MARSITECRUISE
R/V POURQUOI PAS?

October 28th to November 16th, 2014

SIX-MONTHS REPORT

Volume 1: General foreword & Report of instrument deployment and recovery operations during Legs 1, 2 & 3

Chief scientists

- **LEG 1:** Louis Géli (Ifremer)
- **LEG 2:** Livio Ruffine (Ifremer)
- **LEG 3:** Pierre Henry (CEREGE)

MARSITECRUISE

R/V POURQUOI PAS?

October 28th to November 16th, 2014

SIX-MONTHS REPORT

Volume 1: General foreword & Report of instrument deployment and recovery operations during Legs 1, 2 & 3

Table of contents

Tables

Figures

GENERAL FOREWORD (1/2)

Summary of MARSITECruise. The scientific cruise MARSITECRUISE of *R/V Pourquoi pas?* took place from 28 October to 17 November 2014. Part of the operations were carried out within the frame of the MARSITE programme supported by the European Union, which aims at better understanding the behaviour of the North Anatolian fault in the Marmara sea in view of improving the assessment of the seismic hazard weighing on the Istanbul region. Coordinated by the Observatory of the University of Kandilli (KOERI, based in Istanbul), MARSITE groups 23 partners and includes different components: land, spatial and marine. The marine operations of the programme were coordinated by Ifremer and conducted using Italian (R/V Urania) and French (R/V Pourquoi pas?) naval means.

During the first part of the cruise (28/10 to 1/11, 2014), 10 geodetic acoustic stations were deployed on the seafloor to measure directly the relative plate motion along the submerged part of the North Anatolian Fault. Four stations were implemented by the "LDO : Laboratoire Domaines Océaniques" from Brest ; the six others by Geomar. The stations have been designed to remain 3 years on the seafloor. Visits are programmed every six months, using Turkish naval means, to check their functioning and to collect data.

During the second part of the cruise (2/11 to 13/11), the ROV VICTOR 6000 was deployed in order to collect *in situ* samples and measurements (interstitial waters, gas, brines, oil) to understand the migration of fluids along the faults. During Leg 2, 5 ROV dives were conducted (for a total of 148.4 hours) resulting in 18 gas samples, 28 Raman measurements and 41 measurements of gas flow, 35 interface corers and 2 blade corers for geomicrobiology, 7 Titanium seringues to study rare gases. A total of 12 long Calypso sediment cores were made to analyse deep interstitial fluids and 8 CTD associated with the evaluation of 2 methane captors for the geochemical evaluation of plumes observed during acoustic surveys of the water column. The success of *in situ* Raman spectroscopic measurements is novel at Ifremer ; this is the second only success of such an experiment on a world scale and opens doors to a new *in situ* gas sampling strategy.

Finally, a unique experiment, initially programmed for Leg1, was accomplished. An acoustic bubble detector (BOB) and two seabed seismographs were deployed by ROV/VICTOR to study the phenomena of natural degassing of methane on the seafloor.

The third part of the cruise (13-16 November) had a double objective: i) acquire sediment cores in key sites for paleoseismic studies aiming to specify the recurrence rate of earthquakes in the Marmara sea; ii) recover INGV and Ifremer instruments deployed during previous operations within MARSITE.

The MARSITECRUISE is the result of collaboration between 16 partners: Ifremer; 7 CNRS laboratories (IUEM-Brest, CEREGE-Aix-en-Provence, ITER-Grenoble, LOCEAN-Paris, CRPG-Nancy, MNHN-Paris, LIENSs); INGV (Italy); Geomar (Kiel); ITU (Istanbul); KOERI (Istanbul); MTA (Ankara); DEU (Izmir); Beijin University (China) and the University of Munster (Germany).

GENERAL FOREWORD (2/2)

Organization of the present 6-months report. An (almost) comprehensive report was established and sent to the Turkish authorities one month after the completion of the Marsite Cruise. This report includes the description of the marine operations and 9 appendixes, including the report on the discovery of geological assets (Appendix 1) and the proof of reception of data by Turkish Institutions (Appendix 2). Instead, the Six-Months Report includes 3 volumes:

- **Volume 1** describes the different deployments and recovery operations that were completed during legs 1, 2 and 3 of the MarsiteCruise. The final coordinates presented in this report have been checked. These coordinates are thus to be considered as final and definitive.
- **Volume 2** provides updated details on the geochemical sampling completed during Leg 2.
- **Volume 3** provides updated details on the sediment sampling completed during Legs1 and 3 for seismo-stratigraphy purposes. The updated, final coordinates of the sediment profiler lines are also provided.

Package content. The present package delivered here includes:

- the One-Month Report
- the Six-Months Report with the three volumes here-in
- an USB stick including the digital version of the different cruise reports

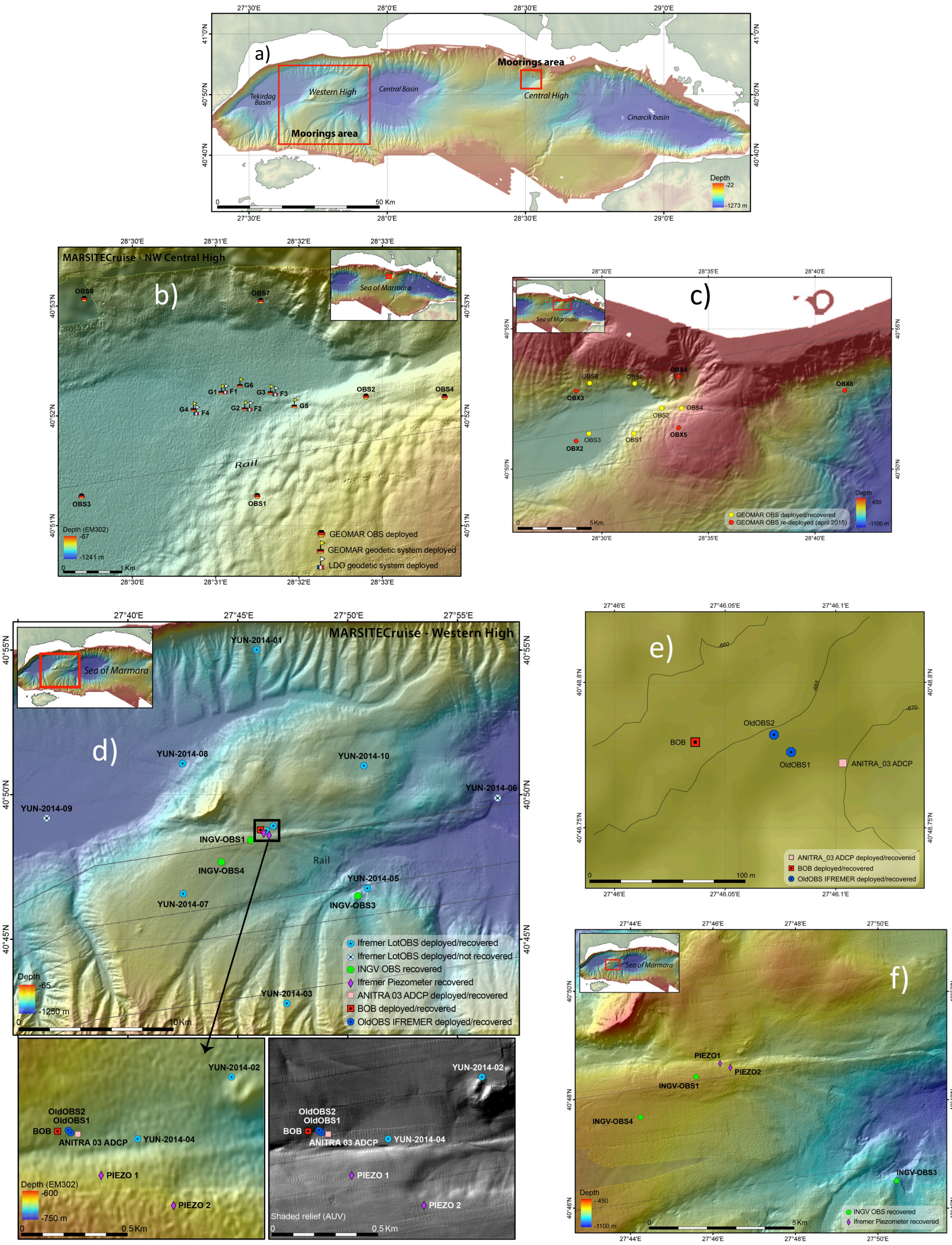
Summary of Six-Months Report on instrument deployments

The present Volume (1) of this Six-Months Report provides updated information (compared to the one in the One-Month Report) on the deployment and recovery operations that were achieved during the MarsiteCruise of *R/V Pourquoi pas?*

These operations include:

- Deployment of 10 geodetic beacons (6 from Geomar, Germany and 4 from IUEM, Brest, France) in the Central High / Kumburgas Basin area.
- Deployment of 8 OBSs from Geomar in the same area
- Recovery of the 10 Ifremer OBSs that were deployed with R/V Yunuz on September 18th, 2014 on the Western High
- Recovery of the 3 INGV OBSs and 2 Ifremer piezometers that were deployed with R/V Urania in October 2013 near the mud volcano system, within the fault valley cutting the Western High
- Deployment and recovery of one acoustic bubble detector (BOB) along with a current meter and 2 OBSs, in order to monitor the temporal variability of the gas emission sources that were identified near the mud volcano system, within the fault valley cutting the Western High.

Synthetic Maps of Instrument Locations



GENERAL MAPS of the Sea of Marmara bathymetry with locations of instruments handled during the MarsiteCruise related operations. a) mooring areas : Central High and Western High; b) Geodetic stations (from France and from Germany) and OBSs deployed during the MarsiteCruise; c) Location of Geomar OBSs in the geodetic experiment area : yellow dots are for locations of OBSs deployed with R/V Pourquoi pas? In October 2014, while red dots are for locations of instruments redeployed in april 2015 with R/V Poseidon; d) general map of instrument locations on the Western High. Turquoise circles indicate the 10 OBSs from Ifremer that were deployed in September 2014 with R/V Yunuz and recovered in november 2014 with R/V Pourquoi pas?; d) Location of the 2 Ifremer piezometers and 4 INGV OBSs that were deployed in October 2013 with R/V Urania and recovered in november 2014 with R/V Pourquoi pas?; e) location of the acoustic bubble recorder (BOB) that was deployed on top of the Western High along with 2 OBSs and one current meter.

I. Geodetic experiment on the Central High

I.1 Background/specific objectives

Whether or not the Istanbul-Sılıvırı segment actually ruptured in 1766 **is still an open question** because historical reports, which are known to be hampered by great uncertainties, cannot be considered as definite proofs indicating the exact location of past ruptures. In addition, detailed, high-resolution bathymetric investigations using Autonomous Unmanned Vehicles conducted in 2009 did not provide any evidence for fresh scarps along the *Istanbul-Sılıvırı segment*, possibly due to the draping of sediment deposits during the last 2 centuries. In addition, while intense bubbling is observed on a structural high, 1 km south of the main fault trace, no evidence of fluid expulsion has been found on the fault itself.

