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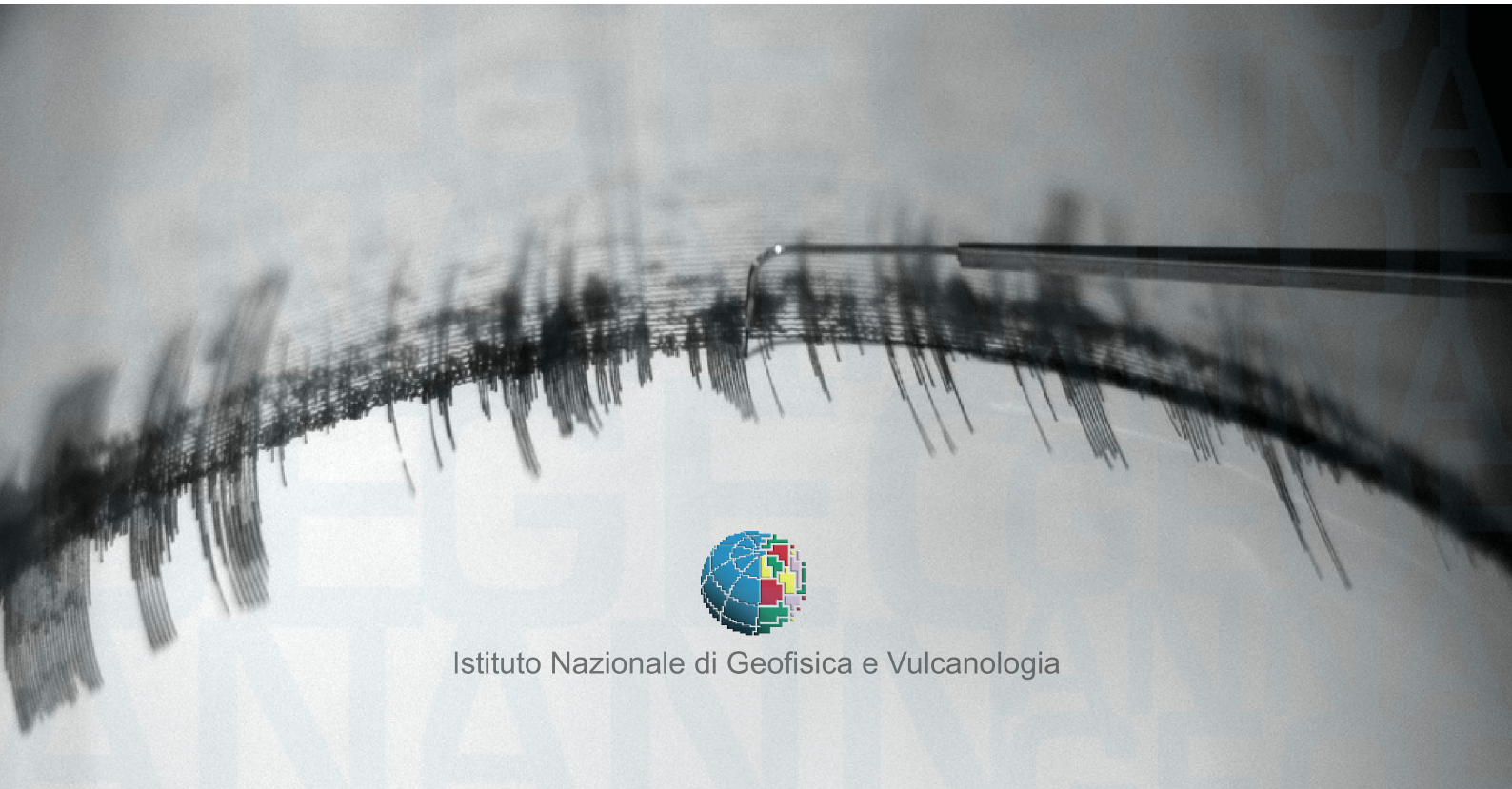

