

# THE “WESTERN MEDITERRANEAN” (WM) BROAD BAND SEISMIC NETWORK. REPORT 2008.

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## 1. INTRODUCTION.

To study the seismicity associated to the Ibero-Maghrebian region, the Real Instituto y Observatorio de la Armada in San Fernando (ROA) has installed, since 1898, different types of seismological stations. At present two networks are in operation: Long Period station and Short Period net (SFS network) and Western Mediterranean Broad Band (WM) net (in collaboration among several institutions). The installation of a network of four ocean-bottom seismographs (FOMAR) is underway. The Ibero-Maghrebian region corresponds to the western part of the Eurasia-Africa plate boundary and is of great seismological and tectonic interest. It extends from 12°W to 3°E, comprising Southern Iberia and northern Africa, including the Gulf of Cadiz and Alboran Sea (figure 1). Seismicity is characterized by the occurrence of moderate and large magnitude earthquakes at shallow depth, intermediate depth earthquakes ( $30 < h < 150$  km) and some very deep events (650 km). The whole area constitutes a broad deformation zone, without a well defined plate boundary line, with a plate convergence in a NNW-SSE direction at a rate of 1 to 5 mm/year (Buform et al., 1995).

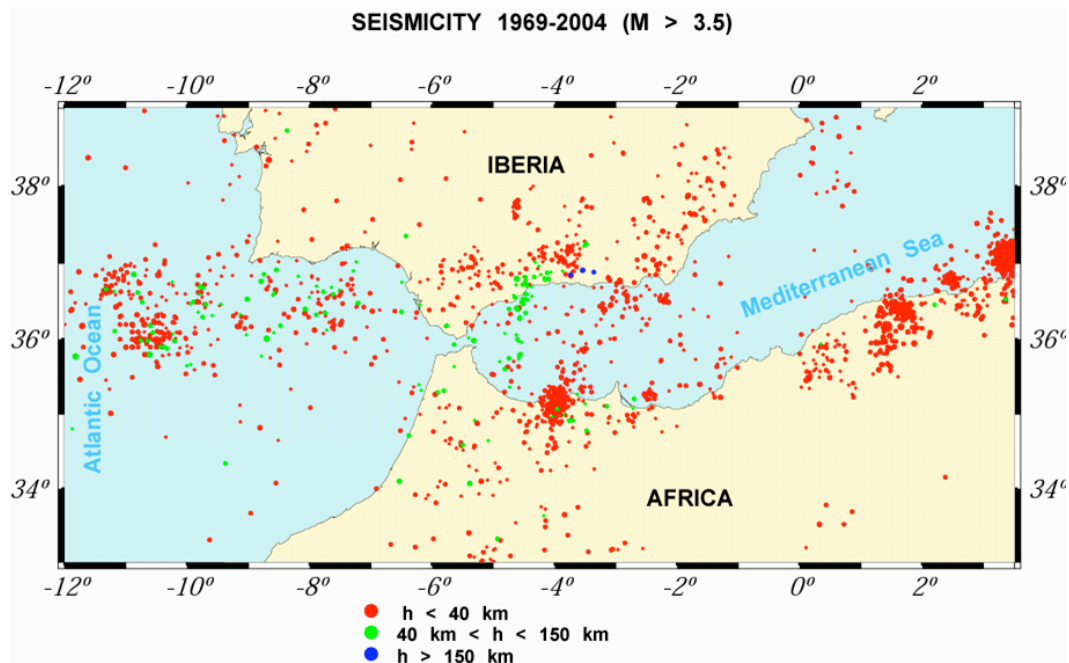


Figure 1: Distribution of epicenters at the Ibero-Maghrebian region (IGN and ROA data files).

## 2. WESTERN MEDITERRANEAN (WM) BROAD-BAND SEISMOLOGICAL NETWORK

From 1996, ROA and the Universidad Complutense de Madrid (UCM), with the support of GeoforschungsZentrum of Potsdam (GFZ), have installed a broad band seismological network with stations located in Southern Spain and Spanish sites located in Northern Africa surrounding the Alboran Sea. This network, initially known as ROA/UCM (Buform et al., 2002), has been renamed as Western Mediterranean network (WM FDSN code) as new stations have been added outside Spanish territory.

The WM network is consequence of several agreements between all participant partners: ROA, UCM, Evora University (Portugal) and ISRABAT (Institut Scientifique of Rabat, Université Mohammed V; Morocco). Being ROA the managing and the coordinator of this network. Also, the GFZ is going to sign the agreement to be a WM partner.

