Signature of Transpressional Tectonics in the Holocene Stratigraphy of Lake Azuei, Haiti: Preliminary Results From a High-Resolution Subbottom Profiling Survey

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November 24, 2022

Abstract

The left-lateral Enriquillo-Plantain Garden Fault (EPGF) is one of two transform systems that define the Northern Caribbean plate boundary zone. Relative motion across its trace (˜ 10 mm/yr) evolves from nearly pure strike-slip in western Haiti to transpressional in eastern Haiti, where the fault system may terminate against a south-dipping oblique reverse fault. Lake Azuei is a large (10 km x 25 km) and shallow (< 30 m deep) lake that lies in the direct extension of the EPGF in eastern Haiti. A single core previously collected in the lake suggests high sedimentation rates at its depocenter (˜6 mm/yr). The shallow lake stratigraphy is therefore expected to faithfully record any tectonic deformation that occurred within the past few thousand years. In January 2017, we acquired a grid of high-resolution (˜10 cm), shallow penetration (˜4 to 5 m) subbottom seismic (CHIRP) profiles spaced 1.2 km apart across the entire lake. A new bathymetric map compiled from these CHIRP data and some prior echosounder survey reveals a flat lake floor (<0.01°) surrounded by steep (˜5°) shoreline slopes. The CHIRP profiles highlight several gentle folds that protrude from the flat lakebed near the southern shore, an area where transpressional deformation is presumably focused. Thin (< 20 cm) horizontal strata from the lakebed can be traced onto the flanks of these gentle folds and pinch out in an upward curve. They also often pinch upward onto the base of the shoreline slopes, indicating that young sediments on the lakebed bypassed the folds as well as the shoreline slopes. We interpret this feature as diagnostic of sediments deposited by turbidity currents. The fact that young turbidites pinch out in upward curves suggests that the folds are actively growing, and that active contractional structures (folds and/or blind thrust faults) control much of the periphery of the lake. A few sediment cores were strategically located where beds are pinching out in order to maximize stratigraphic records. Two of these cores successfully penetrated strata imaged by the CHIRP profiles. On-going Pb210 dating of sediment samples from the cores should constrain sedimentation rates and thus help quantify the rates of the tectonic deformation.

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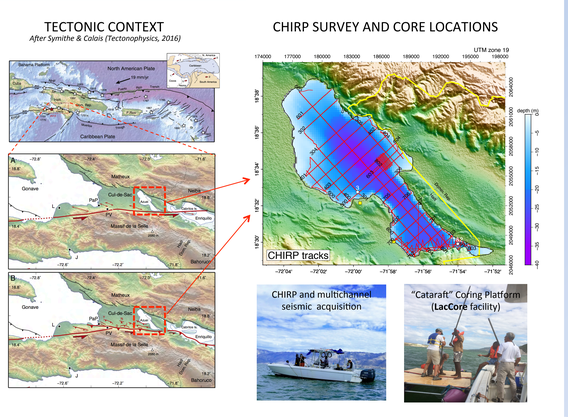
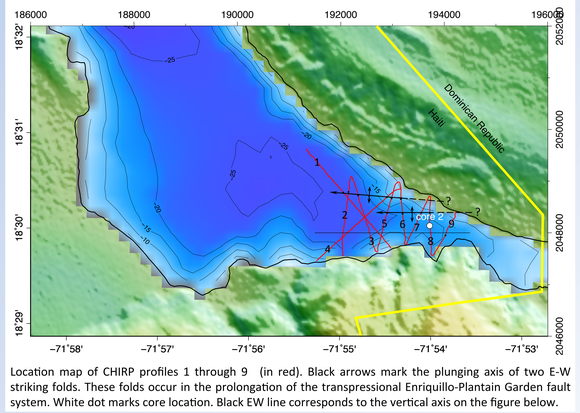
SUMMARY:

Oblique convergence across Hispaniola is partly accommodated by the NW-SE striking Haitian Fold-and-Thrust Belt. In contrast, the submerged folds near the southern edge of the lake strike EW, sub-parallel to the presumed trace of the Enriquillo-Plantain Garden Fault (maps at far right). We propose that the orientation of these submerged folds is affected by left-lateral shear along the fault zone, resulting in counterclockwise rotation of their axis. Their EW orientation is also consistent with that of fold-propagation folds that would develop north of a south dipping oblique-slip EW fault system (see model bottom cross-section at left).