Istituto Nazionale di Geofisica e Vulcanologia

ANNALS of GEOPHYSICS

[Special Issue_59_4_2016]
The TOMO-ETNA experiment

PROLOGUE

ARTICLES

ANNALS of GEOPHYSICS

PROLOGUE

In 1989 the first bases of what is now a strong and consolidated Spanish-Italian scientific relationship in Seismology and in Volcano-Seismology were established. The first stage took place at the University of Catania, in the former Department of Earth Sciences, placed in the old Science Faculty, when a pre-doctoral student from the University of Granada, Cartuja Observatory (now called Andalusian Institute of Geophysics), arrived to complete his formation in seismology. During this stage, in addition to the training process, new contacts with researchers and mainly with pre-doctoral students of the former International Institute of Volcanology of the Italian National Research Council (IIV-CNR) were stablished. These contacts have endured, grown and created a strong international scientific network with consolidated and credible research production. In a short time new working groups were integrated such as the Osservatorio Vesuviano in Naples or the Department of Physics of the University of Salerno from the Italian side, and the Department of Applied Physics of the University of Almería or the Volcanology Department of the Spanish Research Council (CSIC) in Spain. At the present this non-official (but very active) network comprises many Italian Research Centers belonging to the National Institute of Geophysics and Volcanology (INGV) such as Catania, Naples, Rome, Palermo, Pisa or Bologna; Italian Universities as Salerno, Naples, L'Aquila or Calabrian, several Spanish Universities such as Granada, Almería, Jaen, Complutense, Cádiz or La Laguna, but also from other countries such as USA, Russia, Ireland, Portugal, México, Argentina, Germany, France, Norway or UK among others. This collaboration includes a continuous pre-doctoral students training protocols in which the exchange of fellows among the different institutions is fluent.

A great achievement of this network has been the joint participation in many National, International and EU research projects, and the collaboration in several field experiments in different volcanoes around the world. Each action included innovative ideas in term of instrumentation, data analysis and models, presenting a large number of high quality research papers in high impact journals. These works follow the philosophy of joint collaborative publications, in which in many cases more than 3 or 4 different institutions appear as participant of them. Nowadays this policy is worldwide well considered, but in the 90s of last century this idea was something innovative being the work of Ibáñez et al. [1990] the pioneer work of this consortium in which three institutions were involved. This idea of a joint work was also applied to doctoral thesis, being the first that done by Ibáñez [1990] in which data and joint direction was established, but at the present more than 20 doctoral thesis have been done under this collaborative philosophy.

One of the key advances of this teamwork was the use of seismic antennas in different volcanic environments. The first experiment was performed in Teide volcano [Del Pezzo et al. 1997; Almendros et al. 2000] using self-developed technology both in hardware and software [Havskov and Alguacil 2016]. The development of own products have permitted to the consortium to address more experiment with additional autonomy. This experience was exported primary to the Antarctica, Deception Island volcano, producing an intense and high quality scientific production always under the joint collaborative relationship [e.g. Almendros et al. 1997; Ibáñez et al. 1997, 2000; Alguacil et al. 1999; Saccorotti et al. 2001, among others]. Contemporaneously, different joint experiment were performed in several volcanoes around the world such as Stromboli Island [e.g. Del Pezzo et al. 1998; La Rocca et al. 2000, 2004], Mt. Etna volcano [e.g. Del Pezzo et al. 2000; Saccorotti et al. 2004a; Ibáñez et al. 2009], Vesuvius and Campi Flegri [e.g. Del Pezzo et al. 1999; La Rocca et al. 2001; Bianco et al. 2005], Sao Miguel in Azores Islands [e.g. Saccorotti et al. 2004b; Martini et al. 2009], Copahue volcano in Argentina [e.g. Ibáñez et al. 2008a],

Volcán de Fuego de Colima in Mexico [e.g. Palo et al. 2009; Petrosino et al. 2011; De Lauro et al. 2012] or Arenal volcano in Costa Rica [e.g. Almendros et al. 2012, 2014] among other places.

Seismic attenuation analysis is probably the most productive research line of this consortium, both in tectonic and volcanic environment, and it is always present in whatever analysis or experiment performed by this team. The list of high impact papers published by this group is large and comprises different techniques [e.g. Ibáñez et al. 1993; Akinci et al. 1995; Prudencio et al. 2013a, 2013b; Del Pezzo et al. 2016], places [e.g. Del Pezzo et al. 1995; Bianco et al. 1999, Martínez-Arévalo et al. 2003; Prudencio et al. 2015a] or focal depths [e.g. Badi et al. 2009; Mancilla et al. 2012]. Some of the most remarkable results of these analyses are: a) the importance of scattering processes in volcanic environments [e.g. Del Pezzo et al. 1996; Prudencio et al. 2015b]; b) how high intrinsic attenuation is not always associate with the presence of magma [e.g. De Siena et al. 2010]; c) the possibility to perform separate seismic attenuation tomography to better constrain the inner structure of volcanoes [e.g. Patanè et al. 2002; Martínez-Arévalo et al. 2005; Prudencio et al. 2015c]. It is noteworthy that other research lines associated to volcano seismology have specific dedication inside of the consortium such as: precise location [e.g. Saccorotti et al. 2002; Carmona et al. 2010; Díaz-Moreno et al. 2015], moment tensor inversion [e.g. Lockmer et al. 2007], shear-waves splitting and coda waves interferometry [e.g. Martínez-Arévalo et al. 2003; Del Pezzo et al. 2004; Bianco and Zaccarelli 2009; Zaccarelli et al. 2009], among others.

