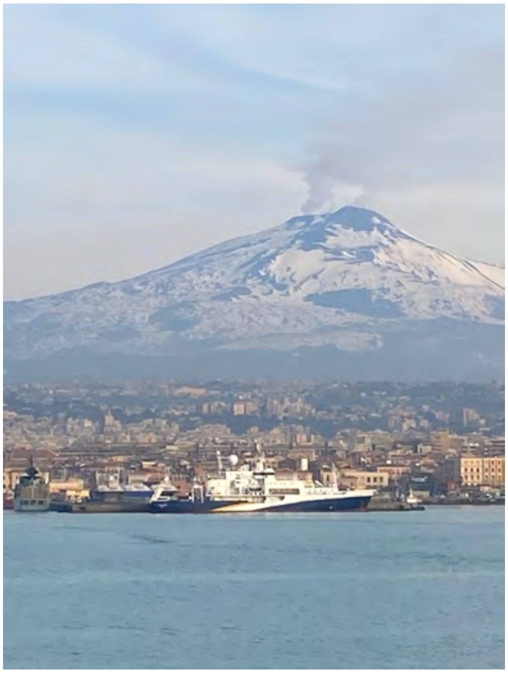
FocusX3 Cruise Report

17-27 February 2023

Catania - Catania

R/V Atalante



R/V Atalante in Catania port on 17 Feb. 2023
(photo credit: M-A Gutscher)

R/V Atalante at sea offshore Catania on 20 Feb. 2023
(photo credit: Ralf Schwarz, Geomar)

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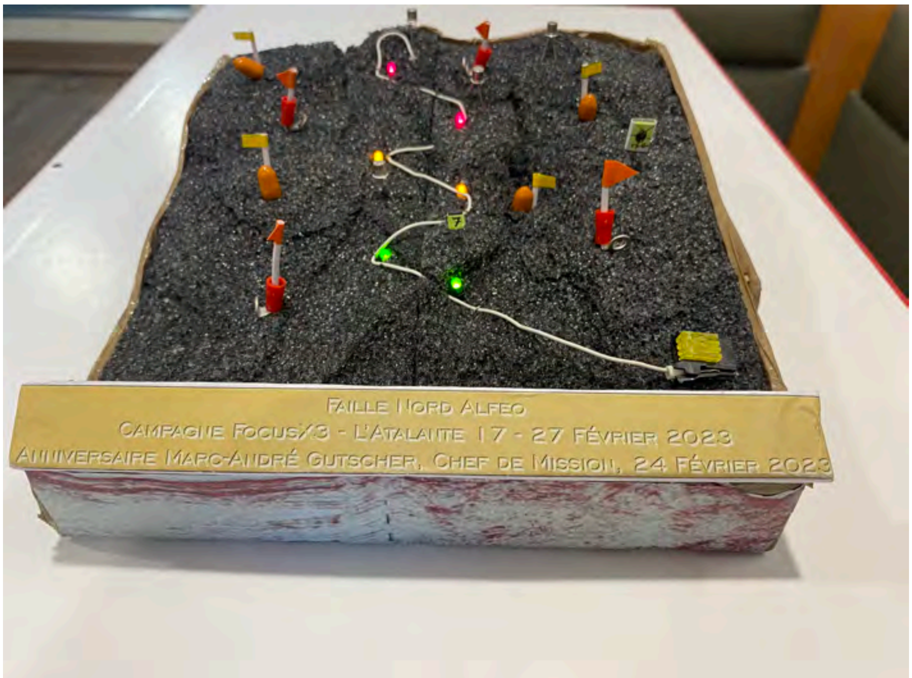


Above: 3-D creation depicting the work performed during the FocusX3 expedition (artist - Walter Roest)

Introduction

Introduction/objective

The majority of the Earth's surface (70%) is covered by water and therefore earthquakes and tectonic activity in that domain are difficult to monitor with modern networks of geophysical instruments (broadband seismological stations, accelerometers, tiltmeters). The use of submarine fiber optic cables to detect seismic waves and to monitor deformation on the seafloor offers the potential for a revolution in natural hazard assessment and early warning capacity related to earthquakes below the sea and active faults on the seafloor. These are the objectives of the **ERC Advanced Grant project FOCUS, funded from Oct. 2018 - Sep. 2025.** The main goal of the ERC project FOCUS is to demonstrate for the first time, the use of **BOTDR laser reflectometry**, to measure **small (1 - 2 cm) displacements across faults on the seafloor** by continuous measurements in real-time, using fiber optic cables and to **calibrate these measurements through other seafloor observations.** The first part of the work planned in the ERC project (site survey, deployment of a 6-km long fiber optic strain cable using an ROV and deployment of 8 seafloor geodetic stations) was performed during the **FocusX1 expedition 8-22 October 2020 with R/V PourquoiPas?.** During the **FocusX2 expedition 16-25 January 2022 with R/V PourquoiPas?**, we deployed 20 ocean bottom seismometers - OBS (to record regional seismicity and identify seismically active faults); acquired high-resolution sub-bottom profiles and micro-bathymetry using the AUV idefX, planned to interrogate the newly deployed network of 8 seafloor geodetic stations as well as a German (Geomar) network of 6 seafloor geodetic stations (to better quantify displacement along the target fault offshore E Sicily); and performed sediment coring (for paleoseismology, sediment geochemistry, and slope stability studies). Several, shorter marine expeditions are also being conducted over the 3 - 4 year period 2021-2024, to recover seafloor instruments and to download data at regular (roughly yearly) intervals, in cooperation with international partners (Italian, German), who are performing marine operations in the area. ERC co-funding has been obtained for these additional cruises. The current expedition **FocusX3 17-27 Feb. 2023 onboard the R/V Atalante** will recover 29 OBS, redeploy 11 OBS, deploy two networks of seafloor geodetic stations: 8 Canopus (iXblue/Exail) and 5 Sonardyne acoustic beacons, deploy a current meter (an ADCP Lander) and acquire an east-west CTD transect. The **Focus project**, will shed new light on the fault behavior of the North Alfeo Fault (20 - 30 km from Catania, an urban center of 1 million people) and will constrain plate tectonic movements, local and past seismicity and seismic hazard of the study region and pursue and complement **the laser strain experiment begun during FocusX1**.

Seismicity

The vast majority (90%) of **earthquakes** occur in subduction zones immediately **adjacent to the coasts** of continents and island chains, which are commonly heavily populated. Other active faults (strike-slip faults) may have on-land and **offshore** portions **near major urban centers**. Prominent examples include the San Andreas Fault (San Francisco, Los Angeles) or the North Anatolian Fault (Istanbul). In all of these cases, most of our knowledge regarding the offshore faults is obtained by onshore networks of instruments, supplemented by marine geophysical surveys. In particular, combined geodetic and seismological networks have been key to increasing our fundamental understanding of the different types of slipping mechanisms that a fault uses to relieve stress (tremor, low frequency events, etc.). In some exceptional cases, temporary networks of offshore instruments (e.g. Marsite project in the Marmara Sea), usually deployed for limited periods of time (a few months to at most a few years) can provide additional data. In recent years permanent networks of instruments have been established offshore densely populated, high-risk regions of industrialized countries (DONET - Eastern Japan offshore cable tsunami early warning network, NEPTUNE - observatory offshore the Pacific NW of the USA and Vancouver Island Canada). Although, offshore, cabled observatories provide important observations (including seismological data in real time) and improve early warning capabilities, they are very costly and cannot be deployed in all geo-hazard zones around the world.

Mediterranean

The densely populated Mediterranean region straddles the plate boundary between Africa and Eurasia, which produces moderate to strong seismicity in many countries (Fig. 1). There have also been numerous deadly and **catastrophic earthquakes (>20,000 victims)** throughout this region over the past several centuries. Four of the six deadliest of these (Catania Italy 1693, Algiers Algeria 1716, Lisbon Portugal 1755, Messina Italy 1908) triggered strong tsunamis (≥5-10 m) and almost certainly ruptured a major fault offshore (Fig. 1). To this day the exact **locations of the faults** that produced these 4 catastrophic earthquakes are still **unknown** or hotly debated. Furthermore, the **displacement rates and the nature of movement (aseismic slip, slow slip events, earthquake)** along the candidate faults remain **uncertain**.

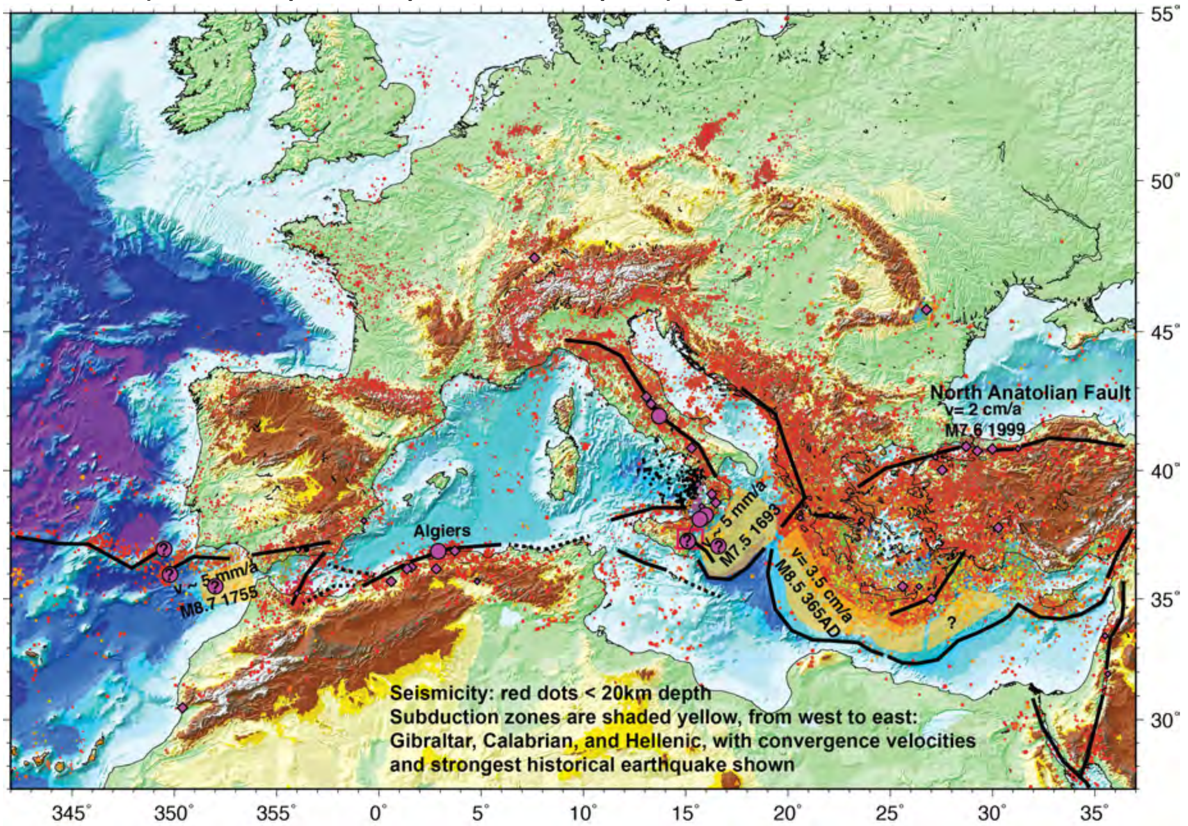


Figure 1: Europe - Mediterranean region with seismicity from 1973 - 2016 (M 2.5 - 7). Small and medium sized purple diamonds are deadly historical earthquakes with >100 and >1000 victims, respectively. Large purple circles show catastrophic historical earthquakes (>20,000 victims). The major segments of the Africa - Eurasia plate boundary are shown as black lines (dashed where uncertain).

