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## **Coordinated seismic experiment in the Azores**

Graça Silveira<sup>1</sup>, Suzan van der Lee<sup>2</sup>, Eleonore Stutzmann<sup>3</sup>, Luis Matias<sup>1</sup>, David James<sup>4</sup>, Peter Burkett<sup>4</sup>, Miguel Miranda<sup>1</sup>, Luis Mendes Victor<sup>1</sup>, João Luis Gaspar<sup>5</sup>, Luisa Senos<sup>6</sup>, Sean Solomon<sup>4</sup>, Jean-Paul Montagner<sup>3</sup> and Domenico Giardini<sup>2</sup>

<sup>1</sup>Centro de Geofísica da Universidade de Lisboa, Edifício C8 Campo Grande, 1749-016 LISBOA <sup>2</sup>Institute of Geophysics, ETH Honggerberg, CH-8046 Zurich

<sup>3</sup>Institut de Physique du Globe de Paris, 4, place Jussieu, 75252 PARIS CEDEX 05 <sup>4</sup>Depart. of Terrestrial Magnetism, Carnegie Inst. of Washington, 5241 Broad Branch RD. NW,

WASHINGTON DC 20015 <sup>5</sup>Contro do Vulcanología da Univ. dos Acoros, R. Mão do Dous, 0501,801, Ponto Dolgada

<sup>5</sup>Centro de Vulcanologia da Univ. dos Açores, R. Mãe de Deus, 9501-801 Ponta Delgada, Açores <sup>6</sup>Instituto de Meteorologia, Rua C ao Aeroporto, 1700 LISBOA

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# Abstract

Memorandum of Understanding COSEA is devoted to coordinate the efforts of Portuguese, French, American and Swiss scientific institutions for the deployment, operation and maintenance of a temporary broadband seismic experiment in the Azores Islands and for the collection, distribution and scientific exploitation of data. In collaboration with other running projects, this experiment has three goals: (1) study of the Azores plume: its structure, its origin at depth and its interaction with the Mid-Atlantic Ridge; (2) investigation of the structure and deep interactions of the plate boundaries between Eurasia, Africa and North America; (3) at a local scale, monitoring of seismic and volcanic activity for a better determination of hazard by combining broadband data with existing volcano and earthquake surveillance networks.

## Introduction

The Azores archipelago occupies a lateral branch of the Mid-Atlantic ridge near the triple junction of 3 large tectonic plates, the North American, the Eurasian and the African plates. McKenzie (1972) considers the lateral branch as a transform fault but the tectonics and seismic activity suggest that the boundary between the Eurasian and the African plates may be a Leaky Transform (Madeira et al., 1990). The tectonic setting is even more complex due to the existence of the Azores hotspot, whose origin at depth (core-mantle boundary, transition zone or asthenosphere) is still controversial. The most recent tomographic model available so far for the Atlantic Ocean (Silveira et al., 1998, Silveira and Stutzmann, submitted) has reached the lateral resolution limit considering the current distribution of earthquakes and

stations in the Atlantic. Their model shows a low velocity anomaly beneath the Azores but the resolution is too weak to constrain the plume shape at depth. International efforts have been concentrated on the Mid-Atlantic Ridge, but for the Azores Archipelago itself, the relationship between the (large-scale) mantle processes, the (mesoscale) crustal structure and the volcanic and seismic activity is not well understood.

Several Broadband stations have been installed in the Atlantic area (e.g. BORG in Iceland, TBT in Canaries, ASCN in Ascens\3430) during the last few years, but the source-receiver geometry distribution is still insufficient to get a good azimuthal coverage of the wave paths beneath the Azores. One permanent VBB 3-component station has been installed in the Azores archipelago in 1997, the IRIS-GSN CMLA station of S\3430 Miguel island which is co-operated by IM. The data will be available through internet at IRIS DMC. The COSEA experiment has been started for the purpose of better understanding the Azores area at different scales.

