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An integrated approach to the seismic activity and structure of the central Lesser Antilles subduction megathrust seismogenic zone

Alfred Hirn (1), Mireille Laigle (1), Philippe Charvis (2), Ernst Flueh (3), Josep Gallart (4), Edi Kissling (5), Jean-Frederic Lebrun (6), Rinaldo Nicolich (7), and Maria Sachpazi (8)

(1) Institut de Physique du Globe - UMR7154, Seismology, PARIS, France (laigle@ipgp.jussieu.fr), (2) Géoazur, Université de Nice Sophia-Antipolis, Observatoire de la Côte d'Azur, INSU-CNRS, IRD, Villefranche-sur-Mer, France , (3) IFM-GEOMAR, Leibniz Institute for Marine Science, Kiel, Germany , (4) CSIC Institut Jaume Almera, Barcelona, Spain , (5) ETH Zurich Department of Earth Sciences Institute of Geophysics, Switzerland, (6) Labo. de Rech. en Géosciences, Université des Antilles et de la Guyane, Pointe à Pitre, Guadeloupe (FWI), France, (7) Dipartimento di Ingegneria Civile e Ambientale, Univ Trieste, Italy, (8) Geodynamic Institute National, Observatory of Athens, GREECE

In order to increase the understanding of plate boundaries that show currently low seismic activity, as was the Sumatra-Andaman subduction before the major earthquake in 2004, a cluster of surveys and cruises has been carried out in 2007 and coordinated under the European Union THALES WAS RIGHT project on the Lesser Antilles subduction zone of the Caribbean-America plate boundary. A segment of the corresponding transform boundary just tragically ruptured in the 2010 January 12, Haïti earthquake. This cluster is composed by the German cruise TRAIL with the vessel F/S M. A. MERIAN, the French cruise SISMANTILLES II with the IFREMER vessel N/O ATALANTE), and French cruise OBSANTILLES with the IRD vessel N/O ANTEA.

During these cruises and surveys, 80 OBS, Ocean Bottom Seismometers, 64 of which with 3-components seismometers and hydrophones, and 20 OBH with hydrophones have been brought together from several pools (Geoazur Nice, INSU/IPGP Paris, IfM-GEOMAR Kiel, AWI Bremerhaven), with up to 30 land stations (CSIC Barcelona, IPG Paris, INSU-RLBM and –Lithoscope, ETH Zurich).

The deployment of all these instruments has been supported principally in addition by ANR Catastrophes Telluriques et Tsunamis (SUBSISMANTI), by the EU SALVADOR Programme of IFM-GEOMAR, as well as by the EU project THALES WAS RIGHT. The main goal of this large seismic investigation effort is the understanding of the behaviour of the seismogenic zone and location of potential source regions of mega-thrust earthquakes. Specific goals are the mapping of the subduction interplate in the range where it may be seismogenic along the Lesser Antilles Arc from Antigua to Martinique Islands, as a contribution to identification and localisation in advance of main rupture zones of possible future major earthquakes, and to the search for transient signals of the activity. The forearc region, commonly considered as a proxy to the seismogenic portion of the subduction mega-thrust fault plane, and which is here the main target has been localized along 3 transects to the Arc, thanks to a preliminary survey in 2001, the French SISMANTILLES cruise.

We will present the first results obtained during these experiments dedicated specifically to image at depth the seismic structure and activity of this region. To image faults at depth and the detailed upper-crustal structure, 3700 km of multi-beam bathymetry and multi-channel reflection seismic profiles have been collected along a grid comprising 7 strike-lines of up to 300 km long and spaced by 15 km and 12 transects of up to 150 km long and spaced by 25 km (SISMANTILLES II). All these airgun shots dedicated to deep penetration have been recorded by the 80 OBSs and 20 OBHs deployed by the F/S Merian and N/O Atalante on the nodes of this grid of profiles.

It will permit to get V_p constraints on the deep forearc region and mantle wedge by wide-angle refraction studies, as well as constraints on the updip and downdip limits of the seismogenic part of the mega-thrust fault plane. Two of these transects have been extended across the whole arc during the TRAIL survey, with up to 50 OBSs deployed along both 240 km long profiles. All these OBSs remained several months after the shot

experiments to gather data for accurate location of local earthquakes and possibly V_p and V_p/V_s tomography. They have been recovered and partly redeployed by N/O Antea during the OBSANTILLES survey. A significant number of those instruments had broadband seismometers, a notable originality in the case of the OBSs to probe the conditions for detecting low-frequency transient signals which have been found recently in the case of the Cascadia and Central Japan subductions and associated to their seismogenic character.