At present, the stations in operation are showed in the figure 2. In the Iberian Peninsula: San Fernando (SFS), Málaga (EMAL) and Cartagena (CART) in Spain, and Evora (EVO) and Setubal (still without international code, SETU is being proposed) in Portugal; Mahón (MAHO) at Minorca Island, and six stations in Northern Africa, in Melilla (MELI), the Peñón de Vélez-Gomera (PVLZ), and Ceuta (CEU) in Spanish places and at Averroes (AVE), Ifrane (IFR) and Tiouine (TIO) observatories in Morocco. In most of them permanent geodetic GPS stations are also installed.

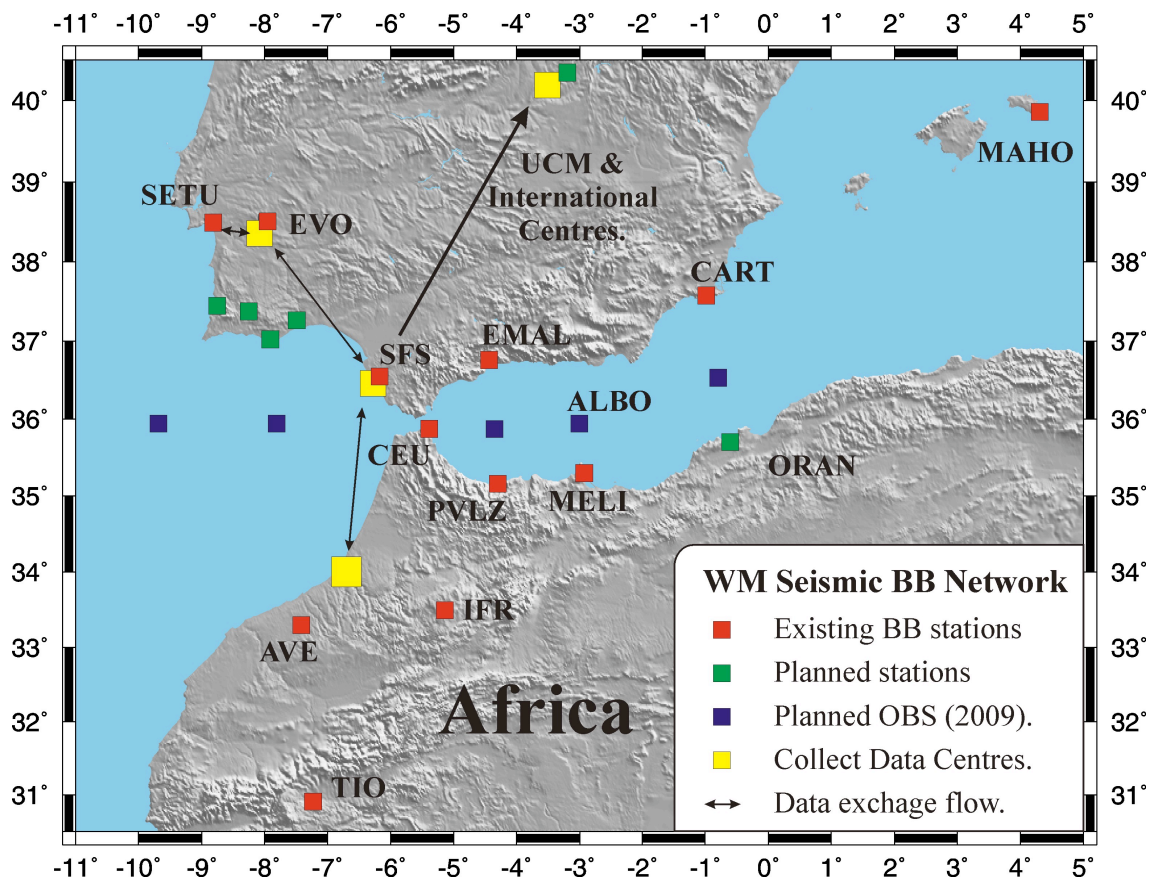


Figure 2: Western Mediterranean (WM) BB seismic network and future OBS FOMAR network.

All WM Network stations (table I), except SETU with a Guralp system (CMG-3ESP sensor and CMG-DM24 digitizer) connected to a Seiscomp (plugin cmgdm24), have Streckeisen STS-2 sensors, Quanterra or Earth Data digitizers, and a Seiscomp system.

Data from SFS, EMAL, MELI, EVO, SETU (GPRS), AVE and IFR stations are available in real time (by Internet), data from CART and MAHO stations are about 10 minutes delayed (they are connected by phone modem), and finally PVLZ, CEU and TIO are not in near real time.

