to migrating hydrocarbons as early as the time of deposition of the F-19 sand. In the F-12 reservoir, closure was established by the time of deposition of the *Nodosaria blanfordi* marker. Migration could have started this early, provided a supply of hydrocarbons was available.

On the basis of the size of the traps then available, the depth of burial at that time, and the associated pressure-volume-temperature relations, it was deduced that accumulation in both reservoirs could have been completed by the beginning of Miocene deposition, but not much earlier. This time coincides approximately with cessation of movement on the principal fault.

The structure was in an area of drainage large enough and sufficiently rich in hydrocarbon source rocks to provide the known reserves. It is further concluded that a trap existed at such time as physical and chemical conditions permitted release of oil and gas from the source material, and they became free to migrate.