The **goal** of this experiment is to determine if the *Istanbul-Sılıvırı* segment of the North-Anatolian Fault within the Sea of Marmara is locked or creeping. This fundamental question is here addressed by combining underwater, geophysical methods including seafloor telemetry and passive seismology using OBSs. The geodetic experiment (GEODEX) was implemented on the eastern part of the segment, e.g. on the Central High where the fault trace on the seafloor of the Main Marmara Fault is visible besides the sediment draping (Fig. I.1).

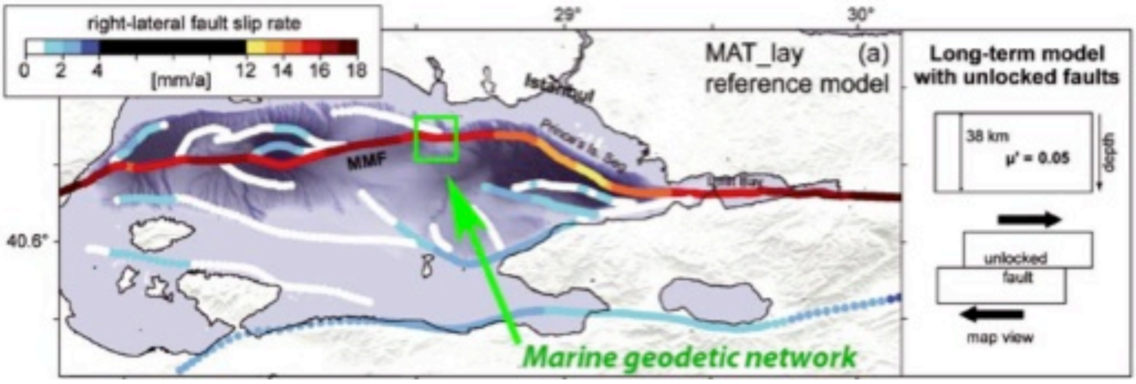


Fig. I.1 *Map indicating the location of the Main Marmara Fault (brown, thick line) and the distribution of slip-rates along the submerged fault system within the Sea of Marmara. The green square indicates the location of the Geodetic experiment. Modified after Hergert et al [2011].*

I.2 Deployment of geodetic instruments

The following geodetic equipment were deployed for an expected duration > 3 years:

- 4 acoustic ranging stations working at 20 kHz, from “Laboratoire Domaines Océaniques” of IUEM (Institut Universitaire Européen de la Mer), called “French stations ”, named F01 to F04.
- 6 acoustic ranging stations working at 23 kHz, from Geomar, called “German stations, named G01 to G06.

FRENCH (IUEM/LDO) GEODETIC STATIONS				
Emplacement	Station Id	Latitude	Longitude	Water depth
F1	2001	40°52.24879'N	28°31.11901'E	811
F2	2002	40°52.0931'N	28°31.4136'E	804
F3	2004	40°52.2268'N	28°31.7193'E	805
F4	2003	40°52.0859'N	28°30.7950'E	825
GERMAN (GEOMAR) GEODETIC STATIONS				
Emplacement	Station Id	Latitude	Longitude	Water Depth
G1	2304	40°52.24551'N	28°31.07442'E	813
G2	2305	40°52.0955'N	28°31.3542'E	804
G4	2307	40°52.08827'N	28°30.73863'E	827
G3	2302	40°52.24284'N	28°31.66376'E	805
G5	2303	40°52.09708'N	28°31.96168'E	779
G6	2301	40°52.28916'N	28°31.3149'E	807

Table I.1: *Locations of geodetic stations*

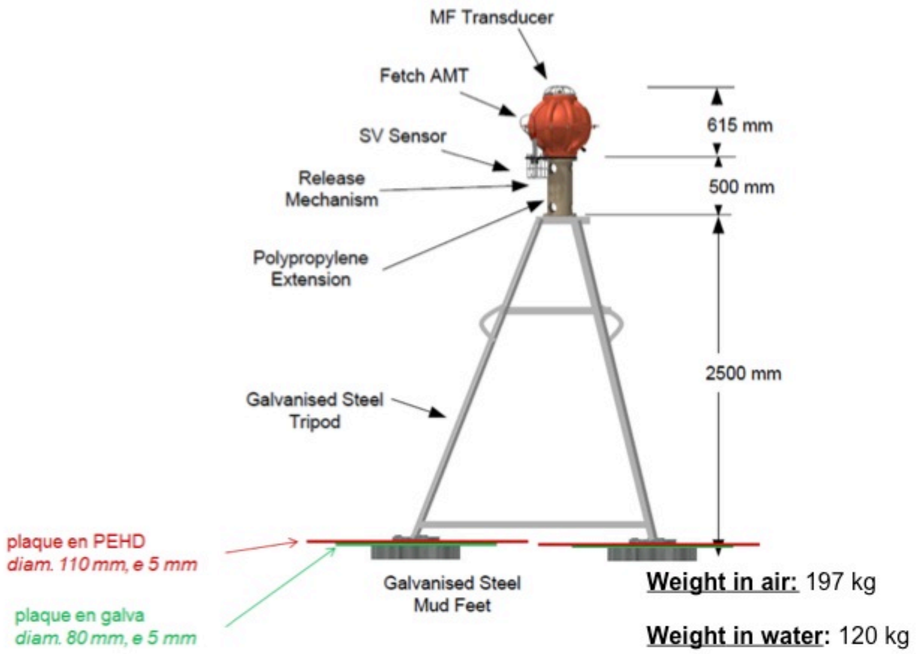


Fig. I.2 : *Equipment dimensions for French geodetic station*

Fig. I.3: *French geodetic stations on deck on board R/V Pourquoi pas? during Marsite Cruise.*

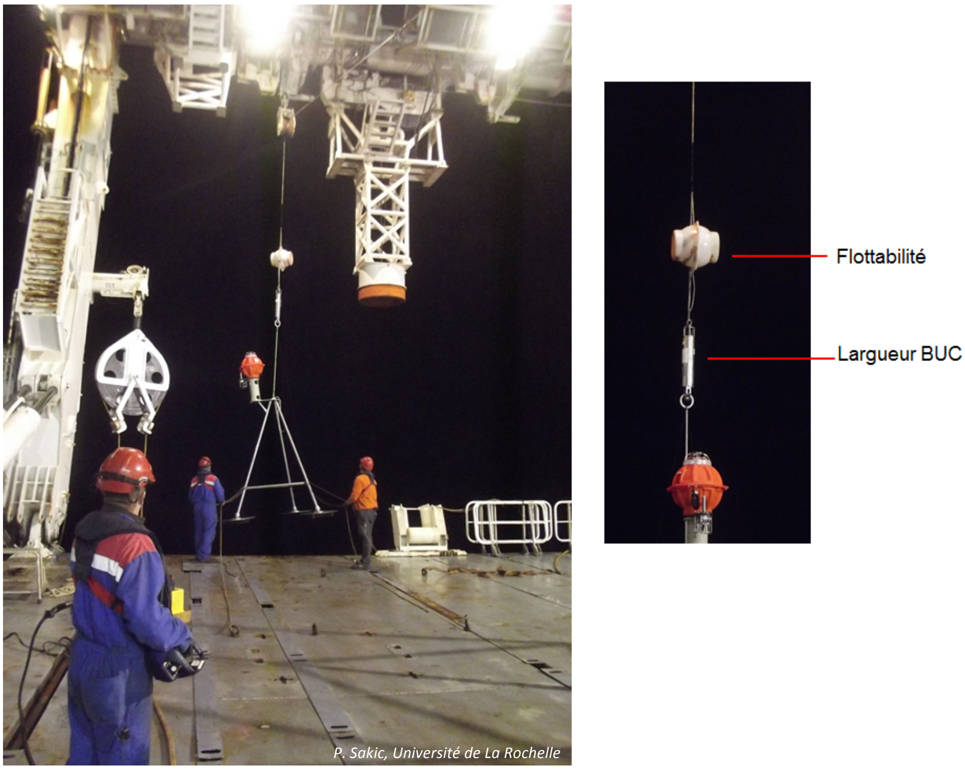


Fig I.4: *Deployment of French geodetic station from R/V Pourquoi pas? during Leg 1 of Marsite Cruise.*

