GL04151

The evolution of Middle America and the Gulf of Mexico–Caribbean Sea region during Mesozoic time

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ABSTRACT

A plate-tectonic model for the evolution of Middle America and the Gulf of Mexico–Caribbean Sea region is presented. The model, which is based upon the existence of the Mojave-Sonora megashear, incorporates into the Triassic Pangea reconstruction three microplates between North and South America, thus avoiding the overlap of the Bullard fit. These plates are the Yaqui, bounded on the north by the Mojave-Sonora megashear; the east and west Maya plates, bounded on the north by the Mexican volcanic zone and on the south by a predecessor of the Motagua fault zone; and the Chortis plate (parts of Guatemala and Honduras). During Late Jurassic time, as North America split away from Europe, Africa, and South America, shear, with left-lateral sense of displacement, occurred along the transform faults that bounded the microplates.

If ~800 km of left-lateral displacement along the Mojave-Sonora megashear, ~300 km along the Mexican volcanic belt, and ~1,300 km along a proto-Motagua megashear are restored, and if Yucatan and Cuba are rotated to fit against northern South America, then (1) a curvilinear belt of late Paleozoic rocks that show lithologic as well as paleontologic similarities extends across the reconstruction and links outcrops in Texas, eastern Mexico, nuclear Central America, and Colombia; (2) a Mediterranean-like sea is delineated that was a precursor of most of the present Gulf of Mexico; (3) correlation is implied between the distinctive quartzose San Cayetano Formation of Cuba and the Caracas and Juan Griego Groups of Venezuela.

Geometric constraints suggest that probably shear initially occurred along the Mexican volcanic zone near the end of the Middle Jurassic. Subsequently, probably about 160 m.y. ago, displacements that total ~800 km began along the Mojave-Sonora megashear. Contemporaneously, Yucatan and fragments of pre-Cretaceous rocks that compose parts of central and western Cuba migrated northward toward their present positions. Rotation of Yucatan was facilitated by considerable displacement along the proto-Motagua zone and along a zone that is probably coincident with the modern Salina Cruz fault. Accumulation of widespread major salt units of Late Jurassic (Callovian to early Oxfordian) age in the Gulf Basin probably occurred contemporaneously with the arrival of these blocks at their present positions. Clastic units that interfinger with some of the youngest salt units and rim the Gulf of Mexico have not recorded major recognized translations since their accumulation.

Clockwise rotation of South America and the Chortis plate occurred during Early Cretaceous time. This movement, which was manifested by subduction of Jurassic ocean floor against the previously rifted precursor of the island of Cuba and under parts of Hispaniola and Puerto Rico, is recorded by circum-Caribbean orogeny.

Abrupt changes in the relative motions between North and South America during Late Cretaceous time may have resulted in extension and outpourings of basalt upon the Jurassic rocks of the ocean floor of the Venezuelan Basin. West of Beata Ridge, sea-floor spreading formed the Colombian Basin. Related subduction occurred as the Chortis plate (including part of Central America, the Nicaraguan Rise, and southeastern Cuba) was sutured against the Maya East plate along the present Motagua fault and Cayman Trench.

Our model is constrained by published geologic data, the relative positions of North and South America from Atlantic sea-floor magnetic anomalies, and the requirement that the major transform faults be compatible with the poles of rotation for the appropriate relative motions between North and South America. Paleomagnetic data from Middle America are sparse but do not conflict with the predicted motions of some of the microplates, especially Chortis.

INTRODUCTION

The Mojave-Sonora megashear, whose existence is suggested by interruption of northeasterly striking Precambrian tectonic belts, was defined by Silver and Anderson (1974) as a zone of major apparent left-lateral offset. This zone of disruption appears to extend S50° E from the southern Inyo Mountains, California, across the Mojave, Colorado, and Sonoran Deserts, into the Sierra Madre Occidental of Sonora, northeast of Hermosillo (Fig. 1). Examination of the regional distribution of overlying late Precambrian and Paleozoic rocks resulted in recognition of truncation of depositional trends offset in a sense compatible with the megashear. Provocative similarities between stratigraphic columns in the Inyo Mountains–Death Valley region and the area around Caborca, Mexico, on opposite sides of the dislocation zone, suggest 700 to 800 km of left-lateral offset. Arguments based upon: (1) the tectonic and stratigraphic history

Supplementary data (Appendix) for this article are available upon request from the GSA Documents Sécretary. Ask for Supplementary Data 83-13.

