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Plate Tectonics of Central America and its Oil geological implications

by J.W. Schroeder*

Production is established at Rubelsanto (Guatemala) from the Cretaceous Coban C formation and in the Reforma fields, (Mexico) from the partly time equivalent (Early Cretaceous - Late Jurassic) high energy Reforma reservoirs. High permeability and porosity of the reservoirs is due to their reefal origin, as well as to their subsequent dolomitization. The entrapment is controlled not only by local structure but also by the regional updip seal of the shelf and back reef deposits. Downdip basinal facies act as source rock. (See *figures 1* and *2);* thus these reservoirs are attributed to a bankedge carbonate facies, and it is usually considered by the authors, that these reservoirs are located on the trend of a perimetral carbonate shoal, present all around the Yucatan peninsula (see *figure 2).*

Continental and micro continent drift, and plate tectonics, allow us to visualize the development of source rocks and of this perimetral carbonate shoal around the Yucatan peninsula: Since sometime between Late Triassic and Early Jurassic, the North American continent is separated from the South American Continent (LADD, 1976, p. 972). At the same time: Southern Guatemala, Honduras and Nicaragua as well as the Nicaragua rise (= Chortis block) lay 1 200 km west of their present position, separated from the N. American continent by the Motagua-Polochic faults or southern Mexico trench. During the Cretaceous, the sea separating North America from South America may have measured 1 500 km and a spreading ridge, pertaining to the N. Atlantic (Azores) spreading ridge system existed there on the median line, as evidenced by the magnetic anomalies in the Columbian basin (LADD, 1976). It is only as a consequence of the Laramide and subsequent orogenies that CUBA, HISPANIOLA came into existence, and the CENTRAL AMERICAN countries (= Chortis block) began to occupy their present day position. As a consequence, since Early Cretaceous, Chiapas province of South Mexico, Peten province of Guatemala, Belize, Nicaragua, Honduras and Nicaragua rise, were covered and bordered by an open equatorial sea (CONEY, 1973, p. 721) in which basinal source rocks were deposited. The perimetral carbonate reefal shoal was deposited between the platform and the basinal source rock. During Late Paleozoic the Chortis block was a segment of a „peninsula", integral part of an orogenic belt „which rimmed the western margins of the Americas" (HELWIG 1974, p. 789). The presence of basinal mesozoic source rocks east of the Yucatan peninsula can be argued from the point of view of applied plate tectonics: only 50 km east of the Yucatan coast, we already find oceanic basalts ridges with intercalated furrows filled with only 1 to 2 km of probably Tertiary sediments. Consequently it appears likely that the mesozoic source rocks deposited east of the Yucatan peninsula have been displaced by the drift of the Caribbean plate along the Turneffe fault *(figs. 1, 2 and 3)* and are nowadays found piled up in western Cuba and represented by the Azucar, Jagua and San Cayetano formations of this country. However, if genuine, the oil seepage reported in 1920 from Long Cay on Lighthouse Reef (OWER, 1928, p. 500) would invalidate this point of view.

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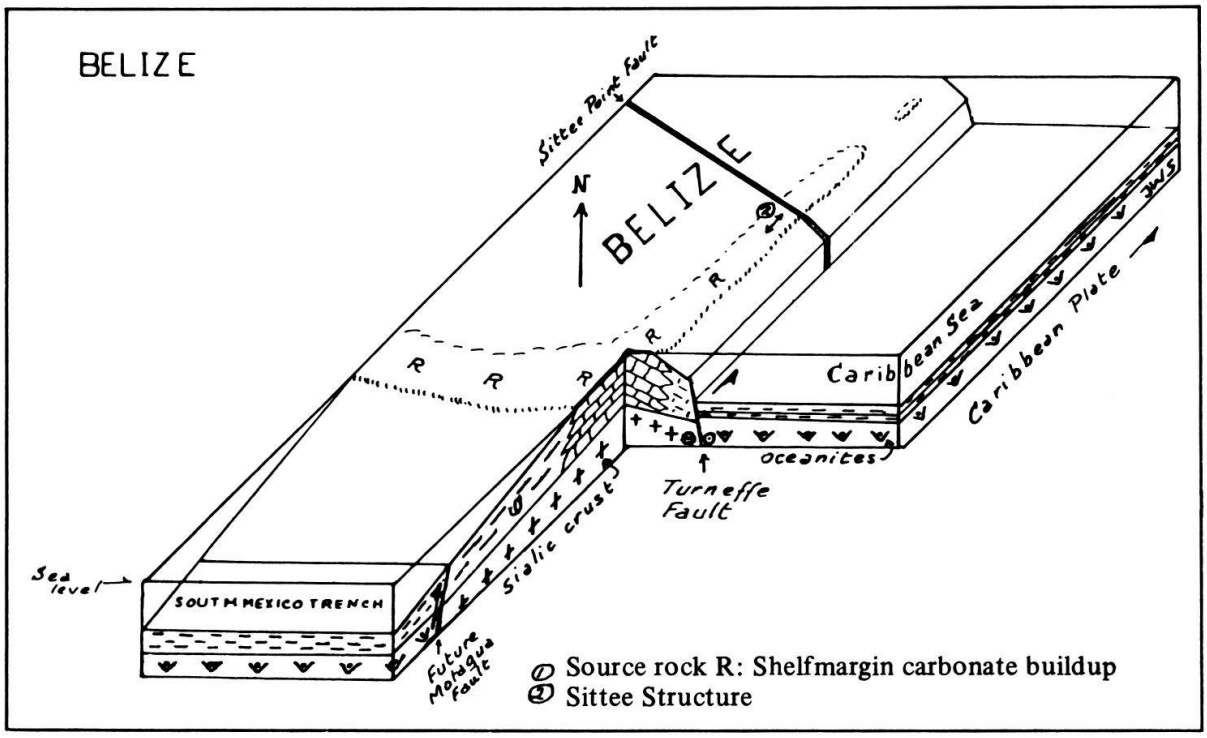