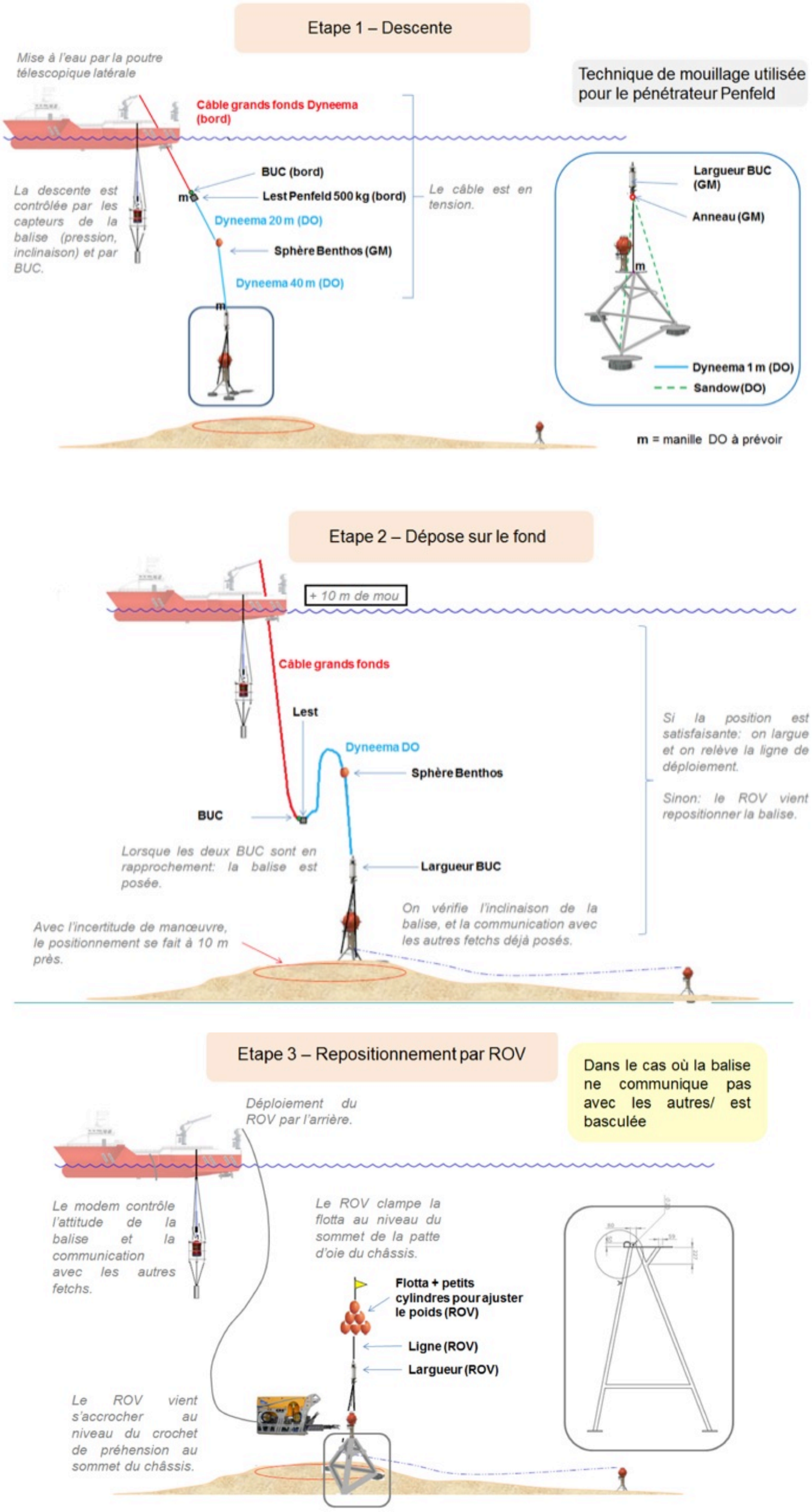


Figure I.5: *Details of the deployment protocol. In Phase 1 (top), the modem is deployed first. Then the station is lowered down with a cable equipped with a weight and an Ultra Short Baseline. In Phase 2, the equipment is released after a good position has been found on the seafloor. In Phase 3, the ROV is used in case of problems. The use of ROV Victor was not necessary during the Marsite Cruise.*

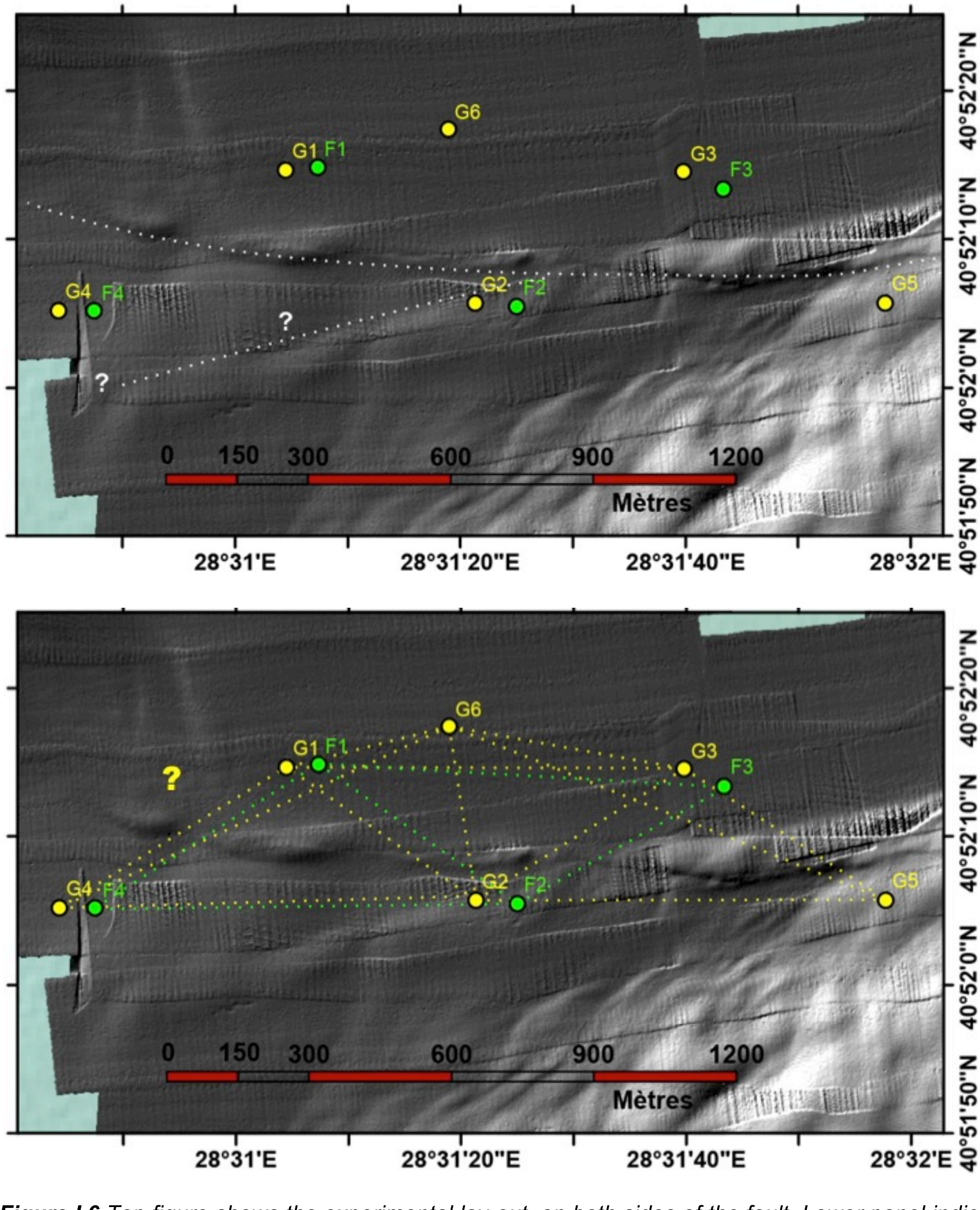


Figure I.6 *Top figure shows the experimental lay-out, on both sides of the fault. Lower panel indicates the geometry of the ray paths between the different pairs of sensors. Redundant sensors from the German and from the french networks have been installed at each node, in order to consolidate results. French stations use 20 kHz transponders emitting every hour, while the frequency used for the German stations is 23 kHz emitting every two hours.*

The geodetic stations are all equipped with AMT-FETCH acoustic transponders manufactured by SONARDYNE inc (UK), allowing reception from -and emission to- all other stations. French and german stations do not emit at the same frequency (20 kHz and 23 kHz, respectivey), hence the two networks (from LDO and GEOMAR) work independently :

- french station emit 20 kHz signals very hour
- german stations emit 23 kHz signals every two hours.

The coordinates are listed in Table I.1 and the network configuration is shown in Figure I.6. The geodetic instruments measure the local sound speed, temperature and inclination and pressure. The distance measured from one beacon to the next ("baselines") is done by the sound travel time measurement between the geodetic stations. From the speed of sound (measured at the endpoints of the baselines) and the travel time of signals between the instruments, the distances that separate them are estimated. In general the installation of the geodetic stations worked without any problem:

- All stations could be deployed in the target location of about 10x10 m and we received in real-time, thanks to the communication with the acoustic modem deployed over the ship side, the baselines which we expected according to the visibility studies done before the experience.
- All instruments work as expected and measure locally all associated parameters (celerity, temperature, pressure, inclination).
- For the german network, it is to be noted that intercommunication between the baselines worked for 12 of the 15 possible baselines (Figure II.1.6). The geodetic stations G2303 and G2307 have no line of sight and baselines longer than 1 km were not recorded due to station settings. During leg3, station G2303 was reconfigured in order to obtain longer baselines, by adding one-directional measurements for the baselines G2303-G2307 and G2303-G2304. This will result in the measurement of 14 from 15 possible baselines, there from 12 baselines with bidirectional distance estimate. Although after leg1 only few baseline measurements are available the first result suggest that the precision of the distance estimate is smaller than 5 mm.

All stations were visited with ROV VICTOR, during the first dive (DIVE01) of Leg 2, on November 2nd, 2014 (Table I.2). All stations were found to be correctly installed on the seafloor, with the three feet firmly coupled to the sediments. All equipments were laying horizontally on the seafloor, except for station G5, which was known to be tilted by an angle of 10°, based on shipboard acoustic interrogations made by the group from GEOMAR. Visual observations with ROV confirmed the inclination.

Station	Hour (TU)	Observations
G4	02/11/14 01:49	OK - Feet completely buried in sediments - stable
F4	02/11/14 02:02	OK - horizontal - Feet laying on top of sediments - stable
G1	02/11/14 02:42	OK - horizontal - Feet slightly buried - stable
F1	02/11/14 02:54	OK - horizontal - Feet buried - stable
G6	02/11/14 03:43	OK - horizontal - Feet buried - stable
G2	02/11/14 04:02	OK - horizontal - Feet buried - stable
F2	02/11/14 04:20	OK - horizontal - Feet buried - stable
G3	02/11/14 04:58	OK - horizontal - Feet buried - stable
F3	02/11/14 05:08	OK - horizontal - Feet buried - stable
G5	02/11/14 06:15	Feet completely buried in sediments – Tilt ~10°

Table I.2: Dates of visual visits of the Geodetic stations on the seafloor using ROV Victor.

Figure I.7 *Photograph of geodetic station F4 taken on November, 2, 2014, at 02:02 GMT with ROV Victor*

Figure I.8 *Photograph of acoustic transponder installed on geodetic station G6 taken on November, 2, 2014, at 03:45 GMT with ROV Victor*

I.3 Status of geodetic stations after 6 months

The geodetic stations were all checked and found in good working status in april 2015 with R/V Poseidon, as shown in the lists below :

Location	Transponder ID	Date of interrogation	Status	Inclination of the structure	Remaining battery life	Data logged (ko)	Operations performed
F1	**2001**	25/04/2015 16h50 UTC	Transponder has been properly functioning	No variation since deployment	83%	742.4	1. Data retrieval - 2.Modification of the logging period from 1h to 2h
F2	**2002**	25/04/2015 18h38 UTC	Transponder has been properly functioning	No variation since deployment	78%	801.8	1. Data retrieval - 2.Modification of the logging period from 1h to 2h
F3	**2004**	25/04/2015 19h12 UTC	Transponder has been properly functioning	0.002 rad decrease of pitch and roll since deployment	84%	562.2	1. Data retrieval - 2.Modification of the logging period from 1h to 2h
F4	**2003**	25/04/2015 17h54 UTC	Transponder has been properly functioning	No variation since deployment	83%	597.5	1. Data retrieval - 2.Modification of the logging period from 1h to 2h

Table I.3 Status of french geodetic stations tested on April 25th, 2015 with R/V Poseidon.

