Crust-Busting Fault Presentation: Polochic/Motagua Fault System, Guatemala

By Kerst Kingsbury, GEOS 304, 5/12/20

Fault Description

- This fault system generally runs E/NE – W/SW as it comes into Guatemala from the Caribbean, and then bends towards A NW direction near Guatemala City
- Extends over 400 Km & reaches depths of ~20 Km
- Consists of various sub-parallel major faults, large ones include the Polochic, Motagua, & Jocotan (In North-South order as well)
- Grabens developed in a North-South system in between the transform faults
- Fault system comprises upwards of nine separate fault zones in the region, and then gradually dies out into a Reverse Fault Province (and then another Strike-Slip Province) in South-Eastern Mexico

Structure-Tectonic Map

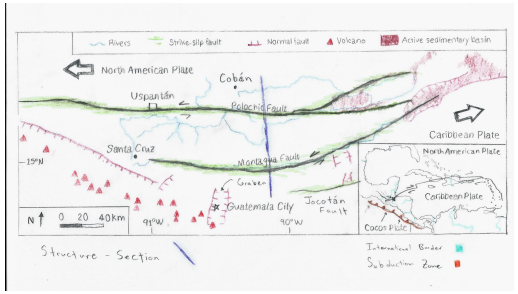

Figure 1: Structure/ Location Map (Susil et al, 2010)

Plate Tectonics

- This fault system makes up the western end of the greater sinistral transform boundary of the North American & Caribbean plates, which snakes through the Caribbean sea (bisecting Cuba from Hispaniola) for over 2000 Km up to Puerto-Rican Subduction Zone
- The PMFS runs straight through Guatemala and intersects the Cocos plate to form a subduction-subduction –transform triple junction off the Western coast of Guatemala
- This Fault Zone is very active, which creates a seismic hazard for cities in the region. The 1976 Quake occurred at a depth of 5 Km on the Motagua, and was 7.5 in Mag. The event claimed over 20,000 fatalities

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Structure-Section

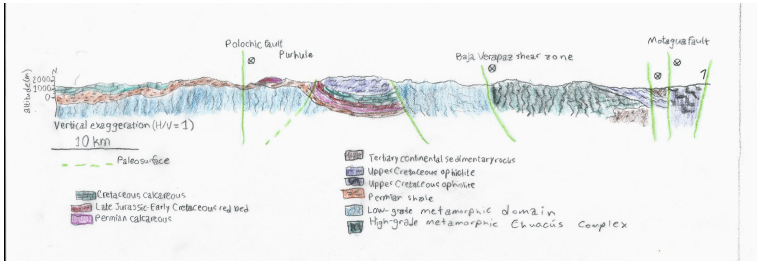

Figure 2: Structure Section (Authemayou et al, 2011)

- The Lithology of this region is dominated by marine deposition from 25 Ma to 12 Ma, where the system became more lacustrine and fluvial up until the present. There are major sandstones, mudstones, and limestones, with significant Metamorphic deposits located between the two major faults. Minor conglomerates and loosely-packed sediments are found in depressions formed via faulting.

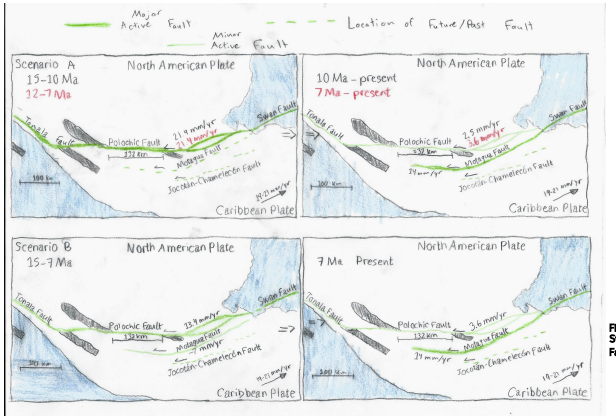

Figure 3: Active Fault Switching (Orbist-Farner et al, 2020)

Kinematics

- The Motagua fault is the primary plate boundary now, but at 2 Ma the Polochic was, with an offset of 13-22 mm/yr. This shows switching activity between the faults
- This highlights the reality of regional deformation here, with the strain spread out through multiple fault jogs
- This Fault system developed and has evolved through the Quaternary
- Earthquake focal mechanisms show most to be typical strike-slip, while some obliquity emerges near the southern bend in the "Z" of the Fault System

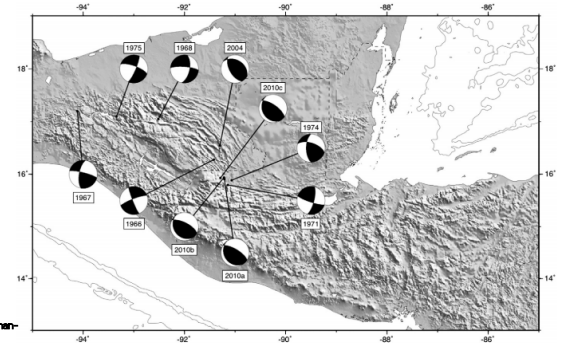

Figure 4: Focal Mechanisms (Guzman-Speziale, 2010)

Dynamics & Mechanics

- The principal stress directions for a strike-slip fault of this nature would have σ_3 & σ_1 in the same plane, with σ_2 perpendicular to that plane. Considering the most Eastern end of the System, σ_3 runs SW – NE while σ_1 runs SE-NW. These directions change as the Fault System jogs in a lazy "Z" path towards the NW
- Large-scale Metamorphics (including Jadelilites) shows that the ancient Geotherm was much lower than it is currently, which indicate relatively high temperature & pressure increasing at depth
- Paleosediments within the Lake Izabal Pull-apart basin have been found to be seismically deposited, which leaves behind an accurate account of the amount, magnitude, and spread of Earthquakes over time. This helps to better define the amount of slip that has taken place, and leads to the most up-to-date model of the region (published in January)