Fig. 1 Tentative Pre Laramide Tectonic Diagram

If this way of conceiving the plate tectonics of Central America and of the Western Caribbean areas is correct the implications for the oil geological conditions are quite evident. Source rocks deposited on both sides of the Southern Mexico Trench, (on the Mexico and Yucatan side as well as on the northern shelf of proto-Central America, including the present day submatine north-eastern submarine peninsula off Honduras and Nicaragua (see *fig. 2*) are still present and could generate oil under adequate thermic conditions. This is evidenced by the oil fields of and Reforma (Mexico) (Guatemala) Rubelsanto but not yet in Central American countries despite numerous favorable surface indications.

For the area east of Yucatan, in particular, the oil geological conditions are sketched in *figures 1 and 3.* Due to the presence of the Turneffe fault, the source rocks drifted, carried on top of the Carribean plates, during the Laramide orogeny towards the NNE and are found today in Cuba. Having lacked, prior to their displacements, the surcharge of the Tertiary sediments of the Chapayal Tertiary foredeep these source rocks had not yet generated their oil: no migration consequently could have taken place towards the shelf margin carbonate build up surrounding the Yucatan, except perhaps for the area south of the Sittee Fault. In fact on the NE of the Yucatan peninsula, a Lower Cretaceous reef barrier is reported (ANTOINE, 1974, p. 684) and a rather consistent occurence of the Lower Cretaceous reef on seismic refraction profiles accross the easten scarp is reported (ANTOINE, 1974, p. 687). Thus it can be anticipated, from the Gulf of Honduras of today accross Belize and Peten, that the Yucatan platform and the Maya mountains were fringed during early and middle Cretaceous by a perimetral carbonate shoal very much alike the present day Florida Keys around the Florida peninsula. Subsequent generation and migration of the hydrocarbon from the basinal facies, following the overburden of the Tertiary sediments, into the porous facies of the carbonate shoals accounts for the accumulations at Rubelsanto and Reforma.