The **deadliest region in the Mediterranean is Eastern Sicily - Calabria** (southern Italy), with 200,000 victims in the past 500 years. On a small scale it is representative for most of the Mediterranean since it is characterized by a complex tectonic setting, with several independently moving micro-plates or blocks interacting, and a network of faults in the nearby offshore zone, whose exact kinematics (direction and speed) remain very poorly constrained (Fig. 2B). It also presents the great advantage that **two fiber optic cables are already deployed here on the seafloor** connecting Seafloor Observatories managed by INFN-LNS (physics institute in Catania) (Fig. 2A). East Sicily is therefore the **ideal study area for the FOCUS project expeditions to develop and test a novel approach to monitor active submarine faults**.

Primary target area offshore East Sicily: State of the art and results of previous cruises

Over the past decade, there has been a major international research effort to better understand the tectonic activity of the Calabria subduction zone, its relation to **crustal faults along the East Sicily margin** and the possible connection to the **strong historical earthquakes** that have devastated the region in the past centuries. Numerous studies used GPS stations on land to better understand the active tectonics of the region and the relative displacement rates between the different blocks (d'Agostino et al., 2011; Devoti et al., 2011; Palano et al., 2012). The results indicate slow but significant displacement (3-5 mm/yr) of the Calabrian block towards the south-east, in a local reference frame (Apulia and Hyblea fixed) as well as N-S convergence (a few mm/yr) in eastern Sicily (Palano et al., 2012) (Fig. 2B). Unfortunately, the absence of GPS data offshore, means that submarine faults accommodating this motion cannot be located (Fig. 2B). This hampers tsunami hazard analysis, since land based GPS networks are generally unable to quantify fault coupling for trench zones in marine environments, e.g. Japan Trench (Loveless and Meade, 2011).

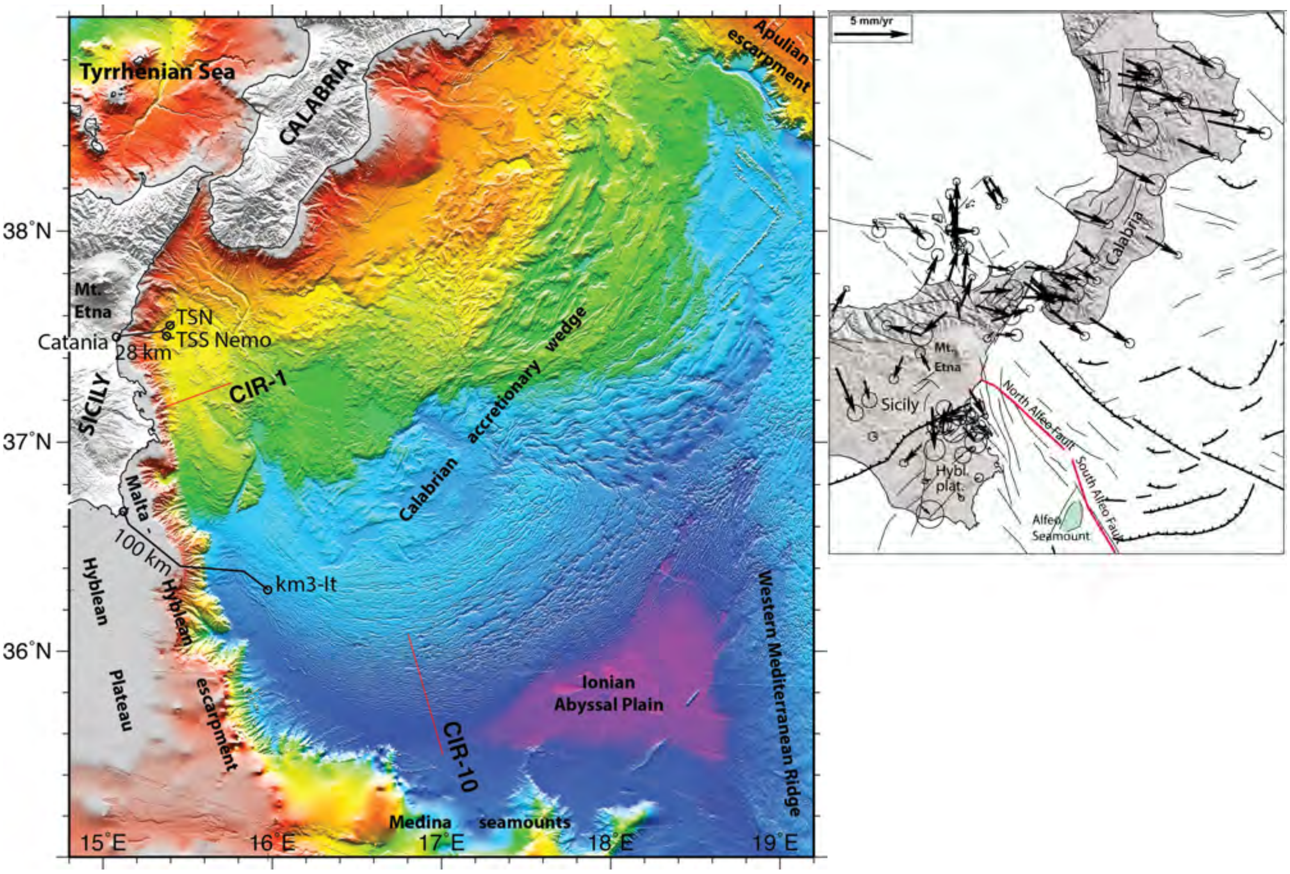


Figure 2: (A - left) Eastern Sicily - Calabria region (Ionian Sea), onshore (white and gray) and offshore in color. Bathymetry is from a recent regional compilation (Gutscher et al., 2017). The positions of the two submarine fiber optic cables are shown (Catania - Nemo and SE Sicily km3-It). The location of two CIRCEE seismic lines is shown (red lines). (B - right) GPS vectors (on land) from a recent study (Palano et al., 2012), (with the Alfeo faults shown). A 3-5 mm/yr movement of the Calabrian block to the SE is observed with respect to the Hyblean plateau (SE Sicily). 3-4 mm/yr of convergence also occur between SE and NE Sicily. In both cases it is unknown how these relative motions continue offshore.

Seismic imaging, bathymetric mapping and sediment coring

Several studies presented the results of deep-penetration multi-channel seismic reflection profiles, which through modern processing techniques have revealed more about the geometry and lithology of the units involved in the Calabrian subduction. These seismic profiles imaged the sedimentary succession in the Ionian abyssal plain (i.e. - old, Tethys age, oceanic northern portion of the African plate) as it is compressed, deformed and tectonically thickened to produce one of the world's thickest and widest accretionary wedges (about 250 km down-dip width, and up to 15-20 km thick) (Minelli and Faccenna, 2010; Polonia et al., 2011; Gallais et al., 2011; 2012; Gutscher et al., 2016; 2017; Maesano et al., 2018).

Major discontinuites revealed near the western boundary of the accretionary wedge and close to the East Sicily margin are thought to be the expression of crustal scale faults (Hirn et al., 1997; Nicolich et al., 2000; Argnani and Bonazzi, 2005; Polonia et al., 2011; Gallais et al., 2013). Several new marine geophysical surveys were conducted in the following years in order to further investigate these crustal faults and search for the expression of an expected lateral slab edge tear fault. Among these surveys was the CIRCEE expedition (R/V Suroit Oct. 2013, PI Gutscher). Results from these **recent surveys document a network of major strike-slip faults** expressed in the morphology and **bathymetry of the seafloor** (Gross et al., 2016; Gutscher et al., 2016; 2017), as well as in **high-resolution seismic profiles revealing strongly focused deformation** of the sedimentary layers below and adjacent to these faults (Fig. 3B,C). These profiles, crossing the North Alfeo Fault in the target study area, image a **single, distinct vertical fault trace (**with no subsidiary fault splays), which **offers the perfect target for geodetic and strain measurements on the seafloor (**Fig. 3B,C).

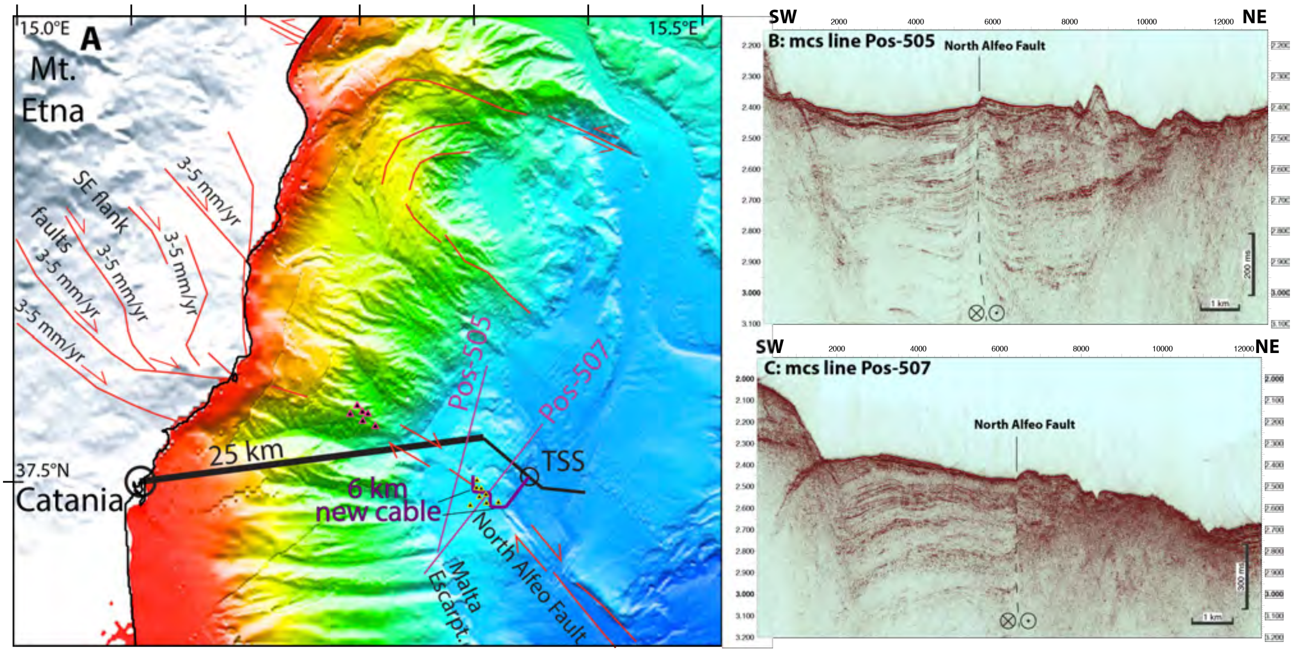


Figure 3: A: Relief map of the Catania - Etna region (NE Sicily), onshore (in gray) and offshore (in color) (Gutscher et al., 2017) showing the position of the Catania EMSO cable, connected to seafloor stations TSN and TSS Nemo (Neutrino observatory). The faults on the SE flank of Mt. Etna connect offshore with the North Alfeo Fault. Small magenta/black triangles show the German (Geomar) network of seafloor geodetic stations deployed 2016 - 2017 (Urlaub et al., 2018). This network was redeployed in Sept. 2020. Small yellow/black triangles show network of 8 geodetic stations purchased by the ERC FOCUS project and deployed during the FocusX1 expedition. The track of the 6-km-long fiber optic strain-cable (shown in purple) crosses the North Alfeo Fault at four positions. B: Multi-channel seismic profiles Pos-505, C: Pos-507 from the Ionian Sea, image the single, vertical fault trace at the junction with the planned strain cable, unpublished data from Poseidon 496 survey, (Krastel et al., 2016).