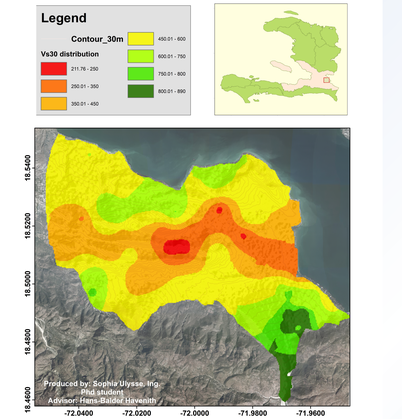


The Enriquillo-Plantain Garden Fault (EPGF) is one of two transform systems that define the Northern Caribbean plate boundary (*Top Left*). Relative motion across its trace (~ 10 mm/yr) evolves from nearly pure strike-slip in western Haiti to transpressional in eastern Haiti, where the fault system may terminate against a south-dipping oblique reverse fault (*Left: Two possible models*). Lake Azuei lies in the direct extension of the EPGF in eastern Haiti (*dashed red box*).

In January 2017, we acquired a grid of high-resolution (~10 cm), shallow penetration (~4 to 5 m) subbottom seismic (CHIRP) profiles spaced ~1.2 km apart across the entire lake, as well as a few sediment cores *(above; red lines and white dots, respectively*)

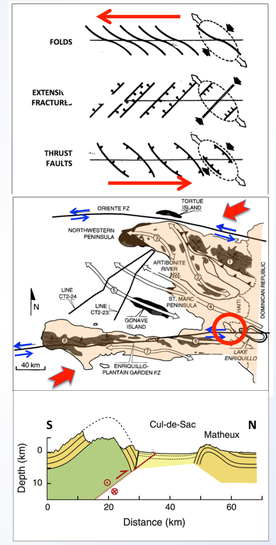


Location map of CHIRP profiles 1 through 9 (in red). Black arrows mark the plunging axis of two E-W striking folds. These folds occur in the prolongation of the transpressional Enriquillo-Plantain Garden fault system. White dot marks core location. Black EW line corresponds to the vertical axis on the figure below.



A recent Vs30 survey of the land area near the southern end of the lake highlights a zone of low shear wave velocities. This zone (orange in red) aligns with the submerged folds and the presumed EW trace of the Enriquillo-Plantain Garden fault (S. Ulysse, Ph.D. dissertation, in preparation)

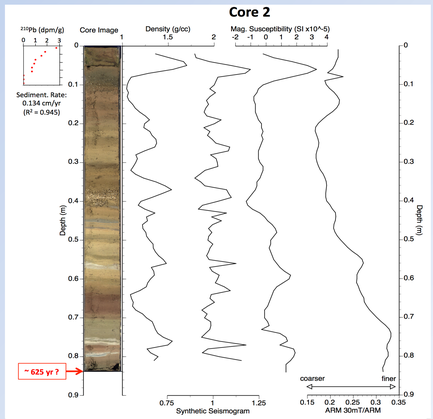
[*Vs30, the shear wave velocity of the top 30 m of the subsurface, characterizes the effects of sediment stiffness on ground motions*]



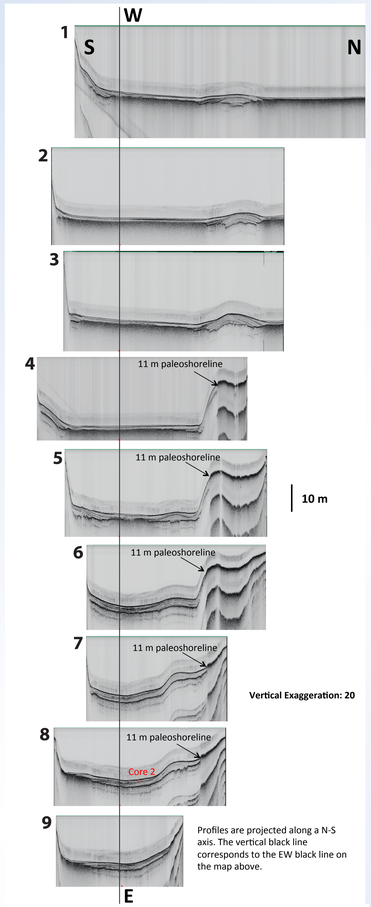
Top: Orientation of folds and faults expected to develop in left-lateral simple shear [*modified from Sylvester, 1988*].

