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# The reef platform of Martinique: Interplay between eustasy, tectonic subsidence and volcanism since Late Pleistocene

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ABSTRACT

Reef positions record the interaction between eustasy and tectonics, and have been used worldwide to characterize vertical deformations of upper-plates at different time-scales and constrain the seismic behavior of megathrusts. Along the Lesser Antilles volcanic arc, high-resolution marine geophysical data were collected on the 2–20 km wide eastern Martinique reef platform to reconstruct its stratigraphic and morphologic history, and understand the influence of local normal faulting, volcanism and plate-scale subduction processes on Holocene and Late Pleistocene reef development. The subsiding Martinique platform's stratigraphy is composed of multiple superimposed sea-level highstand deposits separated by subaerial exposure surfaces of sea-level low stands. The carbonate platform consists of two laterally-extensive carbonate units (unit $U_2$ overlying unit $U_3$) that extend to the platform edge to a depth of −95 m MSL (mean sea level), and form two morphologic terraces, M2 and M3 respectively. The landward portion of unit $U_2$ is partially overlain between 0 and −60 m MSL by the living reef tract $U_1$. The current reef is composed of a landward fringing reef, a lagoon and a seaward barrier reef, the latter forming a double-bank barrier around the Caravelle Peninsula. In near-shore multi-channel seismic profiles, a distinct reflector at ~−35 m MSL, probably a subaerial exposure surface E1, separates the reef sequence formed during the last transgression from a Pleistocene fossil reef tract forming unit $U_2$. Offshore of Mount Pelée volcano (Late Pleistocene), the Holocene reef did not develop above unit $U_2$, whose upper surface is incised by channels and apparent sinkholes. During the Holocene transgression, the possibility of excessive turbidity due to volcanic activity may have inhibited reef development in this area. The un-dated unit $U_2$ probably developed 120–130 ka ago during the last interglacial (MIS 5.5) +6 m MSL highstand as thick, extensive reefs deposited all along the Lesser Antilles arc. Due to subsidence, MIS 5.5 reefs are not represented by onshore facies, except along the southern Sainte Anne Peninsula where normal faulting and uplift balances island-scale subsidence. Based on unit $U_2$'s present elevation and assuming an MIS 5.5 age and +6 m MSL sea level, Martinique has subsided at maximum 0.3 m/ky, likely due to subduction processes that question the coupling state of the megathrust.


## 1. Introduction

Over a short temporal scale, upper-plates deform both horizontally and vertically in response to stress accumulation and release along a megathrust, during a seismic cycle (e.g., Savage et al., 1983; Chlieh et al., 2004; Wang, 2007). The pattern of vertical deformation reflects the elastic behavior of the plates and is controlled by the geometry and mechanical properties of the plate interface (e.g., Métois et al., 2012) as well as the structure of the over-riding plate itself (e.g., Béjar-Pizarro et al., 2012; Wallace et al., 2012). Super-imposed on this transient elastic deformation, vertical and horizontal deformations accumulate within the upper-plate along most subduction zones over centuries (e.g., Sieh et al., 2008; Philibosian et al., 2012; Wesson et al., 2015) to several hundred thousands of years (e.g., Marshall and Anderson, 1995; Taylor et al., 2005; Baker et al., 2013), and even a larger period, leading to mountain chain building (e.g., Armijo et al., 2015). The pattern of long-term vertical deformations being controlled by subduction processes reveals fundamental clues to better understand the seismologic behavior of megathrusts.

Studies of marine terraces and coral micro-atolls, used as markers of vertical deformation (Lajoie, 1986; Taylor et al., 1987; Pedoja et al., 2014), have been carried out along the coasts of forearc islands. They have particularly highlighted the potential persistence of along dip (e.g., Philibosian et al., 2012; Meghraoui et al., 2014) and along-strike