In 2014, a joint German-French-Italian marine geophysical survey (DIONYSUS), used ocean-bottom seismometers and land-based seismological stations to determine the **deep crustal structure of the East Sicily** margin using wide-angle seismic profiles. The **recently published results (Dellong et al., 2018)** confirm that there is a **major crustal scale discontinuity offshore E Sicily** corresponding to the surface expression of a strike-slip fault system (the Alfeo fault Fig. 2B). The coastal geophysical survey (CRACK - Aug/Sept 2016) investigated the connection between a network of faults on the SE flank of Mount Etna volcano observed by GPS and InSAR (Bonforte et al., 2011; Chiocci et al., 2011; Palano et al., 2016; Murray et al., 2018; De Guidi et al., 2018) and the crustal scale North Alfeo fault located further offshore (Figs. 5A, 6A). From 2016 - 2017, **5 seafloor geodetic stations recorded slip along this fault link** (Urlaub et al., 2018) (Fig. 5) and these results are described below. On 26 Dec. 2018 a shallow M4.8 earthquake occurred on the Findaca fault on the SE flank of Mt. Etna, part of the onshore prolongation of the North Alfeo Fault system, with ~30 cm of dextral strike-slip motion (De Novellis et al., 2019).

Results of seafloor geodetic study

An array of five seafloor geodetic instruments, was deployed by Geomar and the Univ. of Kiel with the R/V Poseidon along the offshore continuation of strike-slip and normal faults accomodating a gradual eastward gravitational collapse of the SE flank of Mt. Etna (Fig. 4A, Fig. 4B) (Urlaub et al., 2018). This network was deployed in April 2016 in water depths of 900 - 1200 m and data recovered in July 2017. Analysis of baseline length changes during this 15-month period indicates **a dextral strike-slip movement of 4 cm** (Fig. 4B) along the fault trace (Urlaub et al., 2018), with nearly all the movement having occurred during a **slow slip event in May 2017**. The cumulative motion of the Etna flank faults (Fig. 5A) is about 2 cm/yr (Bonforte et al., 2011). The slip observed by the seafloor geodetic network indicates **an active submarine fault ~20 km to the east of Catania, an urban area of 1 million people**, and crossed by the Catania submarine cable (Fig. 5A). The seismic hazard posed by this major fault and its deep offshore continuation, with a total length of 150 km (Fig. 2B) (Gutscher et al., 2016; 2017), unknown prior to 2010, has yet to be properly estimated. The FOCUS project can provide a major contribution to this seismic hazard assessment by measuring the spatial variation in coupling (i.e. the degree to which the two sides of the fault are locked/sliding) along the fault and by quantifying current slip rates.

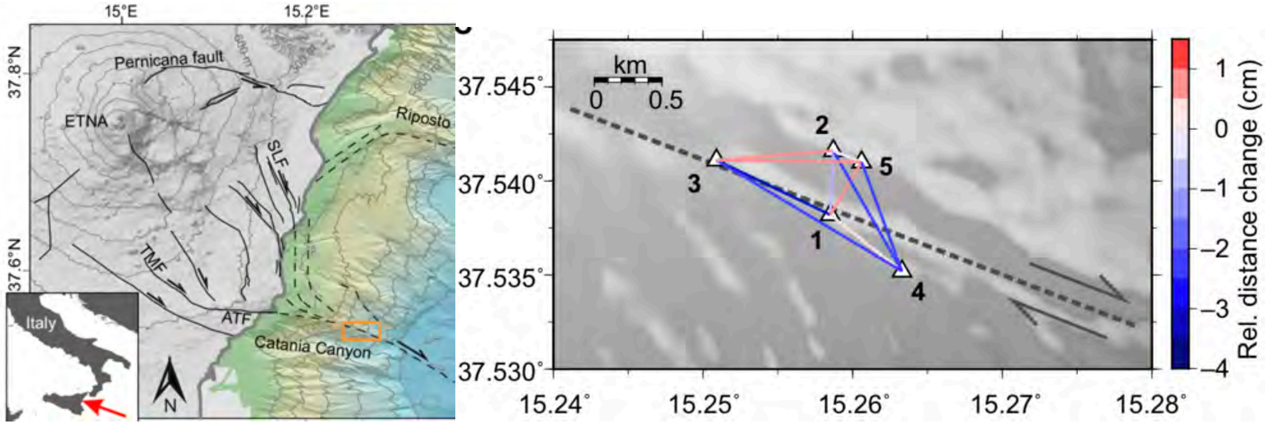


Figure 4: A left): Regional map showing position (orange square) of seafloor geodetic network deployed offshore Catania / Mt. Etna (Apr. 2016 - Aug. 2018) by Geomar and Univ. Kiel (Urlaub et al., 2018).
Figure 4: B (right): change in base-line lengths over 15-months (Apr 2016 - Jul 2017) with 4 cm of dextral strike-slip movement detected between the NE stations (2 and 5) and the SW stations (3, 1 and 4), and interpreted to have occurred during a 5-8 day slow slip event in May 2017 (Urlaub et al., 2018).

The main goal of the FOCUS project is to measure small displacements/strain across the North Alfeo fault using laser interferometry on fiber optic cables. Further instrumentation is required to validate that any observed variations in strain are due to tectonic processes, to classify them correctly and to quantify (calibrate) them. A variety of instrumentation ranging from geodetic (slow slip, afterslip, aseismic slip) to seismic (earthquake, slow slip events) is required to capture different slipping modes. During the FocusX1 cruise (6-21 October 2020) a prototype fiber-optic strain cable and 8 seafloor geodetic stations were deployed across an active submarine fault. Unfortunately 7 out of 8 geodetic stations malfunctioned in Fall of 2021 and they were all recovered during operations with a Fugro ROV in Sept. 2022. During the FocusX2 cruise (R/V PourquoiPas? late January 2022) a network of 20 ocean-bottom seismometers (OBS) were deployed in the working area and 9 additional OBS were deployed with the R/V TethysII in late August 2022 for a total of 29 OBS.

The FocusX3 expedition

Overview of originally planned operations (scheduled dates 21 Feb. - 12 Mar. 2023)

Below is a summary of the originally planned operations for an 18-day (working days at sea) marine expedition:
- recovery of 29 Ocean-bottom seismometers: 15 Geomar OBS, 5 Nammu broad-band OBS, 9 LOT-OBS
- redeployment of 14 OBS (5 Nammu broad-band OBS and 9 LOT-OBS)
- deployment of two networks of seafloor geodetic stations :
    - 5 Sonardyne acoustic beacons (Geomar equipment)
    - 8 Canopus acoustic beacon iXblue/exail)
- deployment of 1 current meter /ADCP lander (Geomar equipment)
- perform two east-west CTD transects to characterize the water column (physical oceanographic work)
- 7 dives with the HROV (Hybrid ROV Ariane) to obtain the orientation of the tripods (seafloor geodetic stations), to perform a video camera survey of the Focus fiber optic strain cable deployed in Oct. 2020 (to identify possible displacements) and a video camera survey along the trace of the North Alfeo fault to seek vent fauna associated with fluid seeps

NATO naval exercises in the area

The authorization to perform marine research in Italian waters was granted about 1 month before the planned start of the cruise. In the document it was specified that we could not perform work in the Ionian Sea offshore Catania from 27 February - 10 March 2023 (due to planned NATO naval exercises in the area during this period). This forced us to drastically shorten the expedition and to try to start work earlier. The new dates were mobilization in Catania on 17 February 2023 (with beginning of work in the evening) and demobilization on 27 February 2023 (with a return to the port of Catania at 18:00 on 26 Feb. 2023).

Overview of operations performed

D-3 14 Feb.	Toulon Port	Loading equipment FocusX3
D1 - 17 Feb.	Catania Port Near FOCUS cable (25 km E of Catania)	Mobilization 17:00 Depart port Recover 4 OBS: 19:50 OBS1 on deck (Geomar) 21:00 OBS2 on deck (LOT-OBS) 12:30 OBS4 on deck (LOT-OBS) 21:00 OBS5 on deck (Geomar)
D2 - 18 Feb.	Near FOCUS cable (25 km E of Catania)	Recover 4 OBS: 01:15 OBS17 on deck (LOT-OBS) 03:30 OBS6 on deck (LOT-OBS) 05:30 OBS7 on deck (Geomar) 09:00 OBS3 on deck (BB) 10:00 deploy ADCP (Lander) 17:00 deploy Sonardyne tripod 10 22:30 deploy Sonardyne tripod 11
D3 - 19 Feb.	Near FOCUS cable (25 km E of Catania)	Recover 2 OBS: 04:00 recover OBS8 (Geomar) 06:00 recover OBS10 (BB) 10:00 deploy Sonardyne tripod 12 15:00 deploy Sonardyne tripod 13 20:00 deploy Sonardyne tripod 14
D4 - 20 Feb.	Distant OBS zone (Ionian Sea) Near Catania port Distant OBS zone (Ionian Sea)	Recover 4 OBS: OBS18 (Geomar), OBS27 (Geomar), OBS26 (BB), OBS20 (LOT-OBS) download data Sonardyne network 14:00 Embark 2, Disembark 5 (by launch) Recover 3 OBS: 19:00 OBS11 (Geomar), 21:00 OBS12 (Geomar), 23:30 OBS13 (BB)
D5 - 21 Feb.	Distant OBS zone (Ionian Sea)	Recover 3 OBS 01:30 OBS14 (Geomar); 04:30 OBS16 (Geomar); 06:30 OBS15 (LOT-OBS) 10:00 Deploy OBS-BB at OBS17 w winch Recover 4 OBS: 16:00 OBS21 (Geomar); 18:00 OBS22 (LOT-OBS); 20:00 OBS23 (LOT-OBS) 22:00 OBS30 (BB)
D6 - 22 Feb.	Distant OBS zone (Ionian Sea) Near FOCUS cable (25 km E of Catania)	Recover 5 OBS 00:00 OBS29 (LOT-OBS) 02:00 Deploy LOT-OBS at OBS29 free fall 03:00 OBS28 (Geomar); 05:30 OBS24 (Geomar); 07:00 OBS25 (Geomar) 09:00 Deploy OBS-BB at OBS26 w winch 13:00 OBS19 (Geomar) ***all OBS recovered*** 17:00 Deploy Canopus (exail) tripod #1 22:00 Deploy Canopus (exail) tripod #2
D7 - 23 Feb.	Near FOCUS cable (25 km E of Catania)	04:00 Deploy Canopus (exail) tripod #3 10:00 Deploy OBS-BB at OBS3 w winch 13:00 Deploy Canopus (exail) tripod #4 19:00 Deploy Canopus (exail) tripod #5
D8 - 24 Feb.	Near FOCUS cable (25 km E of Catania)	01:00 Deploy LOT-OBS at OBS6 w winch 04:00 Deploy LOT-OBS at OBS2 w winch 07:00 Deploy Canopus (exail) tripod #6 12:00 Deploy Canopus (exail) tripod #7 16:00 Deploy Canopus (exail) tripod #8 21:00 reprogram T on Sonardyne network 23:00 Deploy LOT-OBS at OBS4 w winch

D9 - 25 Feb.	Near FOCUS cable (25 km E of Catania) Distant OBS zone (Ionian Sea)	04:00 Deploy OBS-BB at OBS10 w winch 09:00 Deploy OBS-BB at OBS15 w winch 13:00 Deploy LOT-OBS at OBS22 free fall 16:00 Deploy LOT-OBS at OBS20 free fall 17:00 Transit to Catania zone (MB survey) 19:00 download data from Canopus network 22:00 Perform CTD transect 37°29.5'N
D10 - 26 Feb.	Distant OBS zone (Ionian Sea)	13:00 finish CTD transect 37°29.5'N 13:30 attempt to release lost Geomar OBS 16:30 leave zone, go to RDV pilot 18:00 return to Catania port
D11 - 27 Feb.	Catania port	Demobilization
D14 - 3 Mar.	Toulon port	Unloading FocusX3 equipment

N.B - the times of the above operations are rough estimations. The exact times for any given operation may differ by up to ± 2hrs. Exact times for all operations are given in an Excel table in the Appendix.