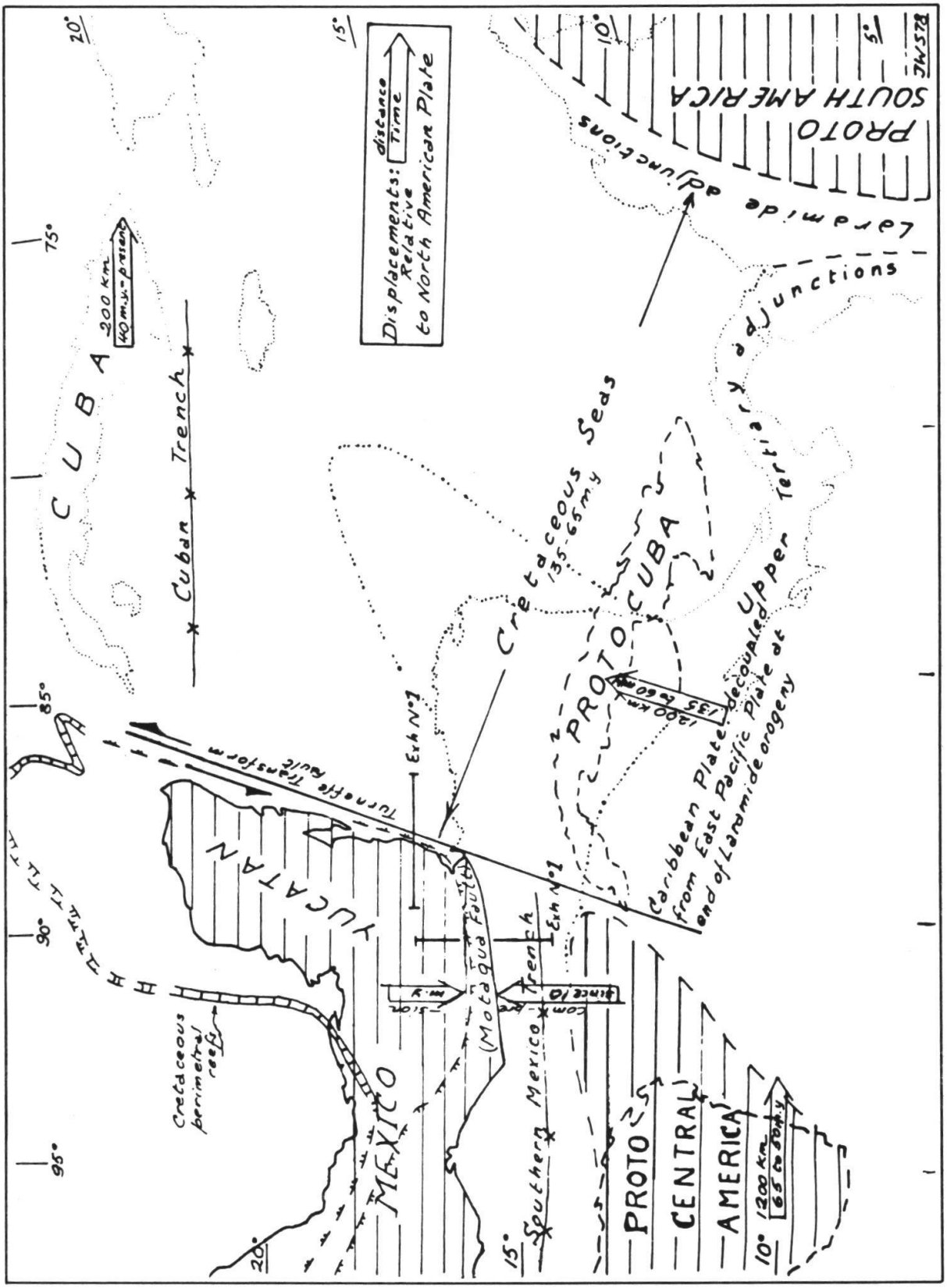

Fig. 2 CENTRAL AMERICA: Pre Laramide, Reconstruction 1 : 10 000 000

In the eastern regions of the Yucatan peninsula *(fig. 3)* we can distinguish from East to West, four main geological units: 1) The Turneffe-Chinchorro ridge, where mafic volcanics are reported by Chevron, represents the outermost western edge of the Carrib-

bean plate. 2) West of the Carribbean Plate one finds the American plate paleoshelf with source rocks deposited on its outer portions. 3) Then at least south of the Sittee fault, a foredeep with a rather thick (13 837 ′ = 4217,5 m) Tertiary section, which joins around southern Belize with the Chapayal through of Guatemala in front of the Sierra Madre Central America Orogen. In the Gulf of Honduras, this northeastern prolongation of the Chapayal basin, measures only about 30 km in with where as it is over 100 km broad further West in Guatemala. 4) West of the Eocene foredeep is the Yucatan platform itself (with the Maya Mountains Uplift) acting as the Foreland to the Central American Orogen. In the North of Belize, east and west of Rio Hondo, prominent NNE striking faults down to the east, are present, with a western sector dip for the outcropping formations, indicating probably also a western paleodip as the thickness of the Cretaceous formations increases towards the West: Blue Creek well was bottomed at 10515′ (= 3205 m) in the Pre-Cretaceous, pointing to an increase of the section towards the west, towards the North Peten basin (in Mexico) and a 20 000 ′ (= 6096 m) exploratory well has been drilled by Pemex in the center of this intra cratonic depression. The Maya Mountains uplift appears to have a western prolongation in the Libertad anticline of Guatemala, but important North-South wrench faults separate the Maya Uplift from the areas lying west.

A further appraisal of the potential depends of course also on the protective role of the Chapayal Tertiary foredeep, for the areas lying to its S and SE, from flushing originating in the areas subjected to an active karstic erosion pertaining to the surroundings of the Maya Mountains Uplift. A post-Laramide migration of hydrocarbon from the paleoshelf edge towards the north, might have been hampered by an important Laramide transverse fault, (antithetic to the great Turneffe wrench fault) which we call the Sittee fault (SF, *fig. 3*). This fault, also mapped seismically offshore and cutting the Maya mountains as well as the 210 million years old Hummingbird batholith, might limit towards the north an offshore prospective area on the paleoshelf edge, west of the Turneffe fault, and east of the Tertiary foredeep. For the area lying north of the Sittee Fault, the probable absence of source rocks, east of the Turneffe fault, displaced by the north-north-eastern relative drift of the Caribbean plate, appears as an unfavourable factor. However, the presence in the North-West of an important cratonic depression may offset these conditions.

