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Paleoseismology, seismic cycle and tectonic coupling of the Lesser Antilles subduction zone : Insights from micro-atolls

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The Lesser Antilles arc is a region of high seismic hazard, which results from the convergence of American and Caribbean plates at 2cm/yr. Several earthquakes of magnitude ≥ 7 have struck the islands in the past. The largest, latest ones occurred only 4 years apart in the mid-19th century, on January 11, 1839 and February 8, 1843, destroying the towns of Fort-de-France and Pointe-à-Pitre, respectively, and killing several thousand people. Today, an earthquake comparable to that of 1843 might cause tens thousands of casualties in Guadeloupe. In addition to devastating seismic shaking, such earthquakes may trigger large tsunamis. In the Lesser Antilles, the behavior and seismic history of the plate interface remain unknown. Important questions that must be answered are: What is the exact geometry and segmentation of the subduction zone? How large might mega-thrust earthquakes be? What are typical recurrence times for such earthquakes on each segment? Could a large earthquake recur in the next few decades?

To better understand and constrain the seismic hazard related to mega-thrust in the Lesser Antilles, we tend to retrieve the history of strain accumulation and relief at the plate interface from alive or dead corals. Certain coral species form micro-atolls that grow just below the intertidal zone and thus "fossilize" with their upper surfaces a history of local relative sea level. The annual coral band (or ring) growth is limited upwards by the so-called Highest Level of Survival (HLS, connected to the elevation of the yearly lowest tide level). When the sea level rises or drops due to tectonic or climatic events, the micro-atoll growth is perturbed. By analyzing in detail the coral aragonite skeleton, and U/Th dating specific events, it is possible to retrieve the history of sea level change through at least parts of several centuries.

We identified several sites with living micro-atolls in the islands we visited (Martinique, Guadeloupe, Antigua, Barbuda). In January 2008, we performed our first chain-saw test-sampling of six micro-atolls in Martinique. The coral of interest (Siderastrea Siderea) is a rather slow-growing species. Its annual growth rate ($\approx$ 3-5 mm/yr) was determined by counting annual bands, chemical analysis calibration and U/Th dating. Preliminary results indicate that during the last two centuries, the micro-atolls have record a sea-level rise of $\approx$ 3 mm/yr, regularly interrupted by sudden emergence events of few centimeters, 15 to 50 years apart. This signal is due both to interseimic deformation and climatic events. The oldest micro-atoll, which is $\approx$ 250 year-old, may have recorded the 1839 earthquake.

Key words : subduction zone, paleoseismology, seismic cycle, micro-atoll, U/Th dating