<b>Station</b>	<b>Location</b>	<b>Code</b>	<b>Lat</b>	<b>Lon</b>
<b>EUROPE</b>				
Cartagena	Spain	CART	37,59	-1,00
Mahon, Menorca	Spain	MAHO	39,90	4,27
Malaga	Spain	EMAL	36,73	-4,11
San Fernando	Spain	SFUC	36,64	-6,18
		SFS	36,47	-6,21
Evora	Portugal	EVO	38,53	-8,01
Setubal	Portugal	SETU*	38,50	-8,96
<b>AFRICA</b>				
Averroes	Morocco	AVE	33,30	-7,41
Ceuta	Spain	CEU	35,90	-5,37
Ifrane	Morocco	IFR	33,52	-5,13
Mellila	Spain	MELI	35,29	-2,94
Peñón de Vélez-Gomera	Spain	PVLZ	35,17	-4,30
Tioune	Morocco	TIO	30,92	-7,26

**Table I: Western Mediterranean (WM) BB seismic network station list. \*Proposed code (not yet assigned).**

### **3. FUTURE PLANS ABOUT WM NETWORK.**

Plans, for the next 2009 and 2010, are focusing on three lines: land installations, off shore deployments and real time communication.

About land installations, the objective is to extend the net to have a good cover along the Alborán sea and also in the Gulf of Cádiz.

In the East part, we are planning a new permanent BB seismic station close to ORAN (see figure 2), in collaboration with Algerian institutions, which will provide better azimuthal coverage on Alborán and Algeria earthquakes.

Toward the West, in the Gulf of Cádiz, four new installations are planned in the South Portugal (see figure 2) in collaboration with the Evora University.

Additionally, a station near Madrid will be installed between UCM and ROA, also creating a data collect Centre at UCM.

The off shore plans will be detailed in next point.

About near real time, a large effort is being done, focusing in the stations where the internet connection has problems. We plan, along 2009, to get PVLZ to internet and change CART and MAHO from phone to internet using the Spanish navy facilities. About CEU station, a WIFI system is being tested for connect to a ADSL line, 1 km away.

Also, an VSAT system is going to be installed in almost stations, in collaboration with the GFZ, in order to integrate them in the “North Atlantic and Mediterranean Tsunami Warning System” (NEAMTWS) initiative.

#### **4. “FOMAR” OCEAN BOTTOM (OBS) SEISMIC NETWORK**

Due to the fact that part of the seismic activity is located at marine areas (figure 1), and the poor geographic azimuthal coverage at some zones provided by the land stations, in order to complement the WM broad-band network, ROA and UCM will deploy a temporary OBS network (FOMAR project) and a permanent OBS near the Alborán island (OBS ALBORAN project).

The permanent ALBO OBS (see figure 2) will be linked to land by a 2 km fiberoptic underwater cable. A broad band sensor (Guralp CMG-3T), a pressure gauge, and a current-meter will be deployed about 1500 m toward the Shouth of Alboran island. Also 9 free TCP-IP and power will be able for additional instruments. This system will be connected to internet for near real time. Now a days, the system is being finished and tested at Guralp laboratories, and we plan to deploy it in summer 2009 with the support of the Spanish Navy.

The FOMAR network project is a four temporary (three years) OBS in the Gulf of Cadiz and Alboran Sea (OBS are mapped in blue in figure 2). The deployment of the OBS will be carried out within of 2009, also with the support of the Spanish Navy.

#### **5. CONCLUSIONS**

In order to study the seismicity associated to the western part of the Eurasia-Africa plate boundary at the Ibero-Maghrebiam region, ROA in collaboration with UCM and the support of GFZ have deployed, since 1996, a Broad-Band seismic network with stations installed in Southern Spain and Spanish sites in Northern Africa. This network has been expanded with a station in Evora and Setubal (Universidade de Evora) in Portugal, and others in Averroes, Ifrane and Tiouine (Université Mohammed V), Morocco, forming the new Western Mediterranean Network (WM). It's planned to install, in the near future, one station near Madrid, one station in Oran (Algeria) in collaboration with the Université d'Oran, and four stations more in South Portugal in collaboration with the Evora University.

In order to improve the WM network, five Ocean Bottom Seismographs (OBS) will be deployed in the Gulf of Cadiz and Alboran Sea, including a permanent station (OBS ALBORAN) and four (FOMAR net) semi-permanent stations. Deployment of OBS is planned to be carried out on the summer of 2009.

## **6. ACKNOWLEDGEMENTS**

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## **7. BIBLIOGRAPHY**

Buform, E., Sanz de Galdeano, C. and Udías, A., 1995. Seismotectonics of the Ibero-Maghrebian region. *Tectonophysics*, 248, 247-261.

Buform, E., Udías, A., Martín Davila, J., Hanka, W., and Pazos, A. (2002). Broadband station network ROA/UCM/GFZ in south Spain and northern Africa. *Seismological Research Letters*, 73, 2, 173-176