Position of GEOMAR Geodetic Stations								
Data reading and configuration POS 484								
Name GEOMAR STATION	**lon.**	**lat.**	**lon**	**lon**	**lat**	**lat**	**depth**	**Looger ID**
	dec. Deg.	**de. Deg.**	**deg.**	**min (dec.)**	**deg.**	**min (dec.)**	**(from AUV)**	
G4	28,5123000	40,8681000	28	30,7380	40	52,0860	827	G2307
G1	28,5179000	40,8708000	28	31,0740	40	52,2480	813	G2304
G2	28,5224000	40,8687000	28	31,3440	40	52,1220	804	G2305
G3	28,5277000	40,8707000	28	31,6620	40	52,2420	805	G2302
G5	28,5327000	40,8683000	28	31,9620	40	52,0980	779	G2303
G6	28,5219000	40,8715000	28	31,3140	40	52,2900	807	G2301

Table I.4 Status of german geodetic stations tested on April 25th, 2015 with R/V Poseidon. All stations had a nominal response.

II. Data quality of GEOMAR OBSs from Central High area

The Istanbul-Siliviri segment is known to be anomalously “silent” compared to the other segments within the Sea of Marmara. The initial plan was to deploy 8 OBSs in order to monitor the low-level micro-seismicity in the Geodetic Experiment area. Due to unexplained, technical failures, only 6 were eventually deployed.

COORDiNATES of GEOMAR OBSs							
LATITUDE		LONGITUDE		Water depth (m) depth (m)	GEOMAR Identification Number	Geographical Site (Number given during cruise)	Status at recovery in April 2016
Deg	Min	Deg	Min				
40	52,1722	28	33,7472	549	OBS8	OBS-GEOMAR-4	8 Go record
40	52,1761	28	32,8038	663	OBS7	OBS-GEOMAR-2	6,8 Go record
40	53,04728	28	31,54003	682	OBS6	OBS-GEOMAR-7	Not running – Battery low
40	53,06452	28	29,42369	658	OBS5	OBS-GEOMAR-6	Not running – Battery low
40	51,26572	28	29,38985	823	OBS4	OBS-GEOMAR-3	Not running – Battery low
40	51,26976	28	31,49927	689	OBS3	OBS-GEOMAR-1	8 Go record

Table II.1 *Coordinates of GEOMAR OBSs deployed during the Marsite Cruise. Right column indicates the status of the instruments after recovery by R/V Poseidon on april 2015.*

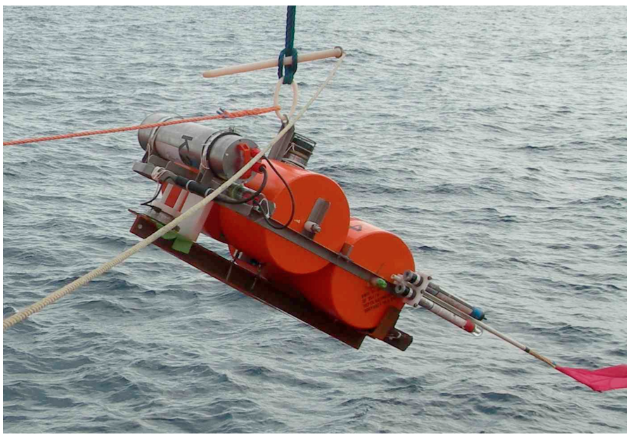


Figure II.1 *Photograph of GEOMAR OBS deployed during Leg1 of Marsite Cruise.*

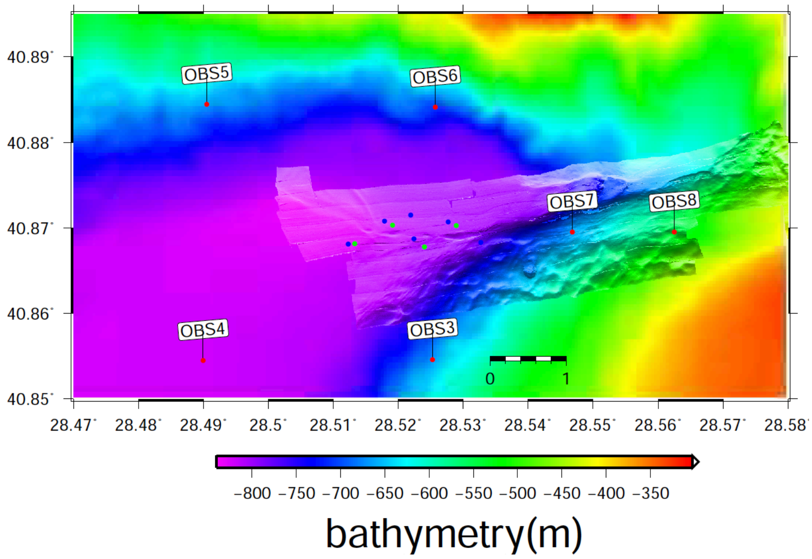


Fig. II.2: Map showing the location (red points) of the GEOMAR OBS stations labelled with station IDs. The geodetic stations are shown with blue (GEOMAR) and green (LDO) points. Bathymetry from echosounder data. In the region of the geodetic network high resolution bathymetry from AUV mapping is shown. In order to enhance the fault structure the AUV bathymetry was illuminated from the South.

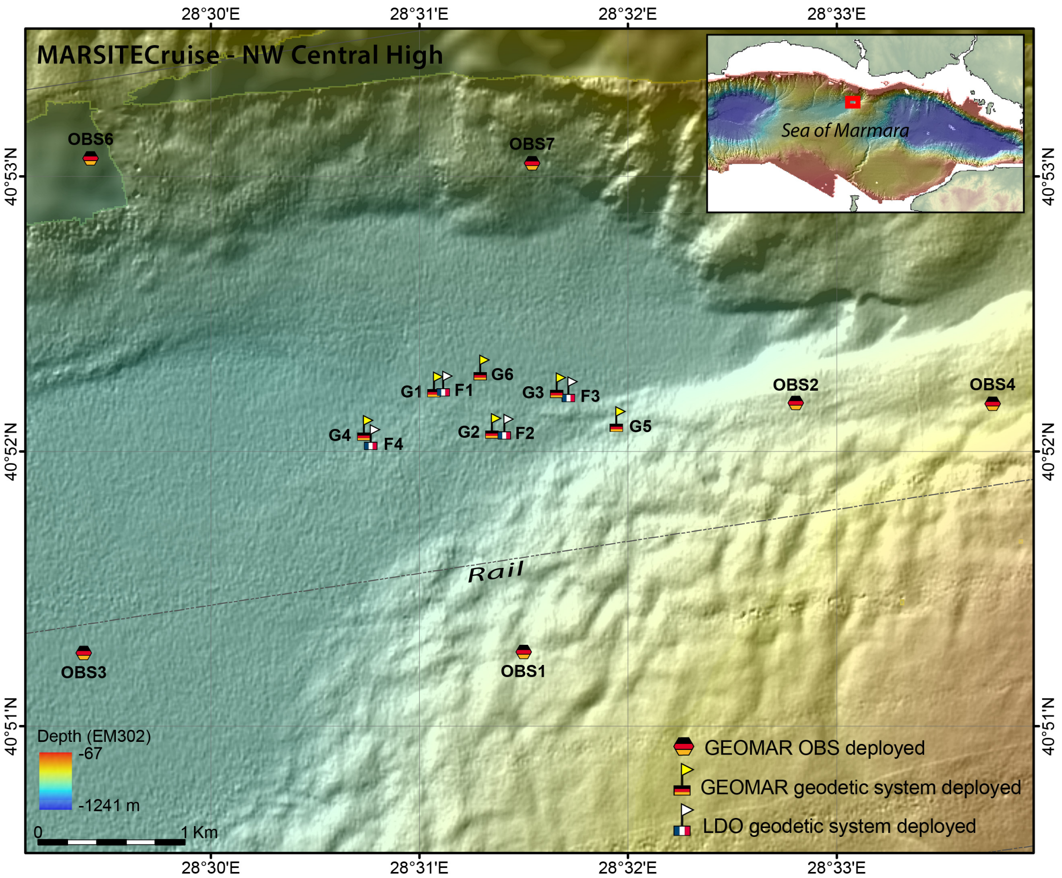


Fig. II.3: Map showing the location (red points) of the GEOMAR OBS stations labelled with site number (see correspondancez between Station ID and Site ID in Table I.2. The geodetic stations are shown with german (GEOMAR) and french (LDO) flags.

The GEOMAR OBSs were recovered in april 2016 with R/V Poseidon. Three stations (out of 6) provided data, with 8, 6.8 and 8 Gigabytes, respectively (see right column in Table II.1).

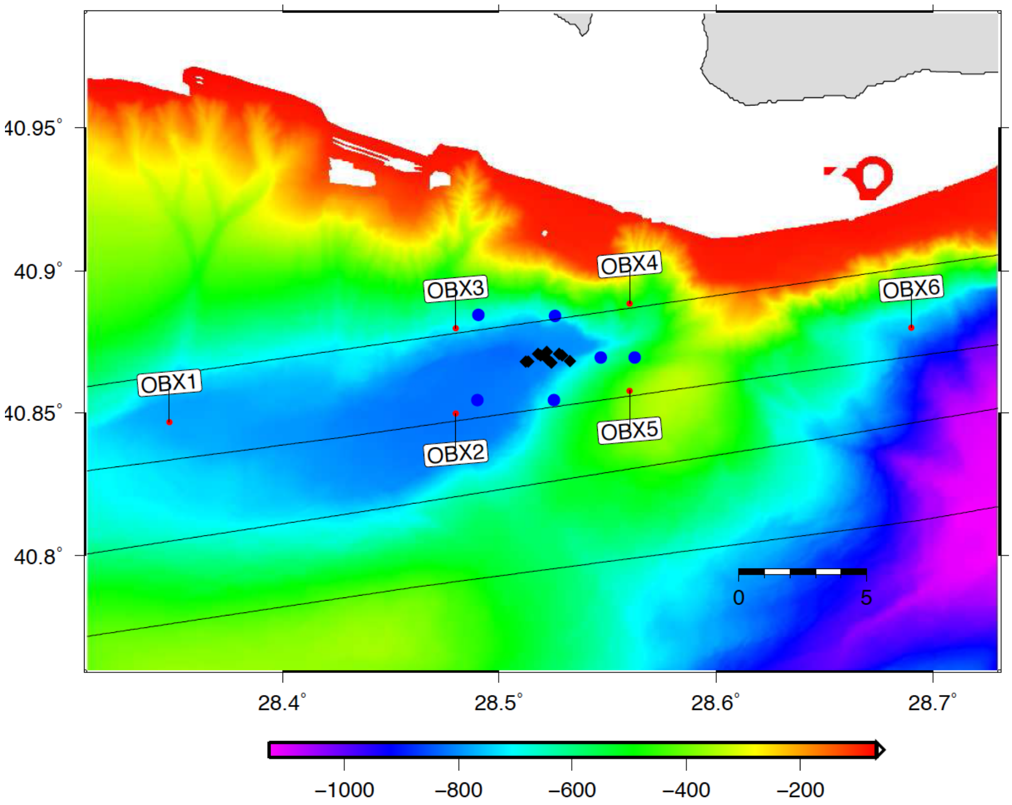


Fig. II.4. Redeployment of GEOMAR OBSs (red dots, OBX1 to OBX6) on April 2015, with R/V Poseidon. Blue dots indicate location of GEOMAR OBSs during MARSITECRUISE. Black diamonds are geodetic stations. Instruments will be recovered in April 2016.