The necessity to know the inner structure of the studied volcanoes induced this consortium to focus their effort in the analysis of seismic tomography, mainly in velocity producing a set of high quality research products [e.g. Chiarabba et al. 2004; Patanè et al. 2006; Zandomeneghi et al. 2008; Alparone et al. 2012; García-Yeaguas et al. 2014]. Contemporaneously, these works showed the necessity of homogeneous distribution of high quality data and seismic stations, not always available in volcanic environments. The success of two important seismic active experiment performed in Vesuvius volcano [e.g. Gasparini 1998; Auger et al. 2001] and Campi Flegrei [e.g. Zollo et al. 2003] aimed this consortium to prepare similar active seismic experiments in other active volcanoes. The TOMO-DEC experiment carried out in January of 2005 in Deception Island caldera in Antarctica was their first great success [e.g. Barclay et al. 2009; Ben-Zvi et al. 2009; Zandomenghi et al. 2009; García-Yeguas et al. 2011]. The quality of the obtained data, and the exceptional international consortium created under the umbrella of this experiment, allowed this team to face a new challenge: to analyze a larger and complex region as the volcanic Island of Tenerife in the Canary Archipelago. Thus the so called TOM-TEIDEVS experiment was performed in 2007 [e.g. Ibáñez et al. 2008b; De Barros et al. 2012; García-Yeguas et al. 2012]. At the same time other active seismic experiment was performed around the Stromboli Island [Castellano et al. 2008; Prudencio et al. 2015a].

Figure 1. Two pictures showing the eruptive activity occurred in Mt. Etna volcano in the period June-November 2014. Pictures kindly provided by (left) Dr. Jesús Ibáñez from Andalusian Institute of Geophysics; (right) by Dr. Boris Benke from INGV-Section of Catania-Osservatorio Etneo.

The obtained results remarked the importance to integrate active and passive seismic sources and to use dense temporal seismic networks to study volcanic structures. These new data provide additional advantages that complement the information given by the earthquakes, mainly covering areas with lack of natural seismicity and eliminating the uncertainty of the position of the focal source. Thus, when the EU project MED-SUV started to be conceived, one of the potential actions to be developed was to perform an ambitious seismic active experiment focused in the study of Etna volcano, but also associated region, comprising Aeolian Island. In this framework the TOMO-ETNA experiment was conceived with the idea of complementing the already available information of the largest active volcano in Europe. Taking into account the acquired experience of this consortium in previous experiments, and the potential high impact in research of the international collaborations, the TOMO-ETNA experiment was conceived. This experiment was designed to integrate marine and terrestrial activities and performing multidisciplinary approaches including wide angle seismic refraction (WAS), multi-channel seismic (MCS) reflection surveys, magnetic surveys and ROV (remotely operated vehicle) dives. The complexity of this experiment, performed between June and November 2014, is reflected by the integration of different research projects from the EU, Spain and Germany. During this period an important volcanic activity took place in the volcano (Figure 1). The experiment used several research vessels as: the Spanish oceanographic research vessel (R/V) "Sarmiento de Gamboa", the Italian hydro-oceanographic vessel (H/V) "Galatea" and the Greek oceanographic research vessel (R/V) "Aegaeo" and two support vessels from the Italian Navy. In total 26 research and academic institutions from Italy, Spain, Germany, Ireland, USA, Russia, France, Greece and Mexico were involved and including participation of more than 120 researchers and technicians. It also demonstrated the powerful capacity of the integration between different European funding schemes to support the research, namely the collaborative project (MED-SUV) and the coordination and support actions for integrating activities (EUROFLEET).

In this special volume we present a set of representative works describing: the nature of the experiment; the activities developed on-land and offshore; the seismic and volcanic activity occurred during the experiment; some preliminary marine analysis; array studies; the analysis of the scattering properties of the wave-field; the preliminary signal processing analysis; the joint inversion tomography software; the impact of this experiment in the marine mammals life. According to previous experiences described above, scientific results will continue along next years (at least 10 years), expecting a high impact scientific productivity.

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