Summary of successful operations

All 29 OBS were recovered from the seafloor: 15 Geomar OBS, 5 Nammu broad-band OBS, and 9 LOT-OBS.
11 OBS were redeployed (all 5 Nammu broad-band OBS and 6 LOT-OBS)
Two networks of seafloor geodetic stations were deployed :

5 Sonardyne acoustic beacons (Geomar equipment)
8 Canopus acoustic beacons (iXblue/exail)

1 ADCP current meter (Geomar equipment) was deployed.
1 east-west CTD transect was acquired to characterize the water column (physical oceanographic work)

All the operations and some very preliminary results will be presented in more detail below.

Current meter / ADCP lander (Geomar - R. Schwarz and M. Busse)

During cruise Focus X3, one seafloor monitoring lander system was deployed in the Strait of Messina on February, 18, 2023. The Geomar SLM lander system (Satellite Lander Module) (Fig. 5) was deployed at 37.4851° N and 15.3627° E, at a water depth of 1921 m. The lander is equipped with an Acoustic Doppler Current Profiler (ADCP 300 kHz, Teledyne RD Instruments) to measure water column flow speed and direction at regular intervals above the sea floor (SLM). The lander is also equipped with a CTD system (SeaBird Electronics) combined with sensors to monitor turbidity (WETLABS), dissolved oxygen (Anderaa 4330) and pH (SeaBird Electronics). Sampling intervals were set to 60 minutes.

Additionally, the Geomar oceanography team successfully performed a pressure test of a 50-liter O_2-bottle on Feb 20, 2023. The test was performed at 37.33040° N and 15.71820° E. Accordingly, the bottle was lowered (winch speed 0,8 m/s) to 1200 m and remained there for 5 minutes. After retrieval no damage was observed.


Fig. 5: left - ADCP lander on deck before deployment on 18 Feb. 2023 (with Mt. Etna volcano in the background); right - deployment of ADCP lander

CTD transect

While chronologically, this was the last operation (performed on 26 Feb. 2023), it is thematically related to the current meter / ADCP work and will be presented here. Indeed, there are two lines of evidence that suggest the presence of strong bottom currents in the study area: strain observations of the 6-km-long FOCUS fiber optic strain cable and the electro-optical cable (Gutscher et al., EPSL in press) and the observation of 2-km long linear furrows observed in the micro-bathymetry acquired in Jan. 2022 with the AUV idefX. The first approach is to measure sea bottom currents directly using a current meter (ADCP) as described above. The second approach consists of characterizing the water column from the shallow continental shelf near Catania to the 2000 m deep abyssal domain adjacent to the FOCUS strain cable. This was accomplished through a series of 9 CTD (Conductivity, Temperature, Depth) casts along an E-W transect with an average spacing every 3 km (Fig. 6).

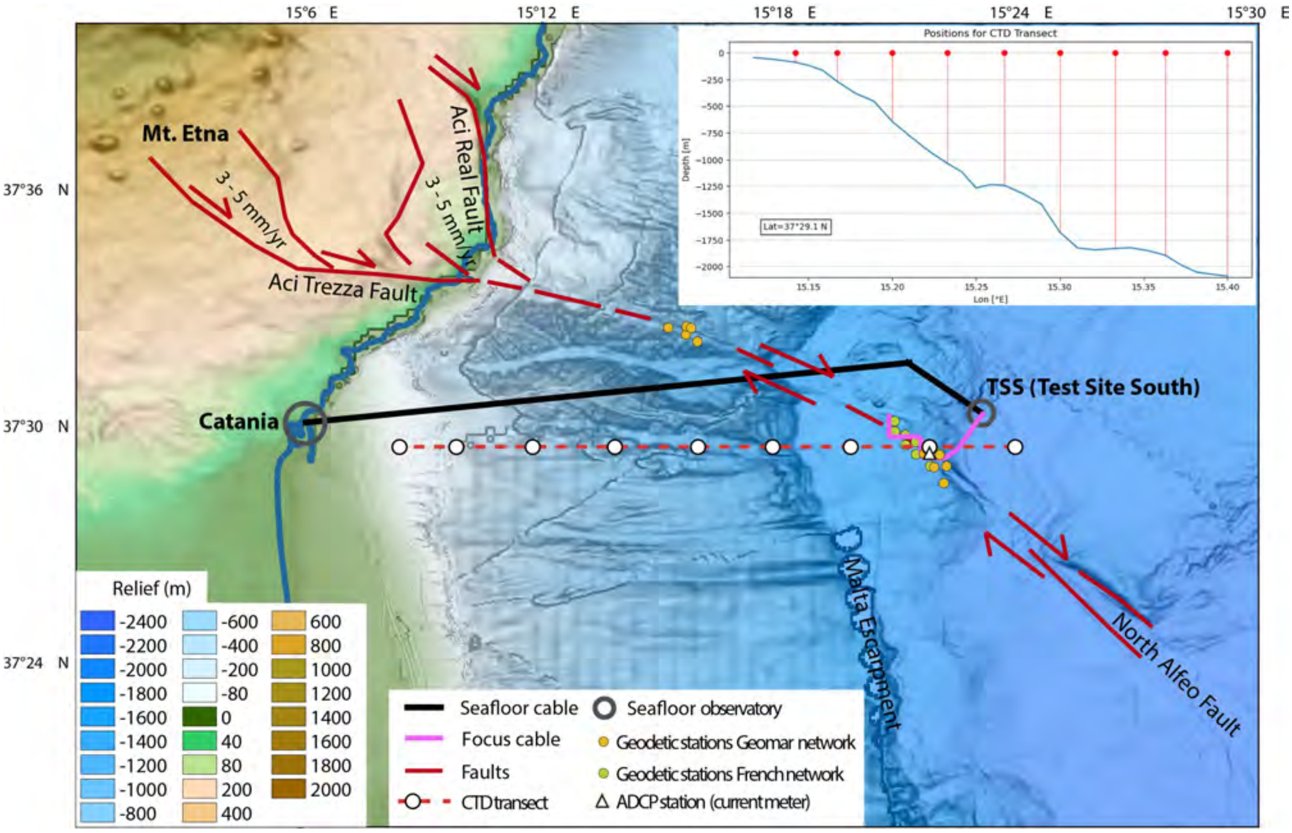


Fig. 6: Map showing the seafloor geodetic stations (yellow and green circles), the seafloor cables: the INFN-LNS electro-optical cable (thick black line) and the 6-km-long FOCUS fiber optic strain cable (pink), the ADCP (white triangle) and an east-west CTD transect acquired with 9 stations spaced ~3 km apart.
Inset : CTD transect showing the bathymetry along the profile.

OBS (Ocean-bottom seismometer) recovery and redeployment

One of the main goals of the FocusX3 expedition was to recover the instruments and the data from the land-sea passive seismological network in order to better record and locate micro-seismicity in the Ionian Sea - E Sicily - SW Calabria region. The onshore network of permanent land stations is operated by INGV Catania. These were supplemented by 15 temporary land-stations set-up and operated by INGV Rome (see map below, Fig. 7). We deployed 20 OBS in January 2022 during the FocusX2 cruise (15 German, short-period OBS from Geomar, Kiel and 5 French broad-band OBS from Geo-Ocean, Brest) (Fig. 7). The 9 LOT-OBS were deployed during August 2022, with the R/V Tethys2 during a few additional days added to the expedition FocusG2 (chief scientist = Jean-Yves Royer). All 29 OBSs were successfully collected during mission, a summary of their location and recovery date are provided in Table 1.

OBS recovery

Station Name	**Latitude**	**Longitude**	**Depth(m)**	**Recovery Date (Time: UTC)**
SG01A	37° 29,634	15°15,235	1320	17/02/2023 18:51
LT02A	37°25,598	15°17,455	1360	17/02/2023 20:00
BB03A	37°28,558	15°20,329	1812	21/02/2023 22:50
LT04A	37°25,373	15°24,51	2110	17/02/2023 21:29
SG05A	37°28,078	15°26,866	2051	17/02/2023 22:56
LT06A	37°32,28	15°20,33	1841	18/02/2023 03:00
SG07A	37°34,368	15°17,503	1118	18/02/2023 04:28
SG08A	37°40,910	15°21,3935	1584	19/02/2023 03:44
BB10A	37°44,227	15°29,3874	1558	19/02/2023 05:20
SG11A	37°43,894	15°41,003	1654	20/02/2023 18:50
SG12A	37°43,397	15°52,409	1672	20/02/2023 20:56
BB13A	37°42,948	16°03,097	1766	20/02/2023 23:12
SG14A	37°31,269	16°03,427	2045	21/02/2023 01:43
LT15A	37°30,500	15°53,269	2135	21/02/2023 06:45
SG16A	37°31,147	15°42,157	2239	21/02/2023 04:39
LT17A	37°30,986	15°31,194	1992	18/02/2023 01:43
SG18A	37°20,139	15°24,575	2126	19/02/2023 00:23
SG19A	37°20,078	15°32,598	2223	22/02/2023 14:00
LT20A	37°19,38	15°43,234	2280	20/02/2023 07:10
SG21A	37°20,057	15°54,303	2550	21/02/2023 15:47
LT22A	37°19,979	16°03,764	1902	21/02/2023 17:33
LT23A	37°09,44	16°04,074	2693	21/02/2023 19:15
SG24A	37°09,324	15°55,176	2901,5	22/02/2023 05:27
SG25A	37°09,201	15°44,209	2452	22/02/2023 07:24
BB26A	37°09,084	15°34,152	2251	20/02/2023 04:30
SG27A	37°08,931	15°25,626	2104	20/02/2023 02:42
LT29A	37°01,277	15°55,838	3076	21/02/2023 23:30
SG28A	36°58,352	15°45,326	2518	22/02/2023 02:53
BB30A	37°03,746	16°4,185	2934	21/02/2023 21:50

Table 1: OBS instruments recovered. Color code is based on OBS type: yellow are German short period OBSs, blue/gray broadband Nammu and yellow short period Lot-OBS.

After recovery of all 29 OBS instruments (and downloading of the data), 5 broad-band OBS and 6 LOT-OBS were redeployed (see map below - Fig. 8).