Name	lon.	lat.	longitude	longitude	latitude	latitude
	dec deg.	dec deg.	deg.	min (dec.)	deg.	min (dec.)
OBX1	28,3478861	40,8468122	28	20,87320	40	50,80870
OBX2	28,4800000	40,8499476	28	28,80000	40	50,99690
OBX3	28,4800000	40,8797855	28	28,80000	40	52,78710
OBX4	28,5600000	40,8883738	28	33,60000	40	53,30240
OBX5	28,5600000	40,8578795	28	33,60000	40	51,47280
OBX6	28,6900000	40,8800000	28	41,40000	40	52,80000

Table II.2 Coordinates of GEOMAR OBSs redeployed in april 2015 with R/V Poseidon.

The Geomar OBSs were recovered in April 2015 with R/V Poseidon, then serviced and redeployed. Eventually, the instruments will be serviced and redeployed again in April 2016.

III. Data quality of Ifremer OBS data from the Western High area

A total of 10 OBSs were deployed with R/V Yunuz on September, 18th, 2014 in the Western Part of the Sea of Marmara and recovered during the MARSITECruise.

- OBS YUN_2014_02 failed (recording stopped after 3 days)
- OBS YUN_2014_06 was recovered by a fisherman, but worked OK
- OBS YUN_2014_09 was recovered by a fisherman on april 28th, 2015; status not known yet
- OBS YUN_2014_03 stopped recording on October 23rd, 2014
- Also note that during this time period, none of the KOERI's cabled OBSs worked.

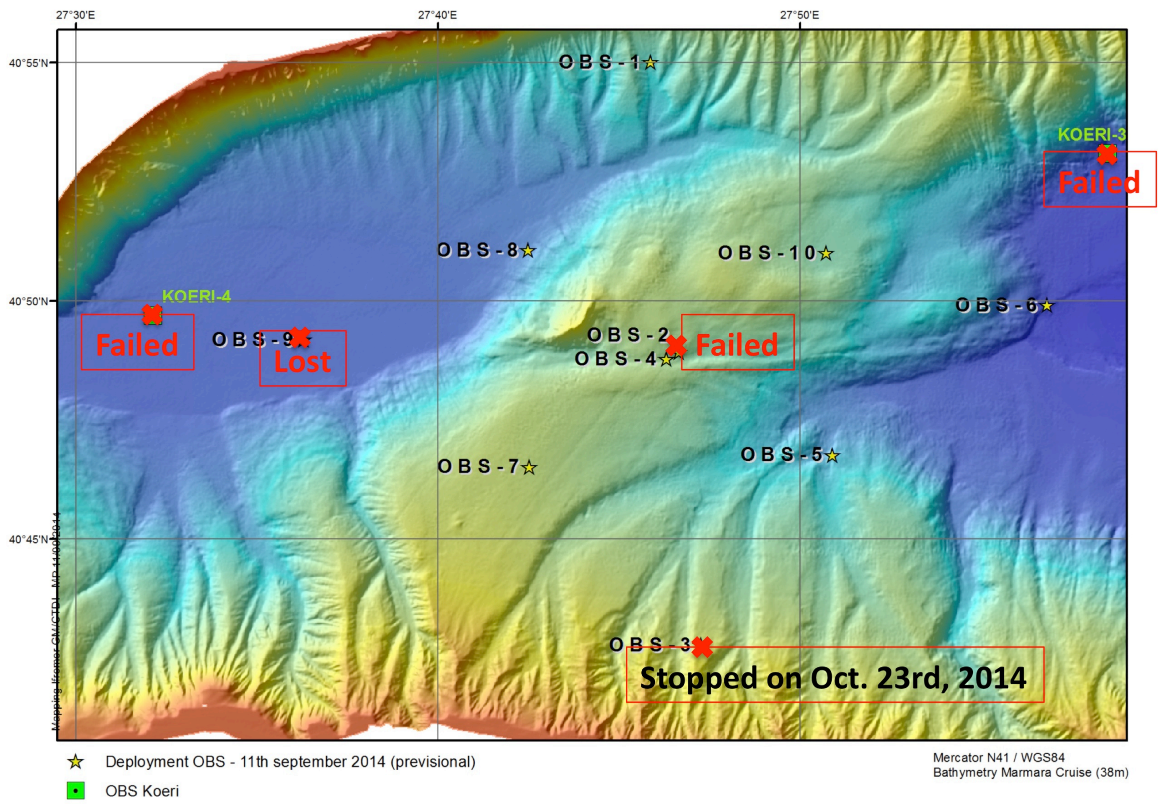


Figure III.1 : Location of Ifremer's autonomous OBSs deployed with R/V Yunuz on September, 18, 2014 and recovered with R/V PourquoiPas? in November 2014. KOERI's, permanent, cabled OBSs (KOERI-3 and KOERI-4) are also indicated.

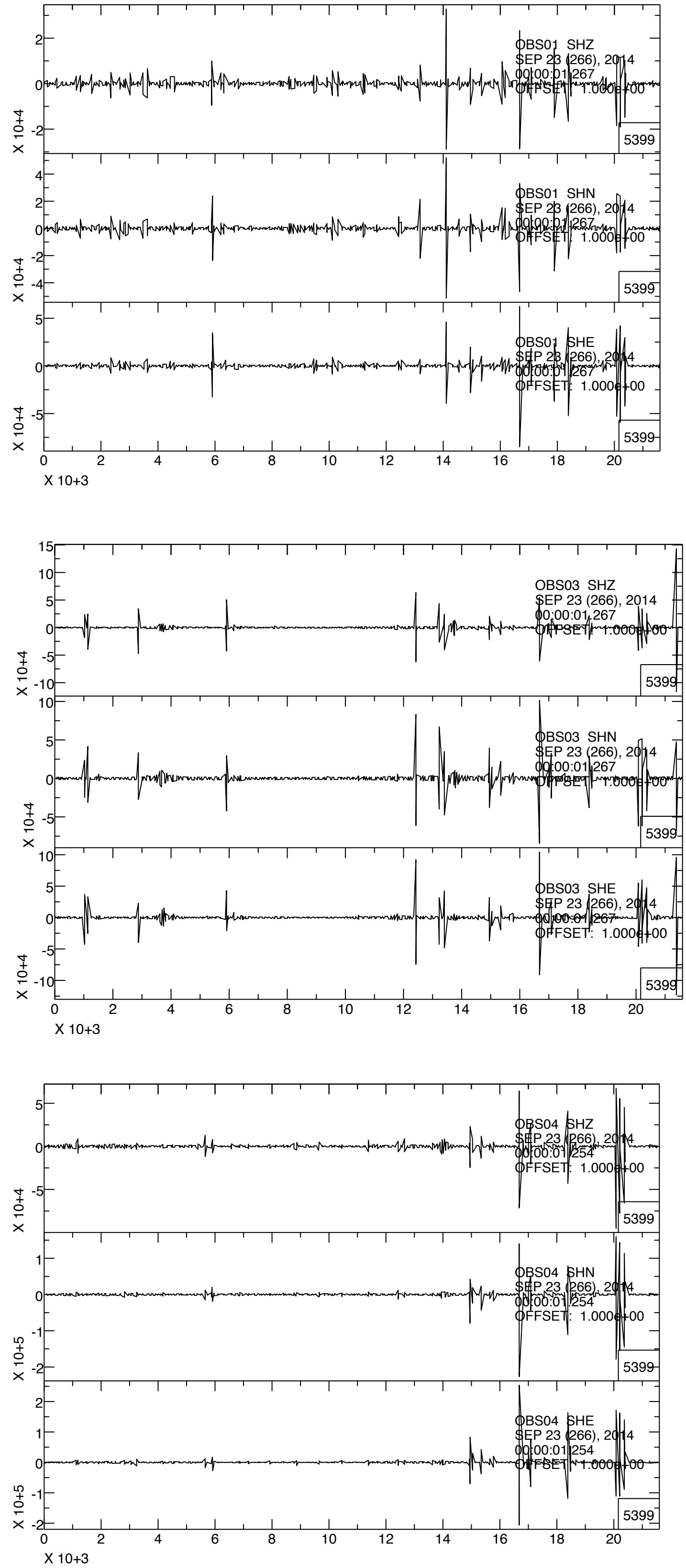


Figure III.2 : Example of 6h of OBS-data record collected on September 23[rd], 2014, at OBS 1, 3 and 4 respectively.

IFREMER OBSs DEPLOYED WITH R/V YUNUZ IN SEPT. 2014 RECOVERED WITH R/V POURQUOI PAS IN NOV. 2014						
Name : YUN_2014 _xx	**Deploy Date YUNUZ (2014)**	**Lat**	**Lon**	**Depth**	**Recovery Date POURQUOI PAS (2014)**	**Quality**
1	9/18/14 12:51	40,91677	27,76436667	443	11/15/14 15 :15	OK
2	9/18/14 8:30	40,81528	27,7769	661	11/14/14 17:11	FAILED AFTER 3 DAYS of RECORDING
3	9/18/14 7:23	40,71292	27,78706667	481	11/15/14 20:35	OK
4	9/18/14 8:27	40,81267	27,7717	665	11/15/14 10:20	OK
5	9/18/14 6:50	40,77940	27,84818333	918	11/14/14 16:02	OK
6	9/18/14 6:13	40,83143	27,947	1191	RECOVERED BY FISHERMAN	OK
7	9/18/14 7:58	40,77620	27,70851667	568	11/14/14 19:39	OK
8	9/18/14 9:08	40,85125	27,708	1024	11/15/14 16:33	OK
9	9/18/14 9:42	40,81977	27,60506667	1106		LOST
10	9/18/14 13:30	40,84997	27,84551667	401	11/14/14 12:21	RECORD STOPPED ON October 23rd, 2014

Table III.1

IV. Data quality of Ifremer piezometer data and INGV OBS data from the Western High area

Two piezometers from Ifremer, along with 4 OBSs from INGV, were deployed in October 2013 with R/V Urania on top of the Western High near the mud volcano area, in order to study the response of sediment pore fluid pressure to earthquakes. A piezometer consists in an 8-m long pipe, equipped with differential pressure sensors installed at 8 different depths. When the instrument penetrates into the sediments, the sensors measure the difference between the sediment pore pressure and the hydrostatic pressure at 8 levels.