Geological Society of America Bulletin, v. 94, p. 941–966, 18 figs., 1 table, August 1983.

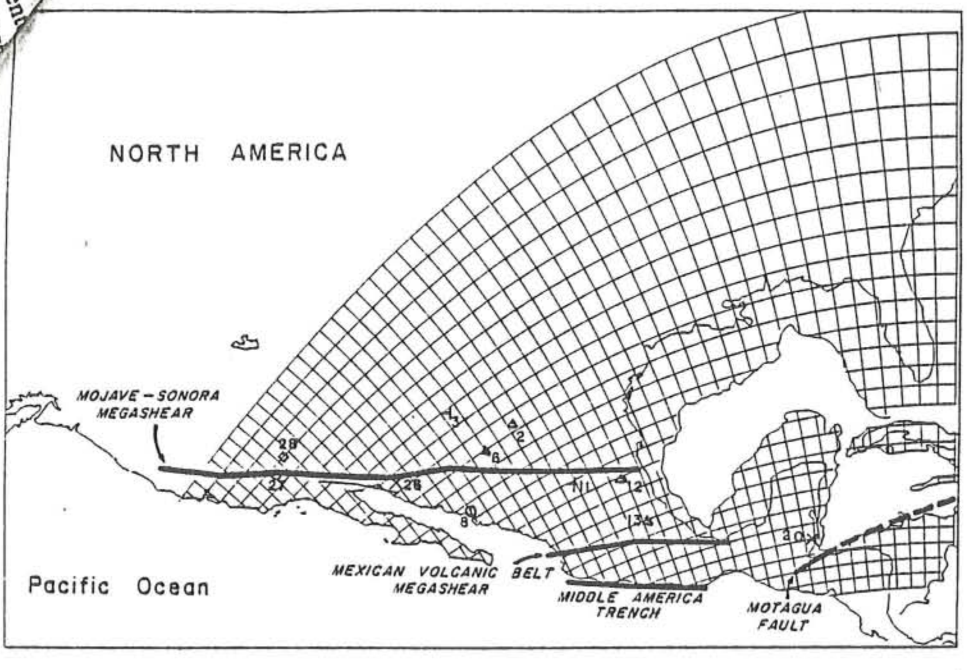

Figure 2. Oblique Mercator projection of Mexico, Middle America, and the Gulf of Mexico from the pole of rotation defined by the Mojave-Sonora megashear at lat. 52° N; long. 79° W.

- **2 - Δ - Marathon Basin**
- **3 - ┤ - Van Horn region**
- **6 - Δ - Mina Plomosas–Placer de Guadalupe**
- **11 - ┤ - Apizolaya, Zacatecas**
- **12 - Δ - Ciudad Victoria region**
- **13 - Δ - Huayacocotla uplift**
- **20 - X - Maya Mountains uplift**
- **8 - ○ - Sonobari complex**
- **26 - X - Caborca**
- **27 - ○ - El Paso Mountains**
- **28 - ◇ - White Mountains–Death Valley region**

Utilizing this postulated trace for the megashear, a pole of rotation was determined from the orientation and curvature of the fault and was found to lie near lat. 52° N, long. 79° W. All transform faults related to this early Mesozoic pole of rotation fall along latitudinal lines for an oblique Mercator projection using this pole (Fig. 2). Examination of the plot resulted in the identification of two additional linear tectonic zones that are approximately parallel to the megashear. These are: (1) the Mexican volcanic belt and (2) a zone made up of the great faults traversing Guatemala and Honduras and including the part of the Middle American Trench that lies off southern Mexico. These former transform zones delineate three crustal blocks, composed largely of pre-Mesozoic sialic basement overlain by younger cover, between North and South America (Figs. 2 and 3).