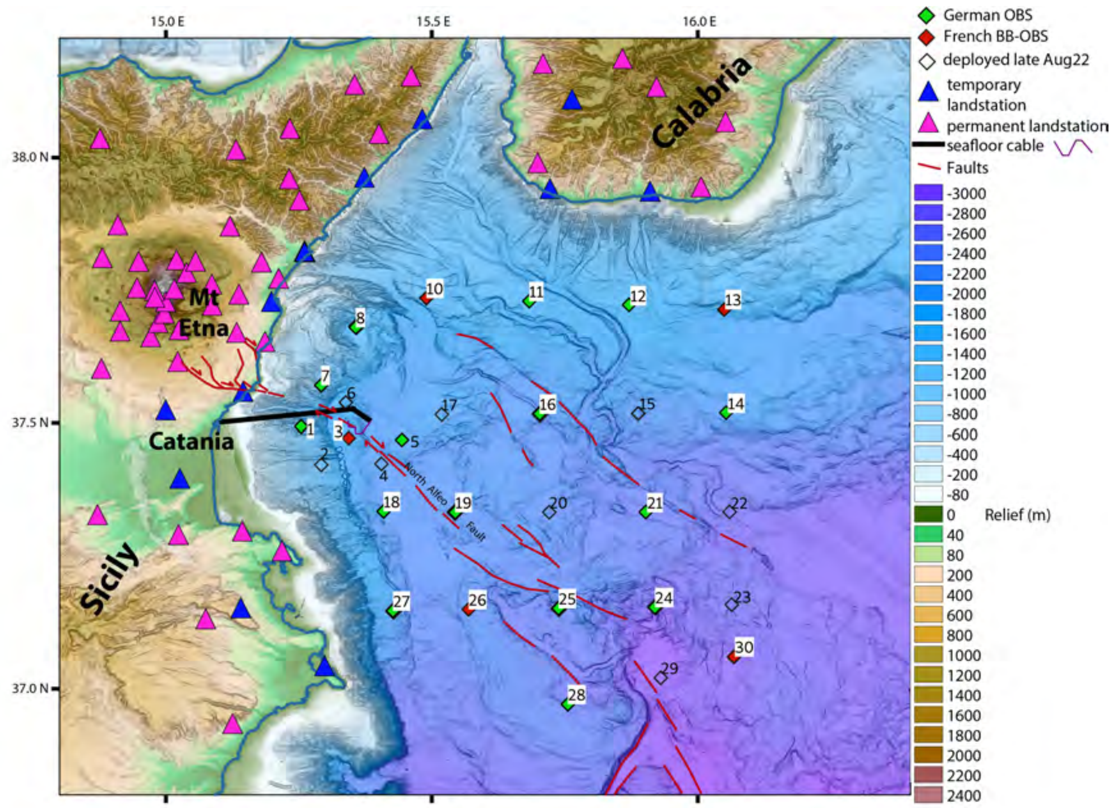


Fig. 7: Map of the Jan. 2022 - Feb. 2023 onshore - offshore seismological network, with land-stations (triangles) and OBS positions (diamonds) shown: green - German short period OBS, red - French broad-band OBS, and black/unfilled - 9 LOT-OBS deployed in Aug. 2022 with the R/V TethysII.

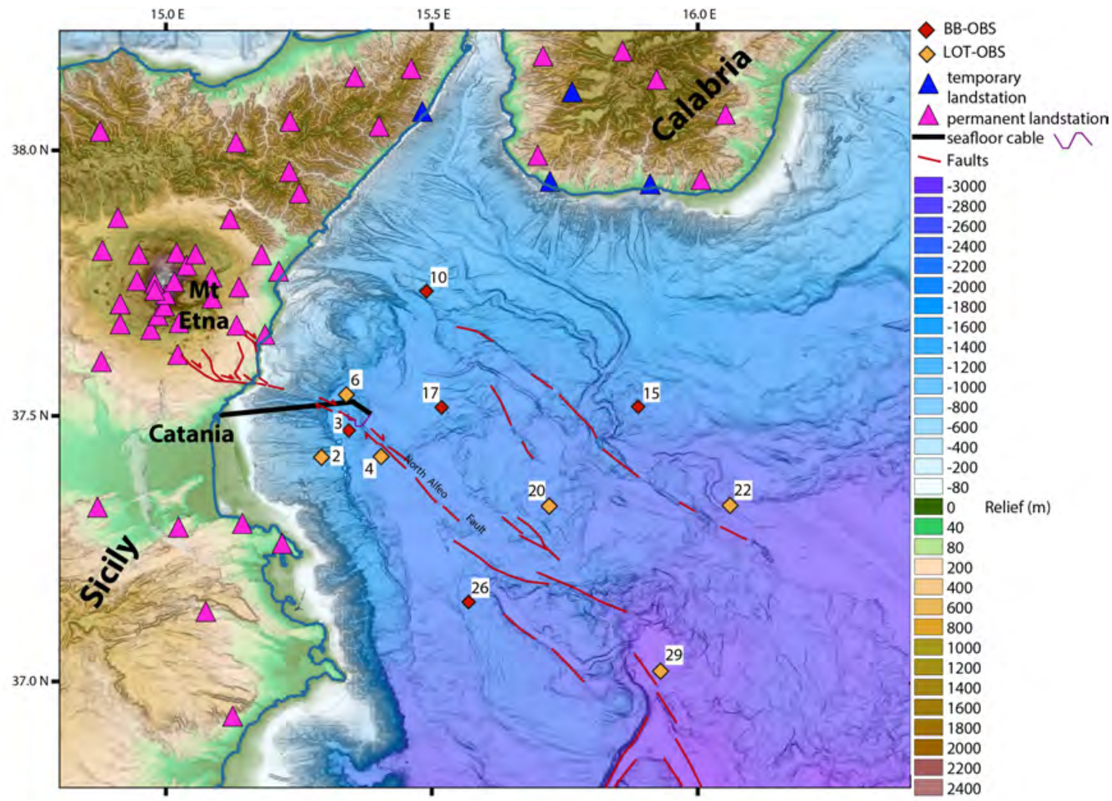


Fig. 8: Map of the new, but reduced (Feb. 2023 - Feb. 2024) onshore - offshore seismological network, with land-stations (triangles) and OBS positions (diamonds) shown. Red diamonds are the 5 Nammu broad-band OBS. Orange diamonds are the 6 LOT-OBS which will be recovered in August 2023 with the R/V TethysII. The four temporary land stations (blue triangles) will be recovered in April 2023. LOT-OBS #2 malfunctioned (released prematurely) and washed ashore in March 2023 in Augusta, Sicily (20 km to the SW).

OBS redeployment

The 5 broadband Nammu OBSs and 6 short period Lot-OBS were redeployed. Information on their deployment positions is provided in Figure 8 (above) and Table 2 (below). Due to the smaller number of OBSs being redeployed compared to the first deployment, the OBSs were positioned so as to provide good coverage on the Alfeo fault, in some instances this meant moving broadband seismometers to locations previously occupied by short period instruments during the previous deployment. The Lot-OBS we be retrieved in August 2023 as part of FOCUS G3 campaign with R/V Tethys2 while the broadband instruments will be retrieved in February 2024 during a German marine expedition onboard R/V Meteor in the study area led by Morelia Urlaub (Geomar).

Station Name	Latitude	Longitude	Depth (m)	Deployment Date	Deployment method
BB17B	37°30,9833	15°31,1848	1951	21/02/2023	winch
BB26B	37°09,0831	15°34,1680	2190	22/02/2023	winch
BB03B	37°28,5864	15°20,34432	1771	23/02/2023	winch
BB15B	37°30,4658	15°53,2518	2099	25/02/2023	winch
BB10B	37°44,21418	15°29,4216	1525	25/02/2023	winch
LT29B	37°01,2765	15°55,821	3076	21/02/2023	free fall
LT06B	37°32,276	15°20,324	1804	24/02/2023	winch
LT02B	37°25,597	15°17,454	1330	24/02/2023	winch
LT04B	37°25,3446	15°24,232	2110	24/02/2023	winch
LT20B	37°19,3037	15°43,2154	2236	25/02/2023	free fall
LT22B	37°19,9706	16°03,7825	2880	25/02/2023	free fall

Table 2: OBS instruments redeployed. Colour code based on instrument type: blue/gray represents Nammu broadband OBS, green are short period Lot-OBS.

GEOMAR Short Period OBS

During the FocusX3 mission, we were able to recover all 15 short-period OBS instruments deployed during Focus X2 expedition in the Ionian Sea (in January 2022). The OBS instruments were provided by GEOMAR and recorded data for just over 12 months.

The GEOMAR Ocean Bottom Seismometer 2000 is a design based on experience gained with the GEOMAR Ocean Bottom Hydrophone (OBH; Flueh and Bialas 1996) and the GEOMAR Ocean Bottom Seismometer (OBS, Bialas and Flueh, 1999). The basic system is constructed to carry a hydrophone and a geophone for higher frequency active-seismic profiling. However, due to the modular design of the front end it can be adapted to different seismometers and hydrophones or pressure sensors. The sensors are HTI-01-PCA hydrophones from High Tech Inc. The sensitive geophone is fixed between the anchor and the OBS frame (Fig. 9), which allows for optimal coupling with the seafloor. The three-component geophone (KUM) is housed in a titanium tube, modified from a package built by Tim Owen (Cambridge) earlier. The geophones with a corner frequency of 4.5 Hz recording with a sampling rate of 250 samples per second. The recording device is a 6D6 recorder of KUM GmbH, which is contained in its own pressure tube and mounted next to the buoyant body opposite the release transponder. The sensors and recorder are powered by 72 Alkaline batteries. The floatation is made of syntactic foam and is rated, as are all other components of the system, for a water depth of 6000 m.

While deployed to the seafloor the entire system rests horizontally on the anchor frame. The instrument is attached to the anchor with a release transponder. The release transponder is the K/MT562 made by KUM GmbH. Communication with the instrument for release and range is possible through a transducer hydrophone. Over ranges of 4 to 5 miles release and range commands are successful. After releasing its anchor weight of approximately 60 kg the instrument turns 90° into the vertical and ascends to the surface with the floatation on top. This ensures a maximally reduced system height and water current sensibility at the ground (during measurement). On the other hand the sensors are well protected against damage during recovery and the transponder is kept under water, allowing permanent ranging, while the instrument floats to the surface.

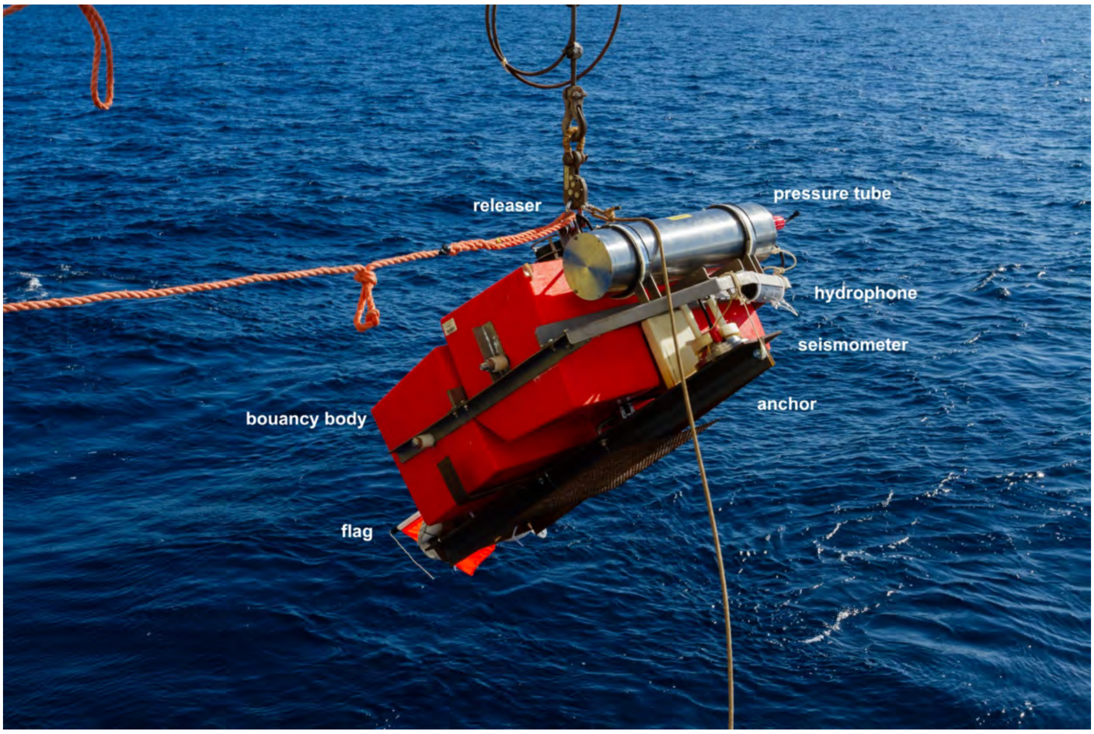


Figure 9: GEOMAR Ocean Bottom Seismometer.