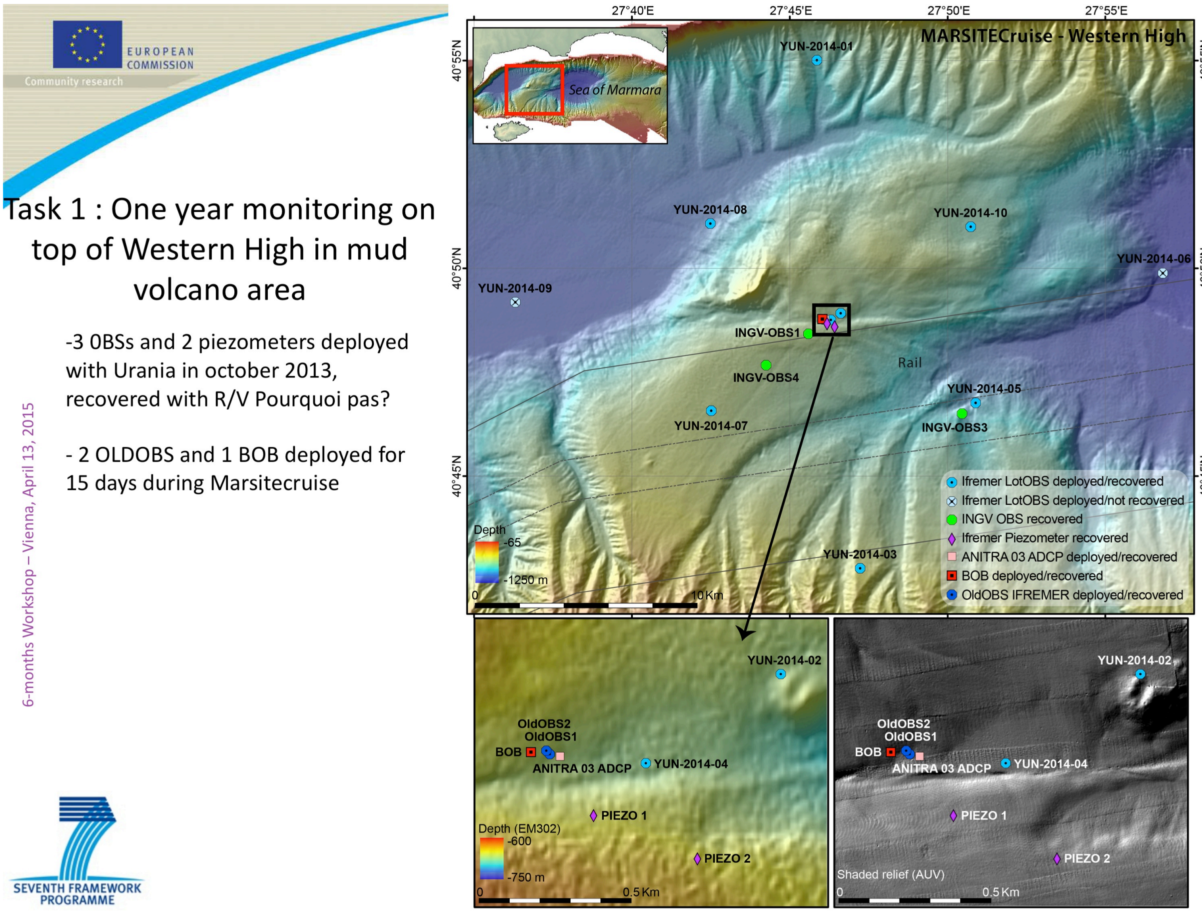
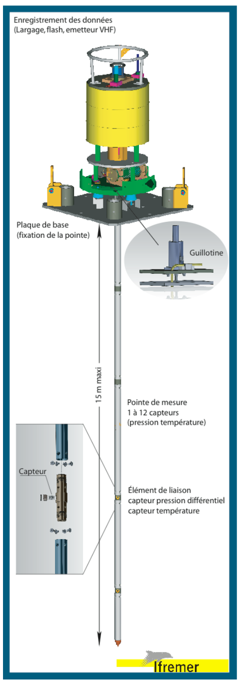


Figure IV.1 *General map of instrument deployments on top of Western High : 1) 4 INGV-OBSs and 2 piezometers were deployed with R/V Urania in October 2013 and recovered with R/V Pourquoi pas? in November 2014. In addition, 10 Ifremer OBSs (labelled as YUN-2014-xx) were deployed with R/V Yunuz in September 2014 and recovered with R/V Pourquoi pas? in November 2014. Eventually, an acoustic bubble recorder (BOB) was deployed along with 2 Ifremer OBSs (OldOBS1 and OldOBS2) and a current meter near the fault zone on top of the Western High.*

INSTRUMENTS DEPLOYED ON Western High WITH R/V URANIA, October 2013, Recovered with Pourquoi Pas November 2014						
Instrument	Long deg	Long min	Deg Lat	Min Lat	Deployment date (URANIA)	Recovery date (Pourquoi Pas)
PZN (Piezometer Ifremer)	27	46,656	40	48,931	2013-10-04T16:09:33	11/15/2014 12:50
PZS (Piezometer Ifremer)	27	46,306	40	48,783	2013-10-06T12:28:19	11/15/2014 11:01
OBS-1 (INGV)	27	46,496	40	48,787	2013-10-04T18:41:42	11/15/2014 12:05
OBS-2 (INGV)	27	46,658	40	48,827	2013-10-04T20:53:41	Recovered by FISHERMAN
OBS-3 (INGV)	27	50,344	40	47,707	2013-10-06T13:15:34	11/14/2015 17:11
OBS-4 (INGV)	27	44,539	40	47,808	2013-10-05T21:22:50	11/14/2015 18:41

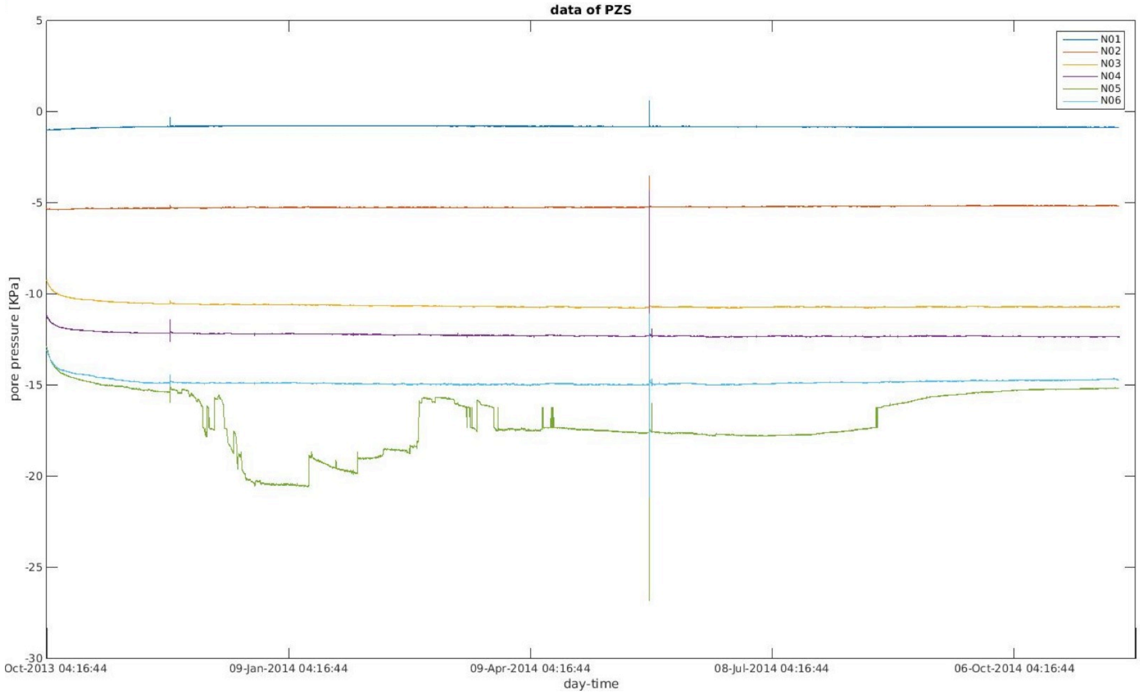
Table IV.1 : Coordinates and dates of deployment and recovery of the 3 INGV OBSs and 2 Ifremer piezometers, deployed with R/V Urania in october 2013 and recovered during the MARSITECruise of R/V Pourquoi pas?

The 2 piezometers have worked remarkably, providing an unique database on the response of sediment pore pressure to seismic shaking.



The IFREMER piezometer (V2) is a device to measure the differential pressure and temperature at different levels in the sediment, for long term duration periods, after which system is recovered at surface by acoustic release. Its applications are relative to geohazards including slope stability and relations between seismicity and fluids. The deployment duration can be up to 2 years (batteries and memory). The system is deployed on the bottom by the ship in station, and released upon satisfactory check of its attitude, principally verticality, to assure proper functioning during the mission. Its main specifications are:

1. Up to 15 sensors, up to 15 m length
2. Water proofness of electronic and sensor (PBOF) up to 600 m
3. Clock synchronization (PPS input and DCF emulation input)
4. Pressure range ± 2000 mbar, accuracy 0.2%, resolution 1 mbar
5. Temperature range 0-40 °C, accuracy 0 to +25 °C± 0.05 °C, resolution 0 to 25 °C< 0.015 °C at 10°C



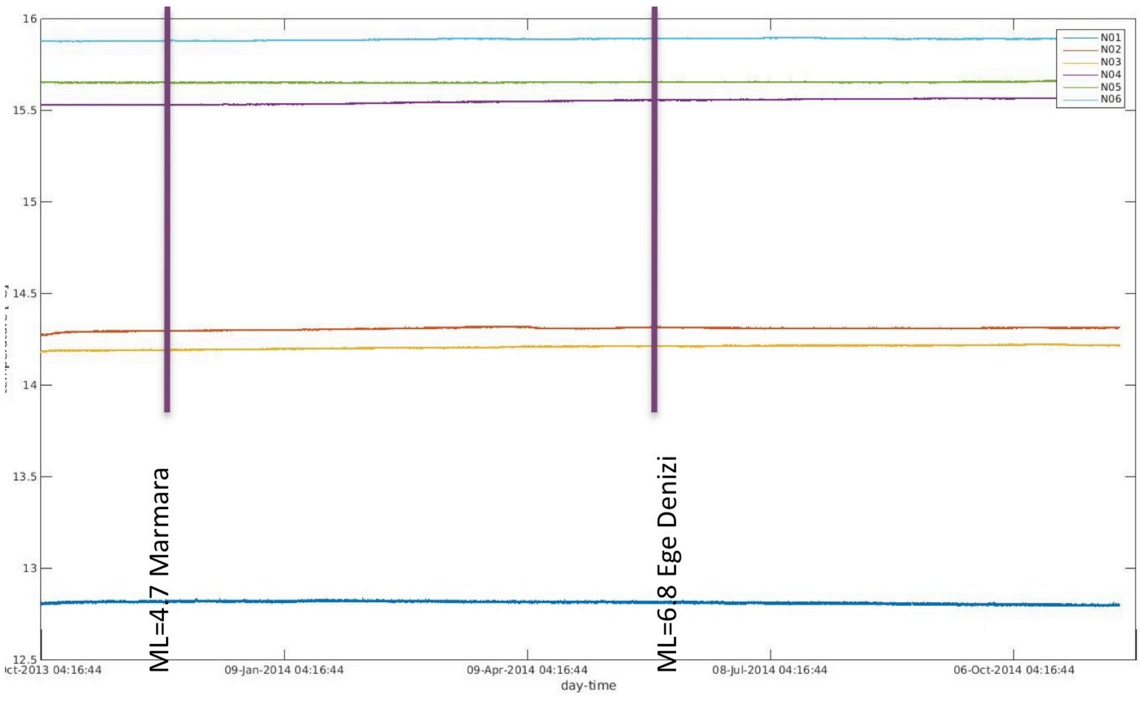


Figure IV.2 : *Differential pore pressure (top) and sediment temperature (below) measured at 8 different levels at site PZS. Violet bars indicate occurrence of 2 earthquakes:*

