Approach to submerged fore-arc subductions in the Lesser Antilles and Hellenic arcs: integrated marine MCS, refraction, and OBS seismic activity and noise recording.

Mireille Laigle (1), Anne Bécel (2), Marinos Charalampakis (3), Philippe Charvis (4), Jordi Diaz (5), Ernst Flueh (6) Mikael Evain (4), Josep Gallart (5), Audrey Galvé (4), A. Gesret (7), Alfred Hirn (1), Edi Kissling (8), Heidrun Kopp (6), Rinaldo Nicolich (9), Maria Sachpazi (3), and Wolfgang Weinzierl (6)

(1) Seismology, Institut de Physique du Globe de Paris, France
(2) Collège de France, CEREGE Aix en Provence, France
(3) Geodynamical Institute, National Observatory of Athens, Greece
(4) GÉOAZUR, Villefranche-sur-mer, France
(5) C S I C, Instituto Jaume Almera, Barcelona, Spain,
(6) IFM-GEOMAR, Kiel, Germany,
(7) Ecole des Mines de Paris, Palaiseau, France
(8) Institute for Geophysics, ETH Zurich, Switzerland,
(9) DICA, University of Trieste, Italy

This decade witnesses the growing observations of recently discovered new types of seismic signals such as "Slow-Slip Events" (SSE), sometimes accompanied by "Non-Volcanic Tremors" (NVT), Long period events (LP), and ultra-long period events (ULP). They have been discovered at Pacific Rim subduction margins prone to large-earthquakes, by on-land permanent seismological observatories and special deployments where the forearc domain is emerged. They are interpreted to be caused by the real-time dynamics of subduction plate boundaries, but the mechanisms remain poorly understood. One of the possible reasons might be that none of them has been yet the target of an approach which integrates seismic imaging of the deep structure together with seismological earthquake recording to detect and locate the associated seismic activity, as well a possible NVT, LP, ULP that could be specific to the evolution of the seismogenic zone. When applied to the more common case of subductions with submerged forearc, the effort of recording by ocean-bottom seismometers (OBS) is required. The Hellenic and Lesser Antilles arcs, the two active subduction zones in Europe and its overseas territories, have been recently the target of such integrated seismic investigations by a cluster of seismic surveys operated in the frame of our EU-funded “Thales was right” programme.

In the Antilles, we collected in a Reflection-Leg (SISMANTILLES 2 - N/O Atalante) a grid of multi-channel reflection profiles which provided structural and velocity constraints through the ~5 km thick accretionary prism down to the decollement and top of the subducting oceanic crust, and also down to the forearc basement. Significant along-strike variation of its shallow upper-crustal structure is revealed and attributed to the ongoing obliquely subduction of two aseismic topographic ridges. In coincidence with two of these dip-profiles, a Refraction-Leg (TRAIL - F/S Merian) operated two 280 km long profiles crossing the whole subduction, with 50 Ocean Bottom Hydrophones or Seismometers (OBH/S) tightly deployed along each profiles, and obtained a depth penetration and resolution that could not be reached by previous regular surveys. Tomographic inversion of first arrivals and forward modelling of secondary arrivals provided 2-dimensional velocity models where the Moho depth constrained under the arc and forearc, as large as 28 km, lends strong support to a new view considering an oceanic plateau crust. Consequently, a larger downdip seismogenic width than previously considered is suggested in the common assumption of the depth of the upper plate Moho being a proxy of this downdip limit.

A dense network extending far-offshore in an Earthquake-Leg (OBSANTILLES - N/O Antea) with OBSs from several pools (Geoazur, INSU-IPGP, IFM-GEOMAR, AWI) provided new observations of the current seismicity. Reliably and accurately relocated within the 3D structural velocity model and megathrust fault, they provide new fundamental constraints, particularly on focal depths, to the previously mislocated seismicity studied with the usual observation from only land seismometers. The continuous recordings by this OBS array comprising a variety of water depths and diverse types of seismometers (3-components short-periods, intermediate- and broad-band), allows to sort out among responses depending on instrument configuration or sites, and thus validate conditions of observation of real signals. This broad-spectrum analysis of offshore continuous recordings prevented us for misinterpreting detected NVT -or LP-, ULP-like bursts of amplitude, that we in fact could attribute to other origins, as diverse as being instrumental or signal forcing by the external envelopes of the solid earth or its tides. Some of these causes which are not related to the earthquake phenomena may also induce apparent transient signals in the case of recording on emerged forearc or with band-limited

instruments, that may not be identifiable as such.

In the Hellenic subduction zone, the earthquake-Leg has been carried out by a dense mobile onshore network, and a one-year dense OBS network offshore Peloponnesus and Western Crete Island. On land, Teleseismic high-resolution Receiver Functions were brought to high-resolution, thus giving constraints on a crust of oceanic thickness at the top of the slab and on its 3D complex topography down to 80 km depth. The Reflection- and Refraction-Legs have been the subject of a submitted proposal to the French National seismic facilities of IFREMER and to ANR agency, for completing there such an integrated seismic approach together with the available continuous offshore recordings.