Geo-Ocean Broadband OBS

Five Nammu broadband OBSs designed by K.U.M. GmbH Kiel were deployed during the FOCUS X2 expedition (Fig. 10). Each instrument houses a 3 component 120s Nanometrics Trillium Compact Ocean Bottom Seismometer within a pressure tube and a High Tech Inc. 100s HTI-04-PCA ULF Hydrophone on its shell. Data is stored on a 4 channel 6D6 datalogger from K.U.M at 32bits at 142db, sampling rate for the was set to 250Hz. The Nammu is connected to a 49 kg (in air) anchor by a KUMQuat 562 releaser. The anchor sits horizontally on the seafloor at the base of the Nammu. Each OBS has a radio beacon, flasher and flag for identification at the sea surface.

Figure 10: deployment of Nammu ocean bottom seismometer.

All broadband instruments were released horizontally 50m above seafloor using a cable and remote releaser. On the seafloor the instruments rest horizontally. The instrument is released through communication by a transducer hydrophone at the sea surface with the KUMQuat 562 releaser. On release the Nammu rotates 90 degrees and floats to the surface, on reaching the surface the radio beacon and flasher are activated and the flag should be visible above the water surface. During the FocusX2 cruise in Jan. 2022, before deployment, the functioning of the releasers was tested for 4 out of 5 instruments (i.e. excluding S/N 1909477) by lowering them to a depth of 1000m and activating their release using a transponder on vessel PourquoiPas?. Maps showing all OBS and land-station locations are shown above (Figs. 7 and 8).

References

Bialas, J., and Flueh, E. R., Ocean Bottom Seismometers, Sea Technology, 40, 4, 41-46, 1999.
Flueh, E.R., and Bialas, J., A digital, high data capacity ocean bottom recorder for seismic investigations, Int. Underwater Systems Design, 18, 3, 18-20, 1996.

LOT-OBS (Long Term OBS)

The LOT-OBS is a variation of the MicrOBS from SERCEL. In this configuration the main difference is in the energy source which is a lithium battery assembly instead of a rechargeable battery assembly.

The philosophy of the instrument consists in favoring a compact instrumentation using a glass sphere as a container. The Nautilus glass sphere provides the container for the electronics, battery and sensors, and also allows it to float for the ascent to the surface.

During the FOCUS campaign, 9 OBS of the LOT-OBS type were deployed, they present two variants concerning the geophones. 7 of them, which will be called LOT-OBS, are equipped with a KUM type K/MT210 external geophone comprising GS11D geospace geophones, and 2 others, which will be called MicrOBS Long Life, use Geospace GS- type geophones. ONE.

The table below presents the main characteristics of the instruments deployed during the FOCUS_G2 campaign, recovered during FOCUS_X3:

LOT-OBS specs		
	LOT-OBS	MicrOBS Long Life
Recording autonomy (4ms Sampling)	150 days	
Battery autonomy (60 LS33600 Cells)	357 days	
Weight (in air)	38kg	
Weight (in air with lest)	74kg	
Water depth	6000	
Hydrophone	HTI90 U 2 – 800Hz -160 dB ref 1V/µPa	
Geophone	GS11D 4,5Hz – 28,8V/m/s(±5%)	GSONE LF 4,5Hz 100.4 V/m/s ± 10%
Hight cut filter	Selectable (Hz) none, 0.15625, 0.3125 , 0.625 , 1.25 , 2.5)	
Low cut filter	0.8 FN linear or minimum phase	
Gain	Selectable 0 dB, 12 dB, 24 dB	
Full scale	1.6V RMS (0 dB), 400 mV RMS (12 dB), 100 mV RMS (24 dB)	
Sample rate	Selectable 4, 2, 1, 0.5 ms	
Clock accuracy	5.10-8	
Dimension of base	550 x 550 mm	
Height	720 mm	
Dead weight size (cross shape)	800 x 800 mm - 36kg	
Release system	Engine	Titanium Burn wire
Release duration	30 s	From 8 to 15 min
ascent rate	1,02m/s	

For the FOCUS deployment, we use the configuration:

- Sampling rate: 4ms
- gain: 12 dB (for Geophones and Hydrophone)
- High cut filter: 0,15625Hz
- Low cut filter: 0.8 FN linear

All 9 systems operated and recovered around 5.5 months of data between 4/9/2022 and 17/2/2023.

As this instrumentation is relatively new, we are, in a way, making our first steps. Thus, a parameter such as the rate of ascent in the water column was determined during the campaign thanks to the recordings.

Unfortunately, the data recording at the time of launching was erased because of the memory capacity which was limited for this deployment.

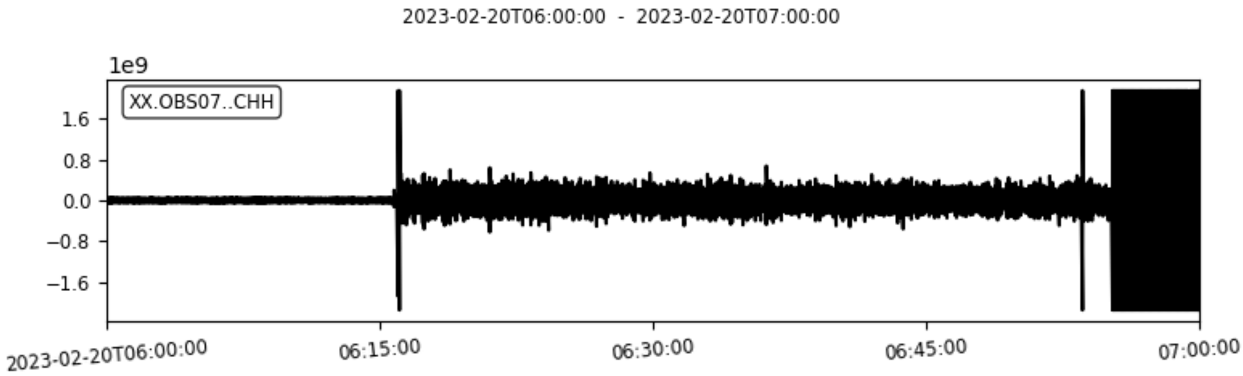


Figure 1: Example of LotOBS OBS7 / SG22 Hydrophone – 06h15 à 06h55 2280m 0,95m/s

For a LOT-OBS the speed is 1902/(50*60) =
Calculation of the ascent rate using the graph and elements of the prog sheet. Depth versus time = 1.02m/s. Depending on the configuration, either the rotation time of the jettisoning motor (30s) or the corrosion time of the "burn wire" fuse, which varies between 8 and 14 minutes, must be added to this time. For 2000 m depth, for example, we have an ascent time of 34 minutes with a release by motor or 46 minutes for a "burn wire".

Regarding clock drift, for a deployment of more than 5 months the average clock drift is $1.098.10^{-8}$ with a minimum value of $0,295.10^{-8}$ and a maximum of $2.897.10^{-8}$. It is a performance of very good quality, not to say exceptional for an instrumentation of the price of OBS. For example, a drift of 1.10-8 is equivalent to a drift of 0.864 ms/day. By referring to a sample rate (SR) of 4 ms, we therefore have an uncertainty equivalent to the SR every 5 days. However, in reality the evolution of the drift is not linear, but we will make an approximation. During post processing, a linear correction is applied to limit the impact of drift as much as possible. This correction is applied by a simple deletion or addition (by copying) of a sample periodically and linearly in the data. In this way, we manage to limit the impact of drift on the dating of each sample. The precision is then the best at the begining and at the end of the dataset.
In addition to clock drift processing, post processing allows the data to be transformed into a scientific format, so the raw data which has a "proprietary" binary format divided into several files of approximately 200Mb will be transformed into MiniSeed or SAC. Each RAW file contains one of the instrument's 4 measurement channels. As a result, a breakdown of the raw data will be produced day by day and sensor by sensor. That is about 440 files per instrument.

An upgrade of the LOT-OBS on-board firmware was carried out during the campaign, it also allows the integration of data compression at the instrument level. This upgrade aims to make it possible not to fill the data storage memory, therefore to have a data set over the entire time range between February and March 2023. The upgrade also aims to halve the time of data download thanks to the integrated compression (factor 2). During the campaign, it took no less than 18 hours of transfer for each instrument. If we integrate that a "crash" of the communication could interrupt the transfer and very often make it mandatory to restart the entire download. In the end, we had to fight until almost the last day to succeed in recovering all the data.
The firmware has been "upgraded" to version 1.5.1 instead of a version 1.4.0. A recording test of a few hours was carried out on two instruments. This test was positive. However, there is a small risk taken because the instruments returned to the water will not be recovered until the end of August 2023, i.e. after 5 months. The long-term functionality of the firmware will then be tested.

Preliminary results: OBS recordings of earthquakes

After recovery of the ocean-bottom seismometers the data were downloaded and a first quality control was performed. We examined the recordings of a few prominent earthquakes that occurred during the deployment period. Below are two examples of recordings from OBS #3 (a Nammu broadband instrument), located next to the Focus cable about 20 km east of Catania (see map Fig. 7).

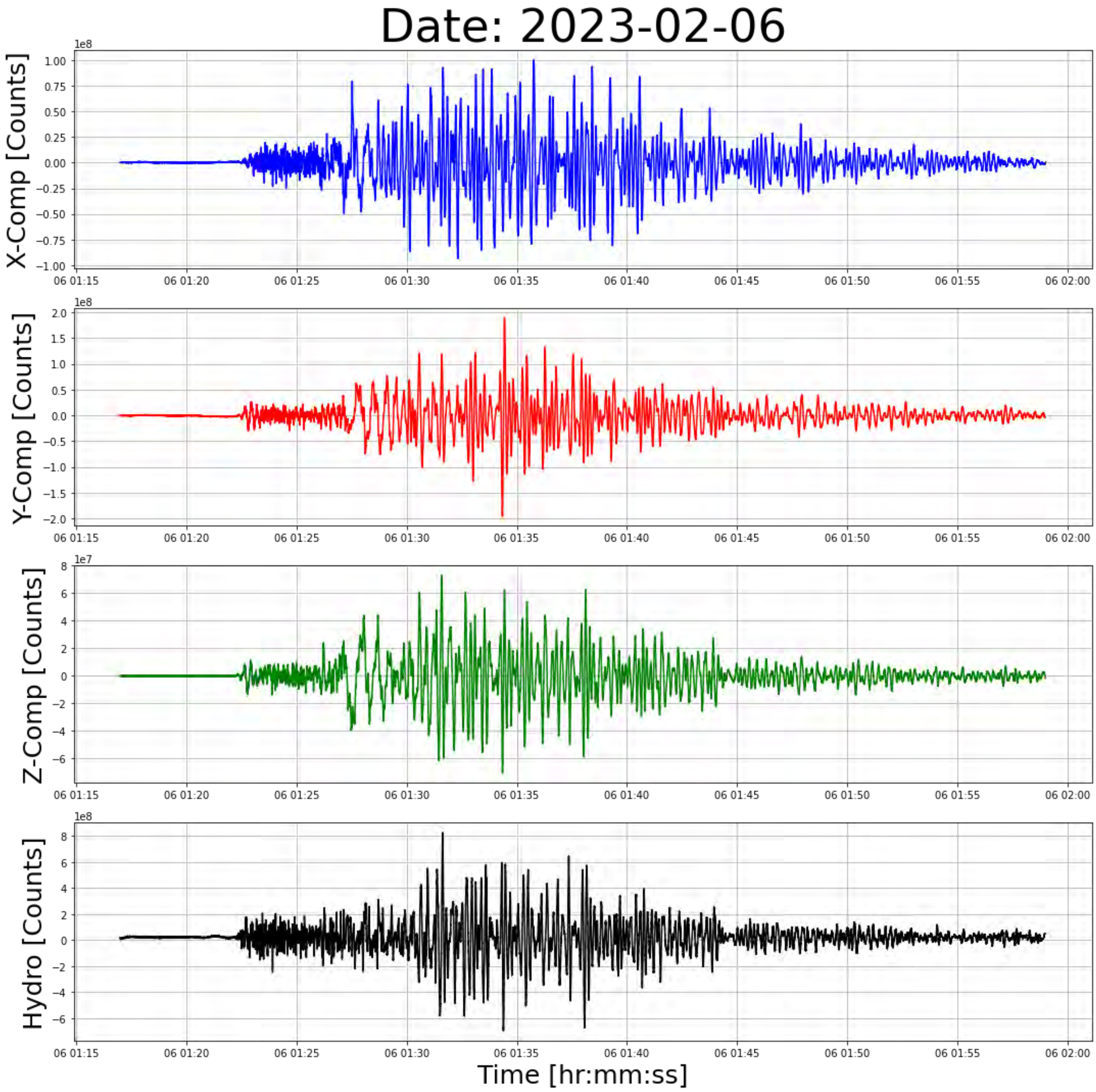


Figure 11: The M7.8 Turkey earthquake recorded on 6th February 2023 at station BB03A by a Nammu broadband OBS.