- *27/11/2013 04:13:37:52 UTC depth=10.8 km (40.8455°, 27.9187°) ML=4.7 Marmara*
- *24/05/2014 09:25:01.59 UTC depth=21.2 (40.3043°, 25.45810°° ML=6.8 Aegean Sea*

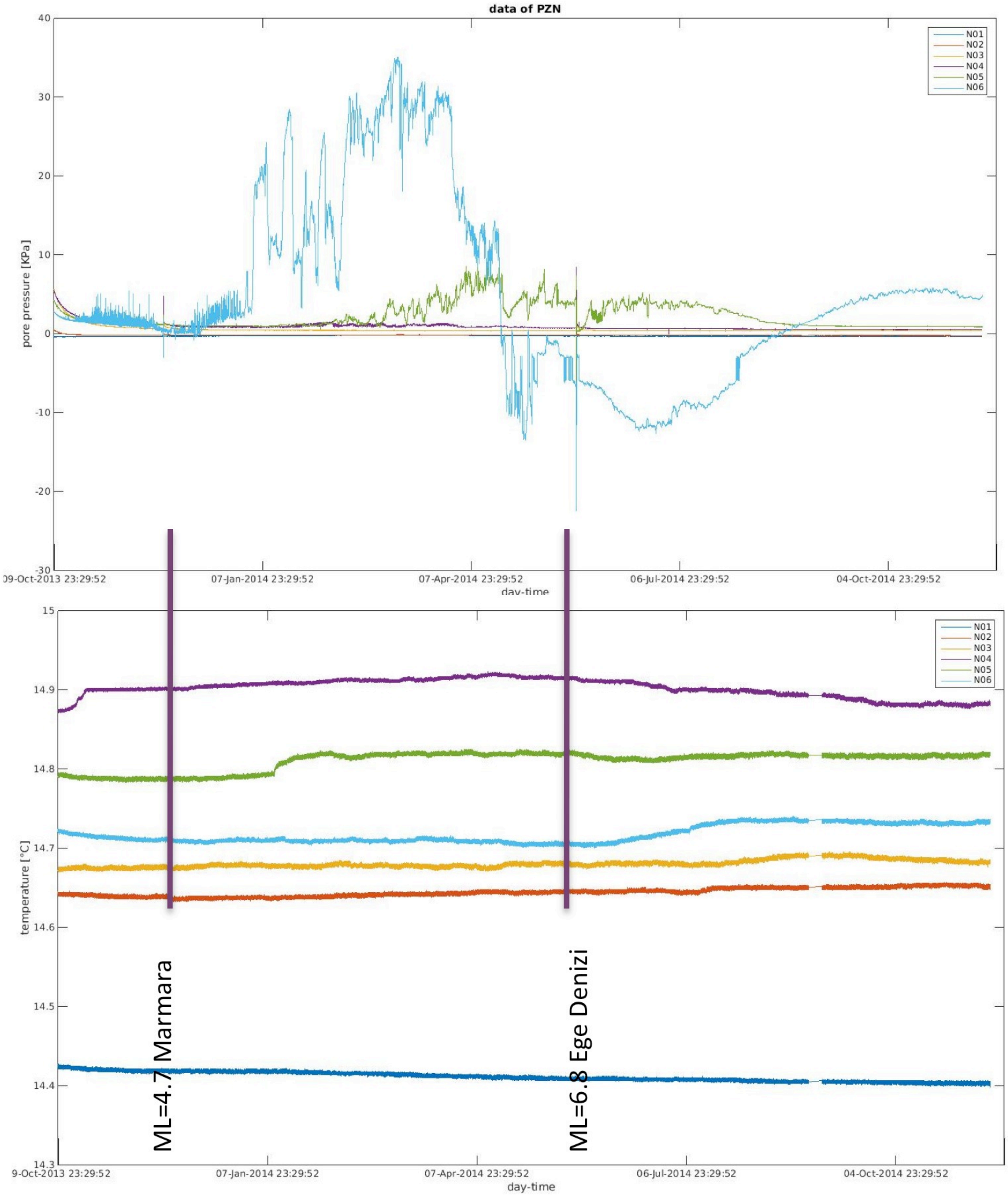


Figure IV.3 : *Differential pore pressure (top) and sediment temperature (below) measured at 8 different levels at site PZN. Violet bars indicate occurrence of 2 earthquakes:*

- *27/11/2013 04:13:37:52 UTC depth=10.8 km (40.8455°, 27.9187°) ML=4.7 Marmara*
- *24/05/2014 09:25:01.59 UTC depth=21.2 (40.3043°, 25.45810°° ML=6.8 Aegean Sea*

V. BOB experiment in Western High area: data quality

Background. Non-seismic microevents have been shown to be commonly recorded by the geophones deployed on the Marmara seafloor. These microevents are characterized by short durations of less than 0.8 s, by frequencies ranging between 4 and 30 Hz, and by highly variable amplitudes. In addition, no correlation between OBSs is observed, except for located 10 m apart. The presence of gas in superficial sediments, together with analogies with laboratory experiments, suggest that gas migration followed by the collapse of fluid-filled cavities or conduits could be the source of the observed microevents. If this hypothesis is proven to be correct, then OBSs could provide valuable information to improve our understanding of natural degassing processes from the seafloor.

To test this hypothesis, a rotating, acoustic gas bubble detector, BOB (Bubble OBservatory) module was deployed during two surveys, conducted in 2009 and 2011 respectively, to study the temporal variations of gas emissions from the Marmara seafloor, along the North Anatolian Fault zone. The echosounder mounted on the instrument insonifies an angular sector of 7°during a given duration (of about 1 h). Then it rotates to the next, near-by angular sector and so forth. When the full angular domain is insonified, the ''pan and tilt system'' rotates back to its initial position, in order to start a new cycle (of about 1 day). The acoustic data reveal that gas emission is not a steady process, with observed temporal variations ranging between a few minutes and 24 h (from one cycle to the other). Echo-integration and inversion performed on the acoustic data, indicated important variations in, respectively, the target strength and the volumetric flow rates of individual sources. However, the observed temporal variations may not be related to the properties of the gas source only, but reflect possible variations in sea-bottom currents, which could deviate the bubble train towards the neighboring sector. Therefore, the 2009 and 2011 experiments were not conclusive.

Consequently, an ultimate experiment was made during the Marsitecruise, in order to decipher the origin of the aseismic events recorded with the OBSs. Gas emission sources were identified within the fault zone using the multibeam echosounder system of *R/V Pourquoi pas ?* (Figure V.1). Then, an acoustic bubble detector (BOB) was carefully deployed with *ROV/Victor* on the seafloor, along with a current meter and 2 OBSs (Figure V.2) , in order to monitor the temporal variability of these sources (see experimental design in Figure V.3 and instrument coordinates in Table V.1).

The data are presently being processed.

OLDOBS, ANITRA, BOB DEPLOYED AND RECOVERED with R/V Pourquoi Pas in November 2014							
Instrument	Long deg	Long min	Deg Lat	Min Lat	z	Deployment date (Pourquoi Pas)	Recovery date (Pourquoi Pas)
OLDOBS-1	27	46,0802	40	48,7768	658	1/11/14 12:12	11/15/2014 8:42
OLDOBS-2	27	46,0711	40	48,7809	657	1/11/14 13:11	11/15/2014 9:16
ANITRA	27	46.1029	40	48.7749	661	04/11/2014	15/11:2014 09:46
BOB	27	46.0363	40	48.7800	654	04/11/2014 06:38	11/15/2014 08:10:00
Gas site 1	27	46.0893	40	48.77436			
Gas site 2	27	46.07286	40	48.77628			
Gas site 3	27	46.05084	40	48.77808			

Table V.1 Coordinates of equipments deployed for the BOB experiment for monitoring gas emission sources (sites 1, 2, 3) within the fault valley on top of the Western High.

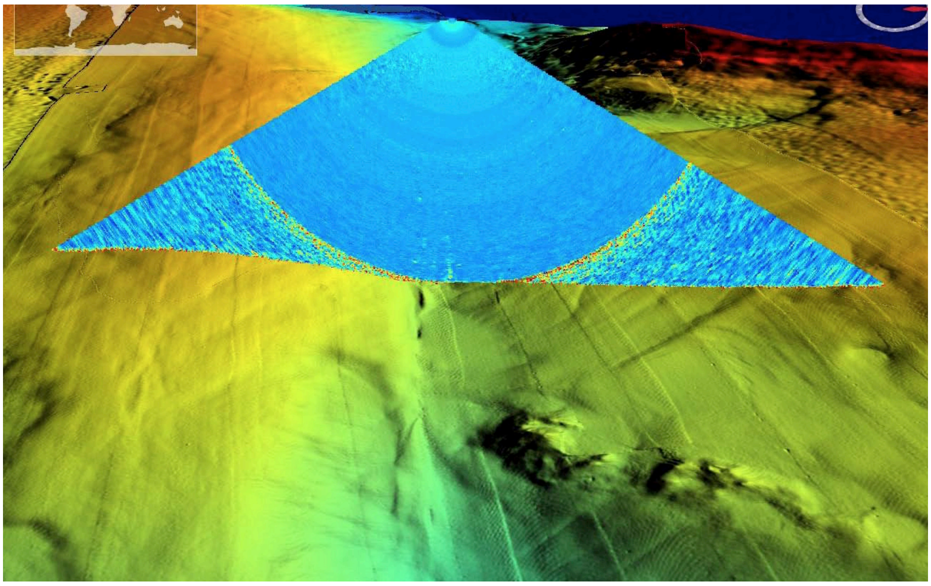


Figure V.1 *Identification of the gas emission site that was surveyed during the BOB experiment on the Western High conducted during the MarsiteCruise.*