Our goal in this report is to follow the evolution of these crustal blocks from a Pangea configuration based upon the Bullard and others (1965) assemblage for Late Triassic time to the present distribution of sialic crust in the Gulf of Mexico–Caribbean Sea region. We have limited discussion as best we could to the blocks of crust that existed by the Jurassic. Younger crust (for example, Panama), the existence of which results from either formation at a convergent margin or any type of tectonic accretion, is not treated unless its evolution played a key role in understanding the history of the pre-Jurassic blocks.

For the purpose of the discussion presented herein, we have designated the plates and microplates (or blocks) as follows:

Apache plate: that part of North America north of the Mojave-Sonora megashear.

Yaqui block: that part of Mexico bounded on the north by the Mojave-Sonora megashear and bounded on the south by the Mexican volcanic belt.

Maya block: that part of Mexico which lies south of the Mexican volcanic belt and north of the Acapulco-Guatemala megashear and Cuba. The Maya block is broken into two microplates along a proposed structure that may have been the predecessor of the Salina Cruz fault, which traverses the Isthmus of Tehuantepec.

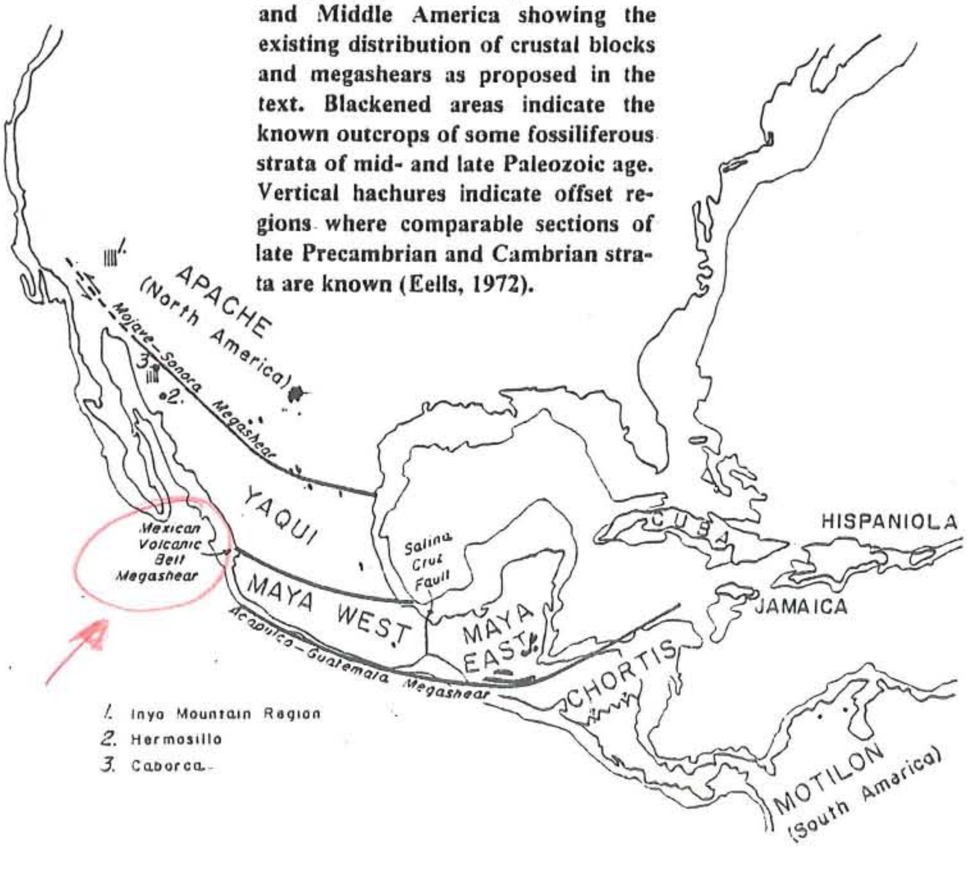

Figure 3. Sketch map of Mexico and Middle America showing the existing distribution of crustal blocks and megashears as proposed in the text. Blackened areas indicate the known outcrops of some fossiliferous strata of mid- and late Paleozoic age. Vertical hachures indicate offset regions where comparable sections of late Precambrian and Cambrian strata are known (Eells, 1972).