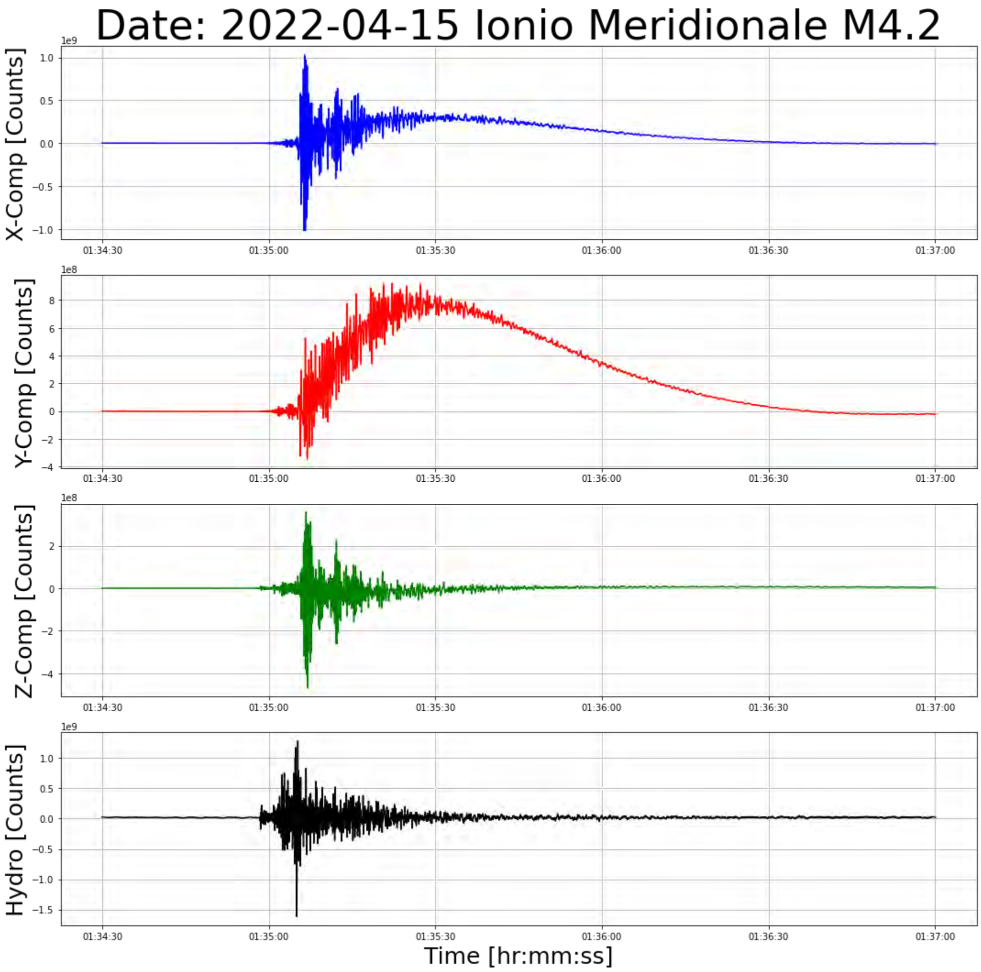


Figure 12 : recording of the 15 April 2022 M4.2 earthquake, the strongest event located in the middle of the OBS network, from OBS#3 (Nammu broad-band)

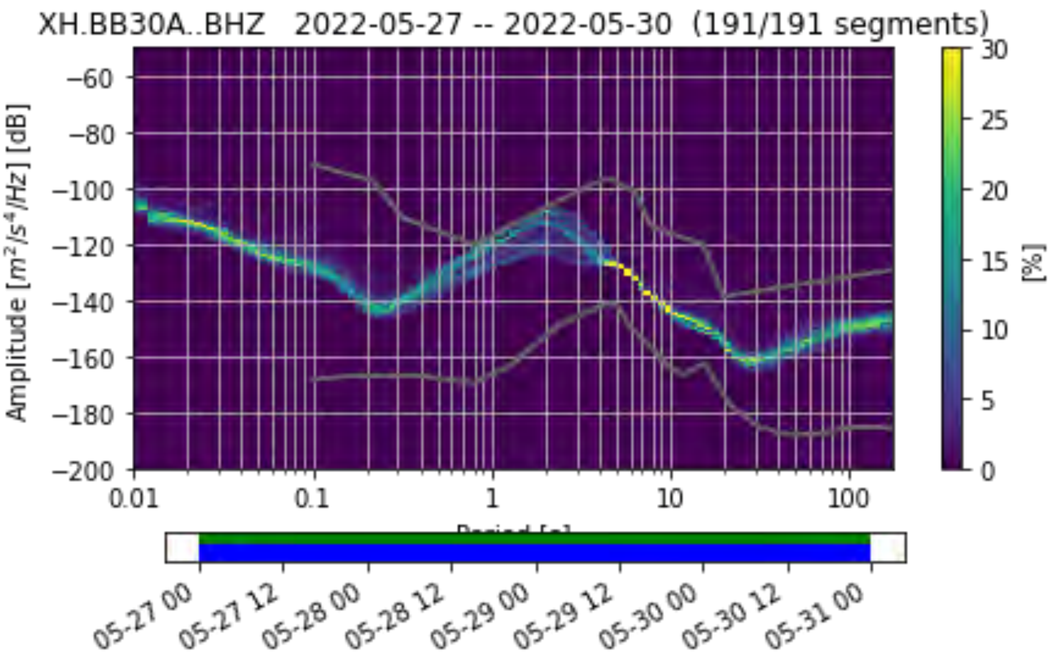


Figure 13: Probabilistic power spectral density of data recorded at station BB03A over the course of 3 days (27th May to the 30th May 2022). This provides a quality control on the noise measurement recorded at the station. For comparison the grey lines represent high and low noise models (Peterson, 1993) representing the envelop for expected noise on land. Despite being at sea, the observed noise sits between the between the high and low range at this site.

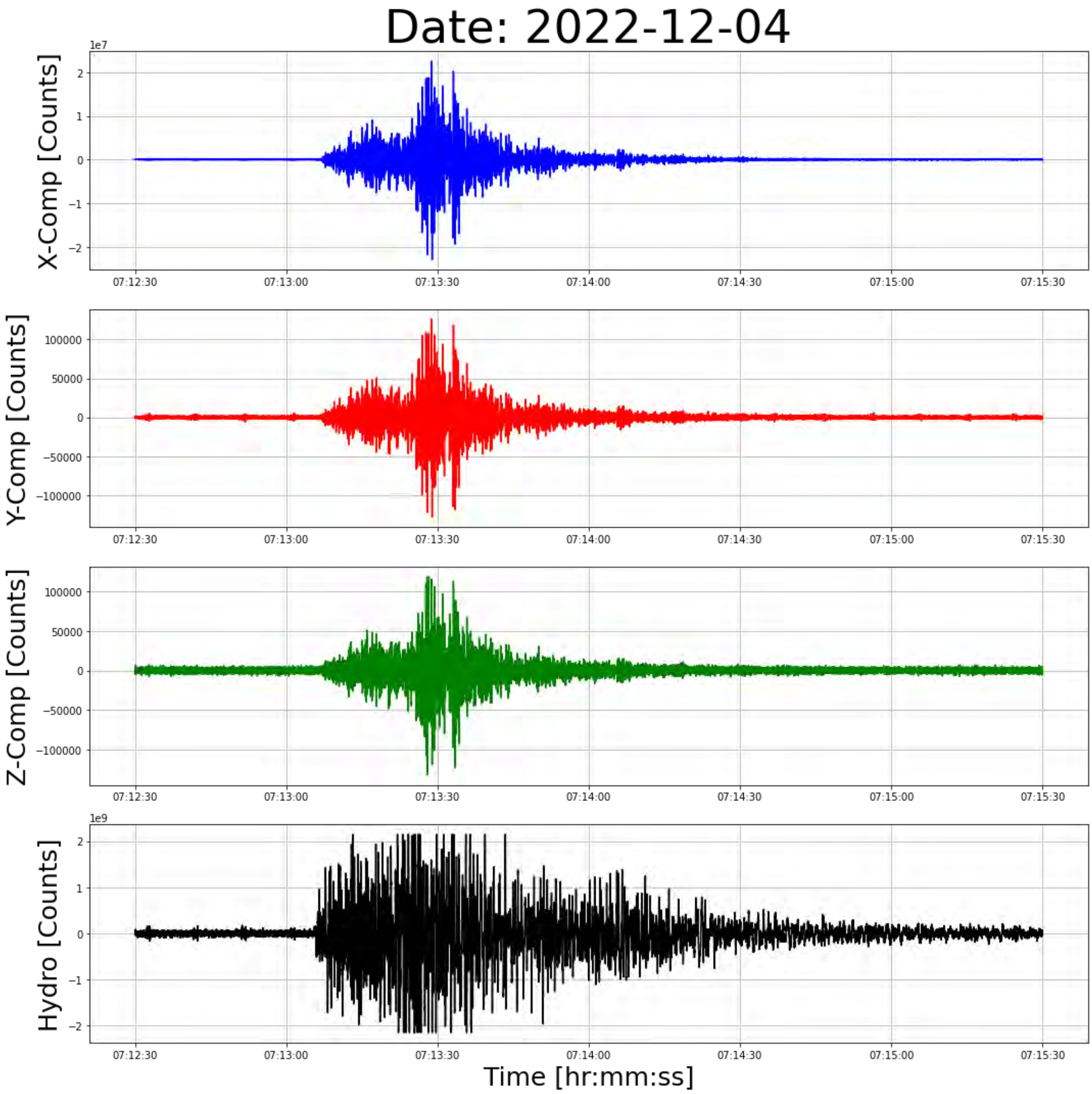


Figure 14: A M4.5 earthquake which occurred locally (i.e. near the Aeolian Islands) on the 4th December 2022 recorded at station LT02A by a short period Lot-OBS

Seafloor Geodesy workplan (Jean-Yves Royer, CNRS senior researcher)

The text below describes the planned redeployment of 13 sea-bottom geodetic stations for the FOCUS project, including 8 Canopus from Exail (iXblue) and 5 AMT Compatt 6 from Sonardyne.