Middle: Double-headed open arrows: Axes of NW-SE-striking active fold-and-thrust belts [*after Mann et al., 1995*]

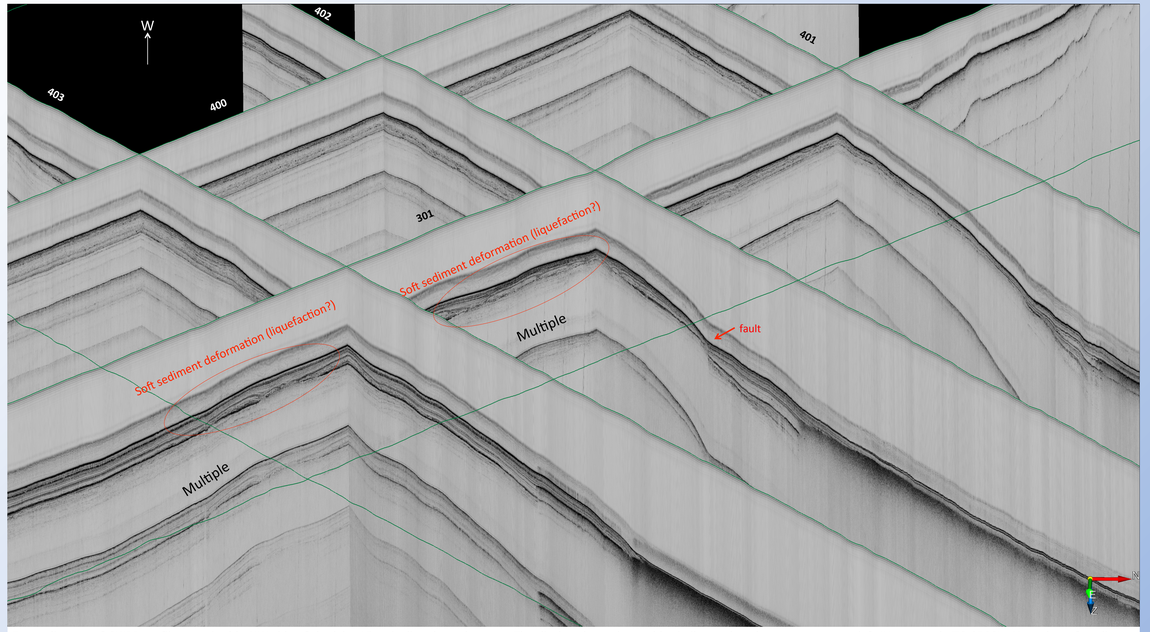
Bottom: Model cross-section near study area, from Symithe & Calais (*Tectonophysics*, 2016.) In this model, transpression is accommodated by oblique slip on a fault dipping to the south with surface trace that projects beneath Lake Azuei, suggesting that the EW submerged folds are fault-propagation folds.



Two cores (located on map above) provide chronostratigraphic information. ^{210}Pb radiometric dating of the upper 10 cm suggests sedimentation rates of about 1 mm/yr



The CHIRP profiles highlight E-W striking gentle folds near the southern shore, an area where transpressional deformation is presumably focused. Thin layers pinch out the flanks. We interpret these layers as deposited by turbidity currents, which suggests that the folds are actively growing.



Fence diagram of CHIRP profiles acquired in NW side of the lake. View is directly to the west. The displayed area is roughly similar to that shown on poster at left (Hearn et al., TG-0566). Note the soft sediment deformation on the top of the monocline, and how turbidites are pinching and curving upward at the base of the slope.