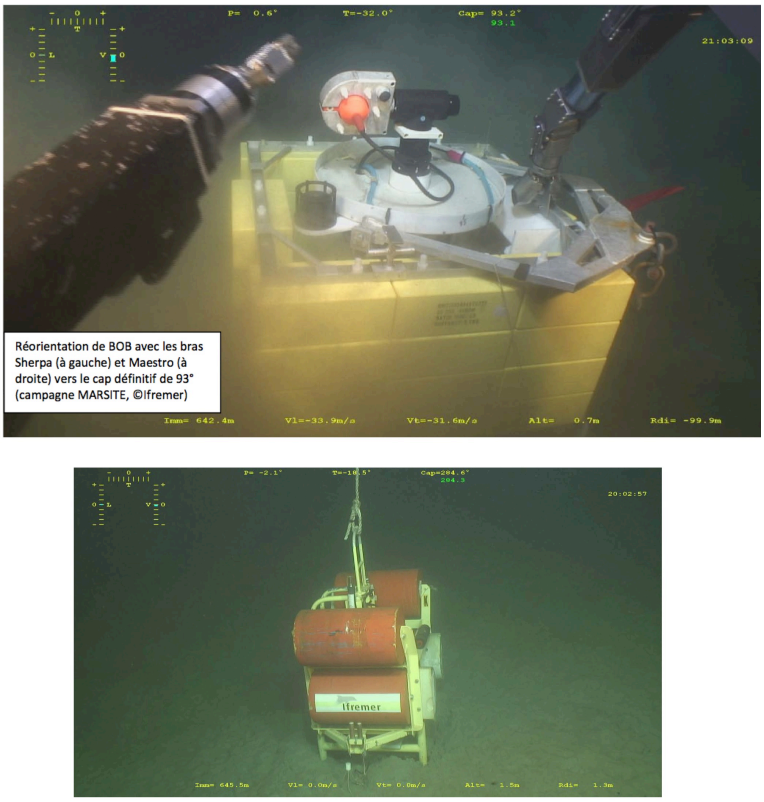


Figure V.2 *Top figure: BOB deployment on the fault valley using ROV/Victor. Bottom Figure: OBS (OLDOBS-type) deployed near the gas emission site.*

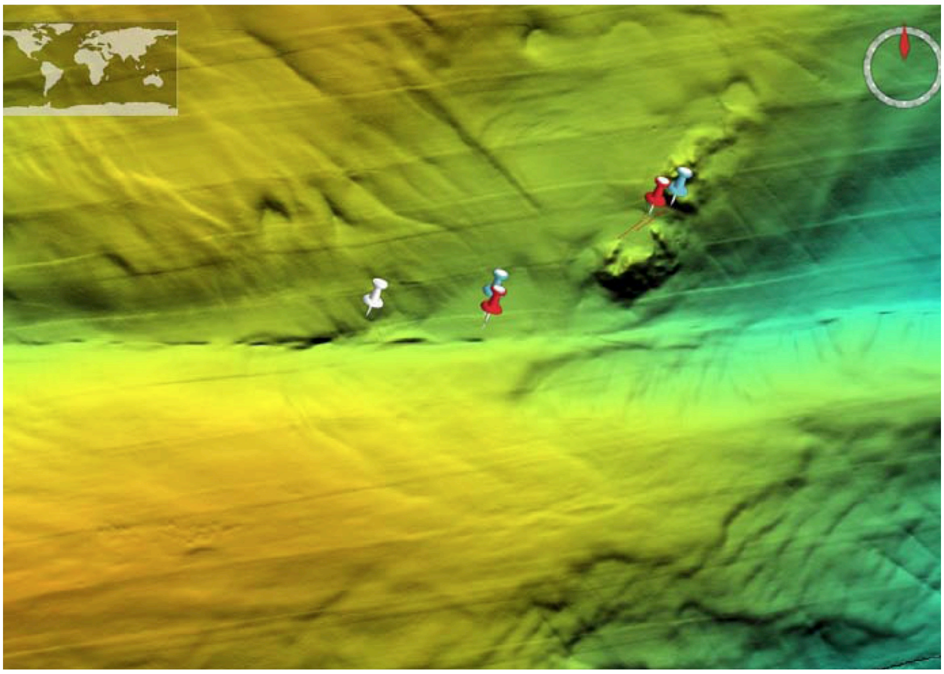


Figure V.3a *Global view of the BOB experiment site (white pin) deployed within the fault valley near the mud volcano system. Red pins indicate location of OBSs 2 and 4 deployed with R/V Yunuz in September 2014 and recovered with R/V Pourquoi pas? in November 2014. Blue pins represent the location of the 2 piezometers that were deployed with R/V Urania in October 2013 and recovered with R/V Pourquoi pas? in November 2014*

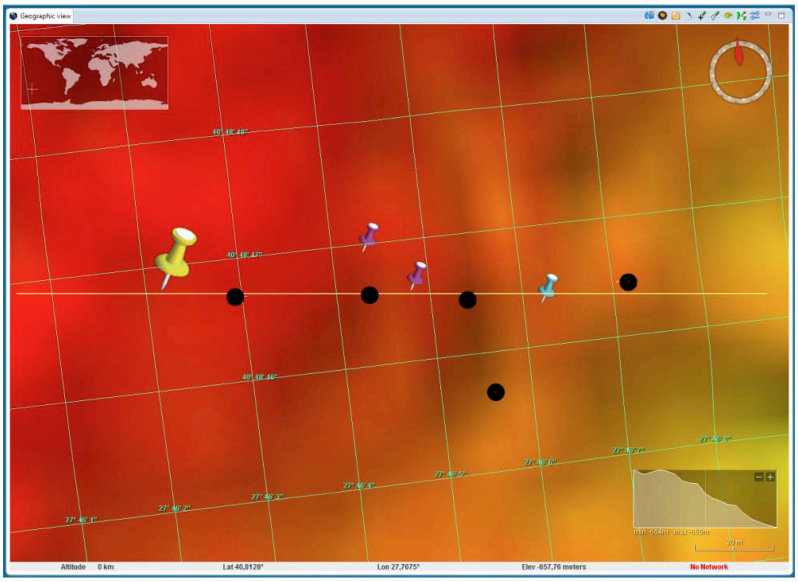


Figure V.3b *Detailed view of the experimental design of the BOB experiment carried out during the MarsiteCruise. Yellow pin represents BOB. Light blue pin is for ANDERAA current meter. Violet pins indicate OBS locations. Dark dots indicate the gas emission sites that were detected.*

APPENDIX : LIST OF PARTICIPANTS ON LEG 1

Name, Surname	Institution	email	Country	Speciality
André Ogor	Ifremer	Andre.Ogor@ifremer.fr	FR	Technician, acoustics (BOB)
Ronan Apprioual	Ifremer	Ronan Apprioual@ifremer.fr	FR	Mechanics
Livio Ruffine	Ifremer	Livio.Ruffine@ifremer.fr	FR	Chief scientist on Leg 2
Jean-Pierre Donval	Ifremer	Jean.Pierre.Donval@ifremer.fr	FR	Geochemical Analysis
Hélène Ondréas	Ifremer	Helene.Ondreas@ifremer.fr	FR	Geology/ Mosaic picture
Louis Géli	Ifremer	Louis.Geli@ifremer.fr	FR	Project leader
Laurent Bignon	Ifremer	Laurent.Bignon@ifremer.fr	FR	mecahnicsPEGAZ & BOB
Carla Scalabrin	Ifremer	Carla.Scalabrin@ifremer.fr	FR	Acoustics
Laurence Morvan	GENAVIR	Laurence.Morvan@genavir.fr	FR	Multibeam
Loïc Bonnet	GENAVIR	Loic.Bonnet@genavir.fr	FR	ROV Operator
Heinrich Bouillet	GENAVIR	Heinrich.Bouillet@genavir.fr	FR	ROV Operator
Patrick Cheilan	GENAVIR	Patrick.Cheilan@genavir.fr	FR	ROV Operator
Guillaume de Parseval	GENAVIR	Guillaume.de.Parseval@genavir.fr	FR	ROV Operator
David Lajoie	GENAVIR	David.Lajoie@genavir.fr	FR	ROV Operator
Xavier Placaud	GENAVIR	Xavier.Placaud@genavir.fr	FR	ROV Operator
Xavier Saint-Laurent	GENAVIR	Xavier.Saint.Laurent@genavir.fr	FR	ROV Operator
Thomas Sandel	GENAVIR	Thomas.Sandel@genavir.fr	FR	ROV Operator
Clément Baussan	GENAVIR	Celement.Baussan@genavir.fr	FR	ROV Operator
Pierre Henry	CEREGE	henry@cerege.fr	FR	Chief Scientist on Leg 3
Julia Kende	CEREGE	kende@cerege.fr	FR	Ph D Student
Anne Deschamps	IUEM	Anne.Deschamps@univ-brest.fr	FR	Geodetics
Hélène Piété	IUEM	Helen.Piete@univ-brest.fr	FR	Engineer. Geodetics
Valérie Ballu	UNIV NANTES	*valerie.ballu*@univ-lr.fr	FR	Geodetics
P. Sakic	UNIV NANTES	pierre.sakic@univ-lr.fr	FR	Ph D Student, Geodetics
Jörg Bialas	GEOMAR	jbialas@geomar.de	GE	Geophysicist
Patrick Schröder	GEOMAR	pschroeder@geomar.de	GE	Technician OBS + Geodetics
Dietrich Lange	GEOMAR	dlange@geomar.de	GE	Geodetics
Florian Petersen	GEOMAR	fpetersen@geomar.de	GE	Technician OBS + Geodetics
Chris Hammersley	SONARDYNE	Chris.Hammersley@sonardyne.com	UK	Engineer
Volkan Özaksoy	MTA	volkan.ozaksoy@mta.gov.tr	TU	MTA - Leader - Geological Engineer
Erdem Onu Baser	MTA	Erdem.Baser@mta.gov.tr	TU	Mechatronic Technician - observer for ROV operations
Murat Cenk	MTA	murat.cenk@mta.gov.tr	TU	Mechatronic Technician - observer for ROV operations
Dogan Kalafat	KOERI	kalafato@boun.edu.tr	TU	Seismologist
Cemil Gürbüz	KOERI	gurbuz@boun.edu.tr	TU	Seismologist
Semih Ergintav	KOERI	semih.ergintav@boun.edu.tr	TU	GPS
Mustafa Aktar	KOERI	aktar@boun.edu.tr	TU	Seismologist
Zyia Sakir	ITU	ziyadin.cakir@itu.edu.tr	TU	GPS, INSAR
Sinan Ozeren	ITU	ozerens@itu.edu.tr	TU	Physicist