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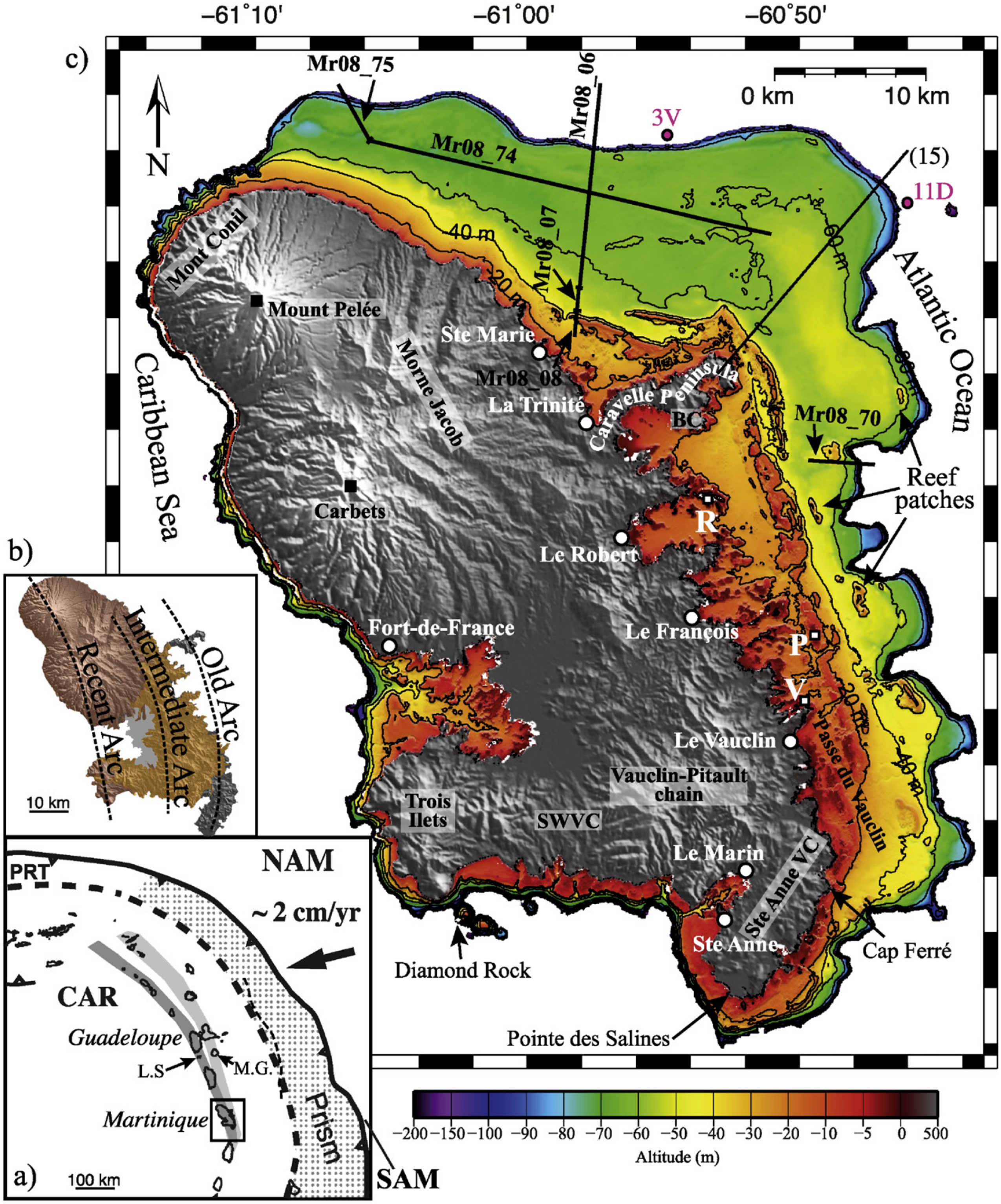


**Fig. 1.** (a) Geodynamic context of the Martinique Island. Vector of convergence between the North American plate (NAM) and the Caribbean plate (CAR) from DeMets et al. (2000). Old and recent volcanic arcs are underlined in light gray and dark gray respectively. MG: Marie-Galante, LS: Les Saintes, SAM: South American plate. Thick dashed black line indicates the subduction backstop as interpreted by Bowin (1976) from a gravity anomaly. Thin black dashed line indicates the backstop as identified by Laigle et al. (2013; and references therein) from active seismic source surveys. (b) Simplified map of the volcanic complexes, after Germa et al. (2011) and Westercamp et al. (1990). Dashed black lines locate the old (gray), intermediate (orange) and recent (red) volcanic arcs. Fort-de-France superficial alluvial and mangrove deposits in light gray. c — The platform of Martinique. The DEM of the platform is gridded at 50 m from the SHOM, Envision and LITTO3D® data. Contours every 20 m. Drilling sites represented by white squares after Adey et al. (1977). R: Ramville Island; P: Pinsonnelle Ridge; V: Vauclin Point. Samples 11D and 3V dredged along the deep platform slope are located by pink dots with pink names, after Andreieff et al. (1979). Onland topography from IGN, gridded at 50 m. Main towns in white circles. Volcanic complex names in black. Sainte Anne VC: Sainte Anne volcanic complex. SWVC: Southwestern volcanic complex. BC: basal complex.