For the onshore and offshore areas of Honduras, and Nicaragua, the general conditions appear interesting on the basis of this analysis as they were lying on the southern side of the mesozoic Southern Mexico Trench and west of the Caribbean cretaceous seas (from 135 to 65 m.Y., *fig. 2*) on the edges of which source rocks were deposited. Such source rocks, an absolutely typical, La Luna facies, with Coniacian Ammonites (*Barroisiceras Haberfellneri* v. HAUER) has also been deposited on the eastern side of these seas, and found in what are presently Laramide adjunctions in NW Colombia.

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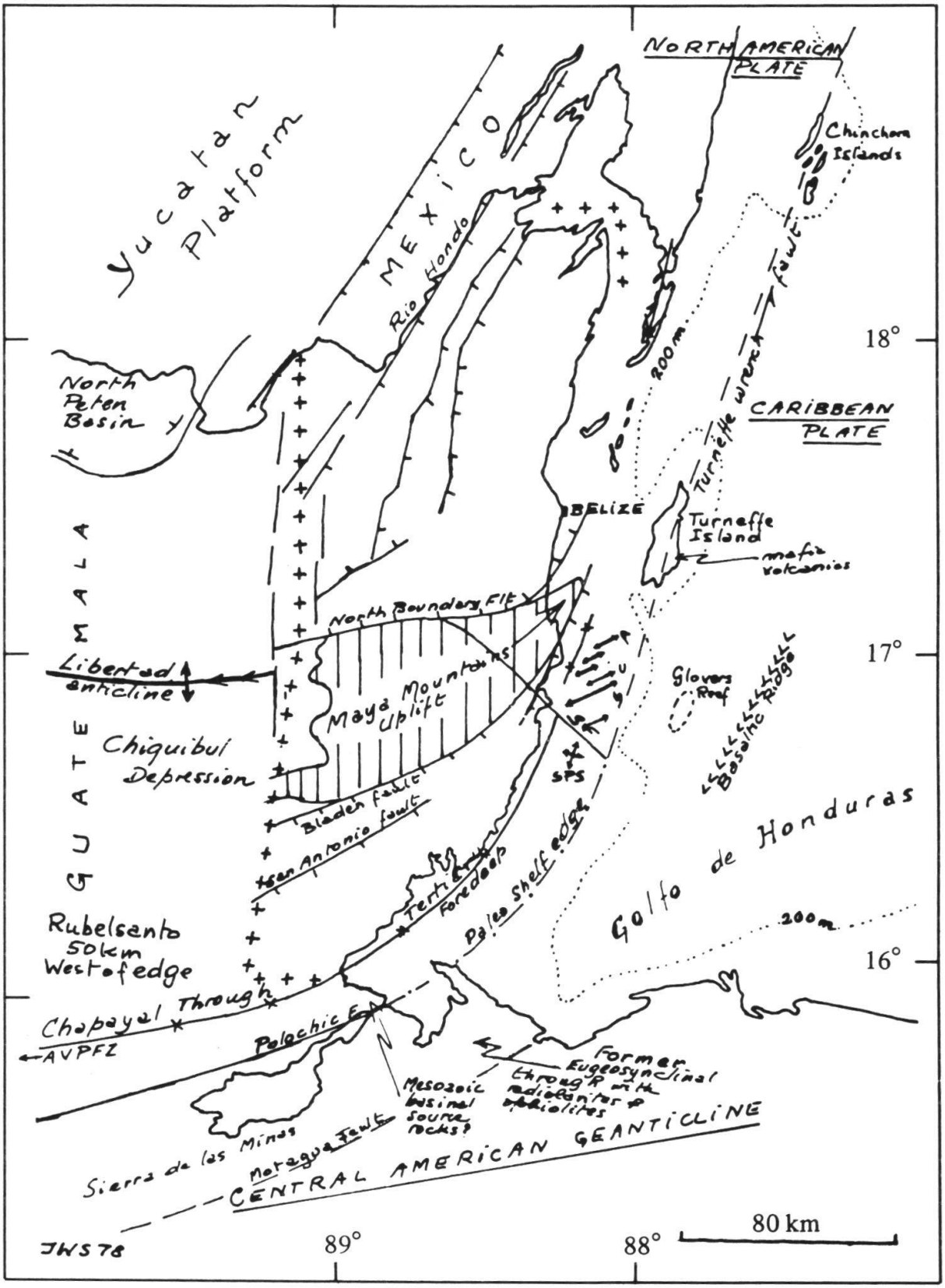

Fig. 3
Tectonic Sketch

AVPZ: Alto Verapaz Fault Zone

SF: Sittee Fault SPS: Sittee Point Structure
SCA: Stann Creek anticlines on top PZ unconf.

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