# **COSEA** Experiment

The COSEA memorandum was established between the following international partners:

- Centro de Geofísica da Universidade de Lisboa (CGUL)
- University of the Azores (UA)
- Institut of Meteorology of Portugal (IM)
- Federal Institute of Technology, Zurich (<u>ETHZ</u>)
- Institut de Physique du Globe de Paris (<u>IPGP</u>)
- Department of Terrestrial Magnetism. Carnegie Inst, of Washington (<u>DTM</u>)

to coordinate the site selection for the deployment of temporary and permanent broad-band seismic stations in the Azores Islands and the collection and analysis of data, with one station on each of the major Azores Islands (see Figure 1).



Figure 1. Geographical distribution of the COSEA VBB seismic stations.

COSEA has coordinated three individual experiments:

- one temporary station on Flores, jointly installed by IPGP and CGUL in October 2000 (see Figure 2)
- one permanent station on Faial, installed by CGUL in July 2001 (see Figure 3)
- five DTM temporary stations on the islands of Santa Maria, Graciosa, Terceira, Pico and Corvo, jointly installed by DTM and ETHZ in the fall of 2000, with the cooperation of the IM (see Figure 4)



Figure 2. Deployment of the FLO (Flores) VBB seismic station; left - shelter used for the TITAN 3NT data aquisition system; right - preparing the STS 2 thermal insulation.



Figure 3. Deployment of the CDRO (Faial) VBB seismic station; left - digging the sensor vault; middle - installing the STS 2 in the concrete pier; right - preparing the TITAN-3NT acquisition parameters.



Figure 4. Left and middle - deployment of the PSCM (Terceira) VBB seismic station; right - PSJO (Pico) VBB seismic station after deplyment.

A first phase of data collection will run for a minimum one year, with the possibility of renewal for a second year, corresponding to the deployment period of the DTM/ETHZ experiment; a second phase of scientific investigation will last for a minimum of two years beyond the end of the data collection period. All stations are equipped with broadband digital equipment, with 24-bit ADC electronics and broadband (STS-2) sensors.

## Data assembly and distribution

Data from the COSEA experiment will be pre-processed by each partner and then deposited at the IRIS DMC <u>Temporary Networks</u> following their format specifications. The IRIS DMC will provide restricted access to the complete data set to all partners and to collaborating European data centers (but also with restricted access to the COSEA partners). Two years after the end of the field experiment, the data will be made available to the worldwide scientific community. The specific data to be jointly assembled (channels, events, continuous wave forms) have been defined by the scientific teams depending upon the scientific goals to be reached. Figure 5 shows an example of the an earthquake near Coast of Peru, recorded at CDRO seismic station.



Figure 5. Earthquake of 7th July 2001 near coast of Peru earthquake recorded at CDRO (Faial). Both channels MH (1.25 sps) and BH (20 sps) are presented.

# **Scientific Purposes**

The COSEA project has three scientific and monotoring goals: (1) study of the Azores plume: its structure, its origin at depth and its interaction with the Mid-Atlantic Ridge; (2) investigation of the structure and deep interactions of the plate boundaries between Eurasia, Africa and North America; (3) at a local scale, monitoring of seismic and volcanic activity for a better determination of hazard by combining broadband data with existing volcano and earthquake surveillance networks.

Regarding the determination of the deep origin and structure of the Azores plume and its interaction with the Mid Atlantic Ridge, data collected from the permanent VBB stations and from the temporary VBB station will be processed using surface and body techniques. Fundamental and higher-mode surface wave tomography will also be used with earthquakes from the Mid-Atlantic ridge and from along the Eurasia-Africa plate boundary in order to image the uppermost-mantle structure in the region of the latter plate boundary.

This study will be complemented with other running projets at the CGUL. Using data from both VBB temporary network and from the local short period SIVISA network, we wish to study the seismicity pattern of the Azores islands in terms of: 1) crustal seismic anisotropy; 2) source mechanisms and 3) seismic strain rate.

## References

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