The general idea for the station layout (Figure G1) is the same as for the 1st deployment in October 2020 with:

- baselines parallel to the cable, where it crosses the North-Alfeo fault;
- baselines across the fault as oblique as possible, given that the North-Alfeo fault is a (right-lateral) strike-slip fault (i.e. motion is maximum parallel to the fault);
- station numbering set so that all stations south of the fault have an even number, and all stations north of the fault have an odd number.

With the 5 additional Sonardyne stations lent by GEOMAR, it becomes possible:

- to extend the network ~800m to the south and get 5 additional baselines crossing the fault;
- to double some baselines with both types of stations, to compare their performances and/or to compensate for the failure of one or more instruments. A priori, the two types of stations should not interfere with each other, since they use different frequencies and interrogation protocols.

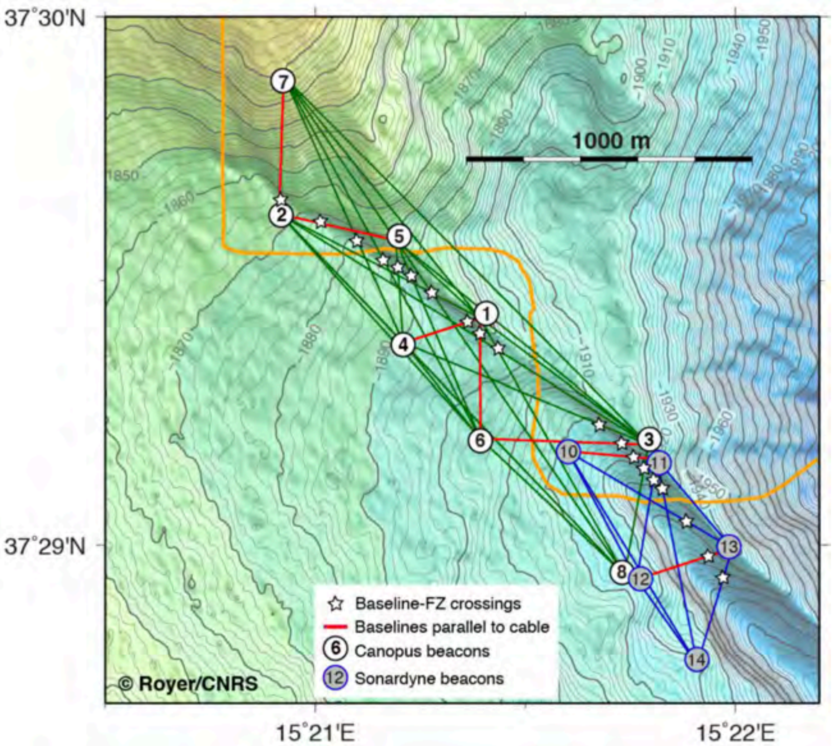


Figure G1: General view of the geodetic networks. Baselines between Exail's Canopus beacons are in green, and between Sonardyne's AMT beacons, in blue. Baselines in red are more or less parallel to the fiber-optic cable route (orange line). Stars show the crossings of the baselines with the North-Alfeo fault.

The communication (i.e. line of sight) between pairs stations have all been checked with the Bellhop ray-tracing software. All models assume a punctual source at 20 kHz, the same sound-speed profile for the area from the GDEM database, and source and receiver 2.5m above the seafloor. Statistical GDEM sound-speed profiles at depth (> 300m) are all the same throughout the year. However, data from the first deployment showed that, near the sea-bottom, the sound-speed varies by ±0.1 m/s and is very inhomogeneous throughout the area, probably due to transient fluxes of "hotter/colder" (±0.02°C) or softer/saltier waters along the fault (coming down the slopes of Sicily). To monitor these subtle changes, all Canopus stations are equipped with ancillary sensors: temperature (Seabird external probe), pressure (built-in). Stations 1 and 2 have also a built-in sound-speed meter. Similarly, all AMT Compatt 6 beacons have built-in temperature, pressure, and sound-speed sensors. All stations with a sound-speed meter (1, 2, 10, 11, 12, 13, 14) are spread to provide a uniform glimpse of the sound-speed field through time across the geodetic network. Sensors specs are given in the Appendix.

The stability of the tripods is monitored by two orthogonal inclinometers. A special care in mounting the tranponders on their tripod should be given, so that an ROV inspection can tell the inclinometer orientations, allowing to correct baseline changes from any subsequent tilt of the tripods (a 1 degree tilt at 3m height will move the acoustic head by 5 cm).

In terms of difficulties in the deployment, some stations are located on a very narrow ridge crest (1, 3, 11, 13) and some pairs of Canopus and AMT are only 50m apart (3 and 11, 8 and 12). Close-up of the maps are shown further. Their geographic coordinates are as good as the bathymetric grid is accurately positioned. One must keep in mind that, due to the topography of the area, displacing one beacon by 50m or 100m from the proposed locations may make it invisible to one or more stations.

Canopus (iXblue/Exail) network

In the proposed layout for the Canopus network, there are 28 baselines, of which 15 cross the North-Alfeo fault (Figure 2). The numbering of the Canopus beacons is set so that the station number “x” matches the beacon serial number “1906-00x”, to facilitate data processing. Most stations have a location very close, if not identical, from the 2020 initial layout (here 1, 2, 3, 4, 5, 6, 7), so we do know that they are all in the line of sight of one another. Station 8 is at a new location (Table G 1 below). Ray-tracing models for all baselines are given in the Appendix. The longest baseline is 2115m long (7-8) and the shortest 282m (1-4; Figure 3). The highest station is #7 (1808m), and the deepest #8 (1921m). Transmission loss for the longest line 7-8 would be in the order of -67dB (see ray-tracing models in the Appendix).

N	Longitude	Latitude	Z [m]
1	015°21.391'E	37°29.428'N	1882
2	015°20.915'E	37°29.626'N	1864
3	015°21.793'E	37°29.190'N	1912
4	015°21.209'E	37°29.382'N	1887
5	015°21.191'E	37°29.575'N	1870
6	015°21.393'E	37°29.201'N	1902
7	015°20.924'E	37°29.887'N	1808
8	015°21.735'E	37°28.943'N	1921

Table 1: Location and depth of the Exail Canopus beacons.

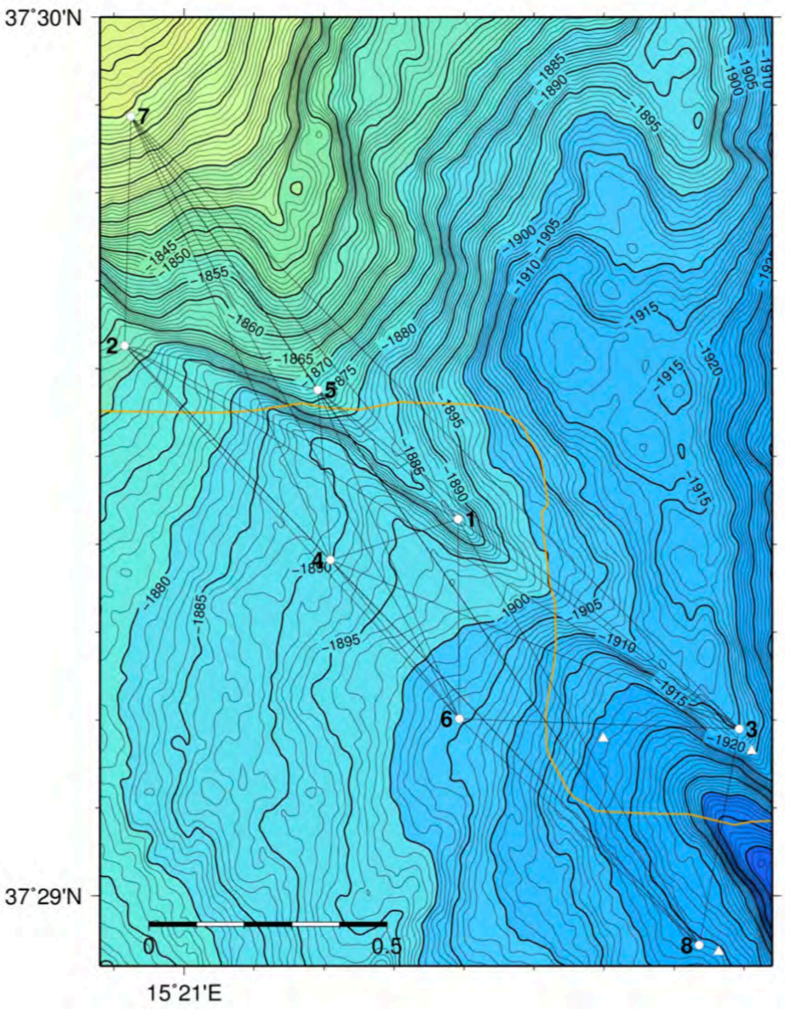


Figure G2: Canopus beacon layout (circles) and baselines. AMT beacons are shown by triangles. Bathymetric contours every meter. Scale bar is 500m long.

Deployment of Canopus (iXblue/Exail) network (by Gregor Jamieson: Engineer Exail)

FOCUS X3 Canopus deployment for geodetic monitoring.

The FOCUS X3 deployment follows the recovery of all Exail Canopus transponders. Exail, formerly iXblue. The initial deployment in October2020 had 8 transponders to monitor ranges between each station and to have the data logged internally to be taken off via Ramses modem. The initial deployment had a fault that meant the sleep function of the transponders did not properly trigger and battery life was prematurely depleted. The lifting of data from the transponders using Ramses modem function also proved challenging.

Changes to the Canopus transponder firmware and Ramses firmware fixes these issues and should result in more robust deployment and battery life. The language that the data is transferred with has been repackaged to minimize the likelihood of any corruption. The packaging now in binary is as compact as possible, and when recovered any break in data can result in the fault point being recognizable and can be used as the next start point for recovery, resulting in nothing lost. Previous method was susceptible to lost packets corrupting the whole file, thankfully this is no longer the case. A new array shape (transponder locations) was chosen for FOCUS x3, detailed in 2023_FOCUS_Geodesy pdf.

The deployment of the Transponders was similar to FOCUS X1, and each transponder was asked for telemetry data on its way down and once on the bottom. The telemetry points showed good communication, and that seabed transponders were visible to each other. This was proven in all combinations 1to2, 2to1, etc. Each transponder frame upon landing was asked for its inclination to establish it landed on its feet as intended and this was the case with the highest lean being 9 degrees but with reliable line of sight in the array regardless.

Modem of data was tested while drifting through the array post deployment. This showed the data able to be collected. The drift track through the array was not controlled and resulted in undesirable positioning and speeds. There was some data not able to be collected in this timeframe. The telemetry showed some difficulty at this test too, which confirms the placement and speed were factors not helping. This is in contrast to the perfectly good telemetry when holding position on DP over a transponder. It is recommended that the Modem recover in future is done above the transponder with minimal movement. Which we would have tested if there had been time in the schedule. But it did show we were able to get about half of all data from 3 days in the under two hours we had, which bodes well for future.

Sonardyne geodetic network

The proposed layout of the Sonardyne AMT beacons (10, 11, 12, 13, 14) place them on either side of a deep graben (pull-apart basin? Figure 5). Two of them are very close (~50m) from Canopus stations (12 from 8, 11 from 3), two baselines parallel the cable (10-11 and 12-13), and two parallel those of the Canopus network (10-11 // 6-3, 11-12 // 3-8). The numbering scheme is the same as for the Canopus beacons: odd numbers (11, 13) are north of the fault, even numbers (10, 12, 14) are south of it. The serial number of these beacons is not known yet, but the best mnemonic association must be found to facilitate data processing.

N	Longitude	Latitude	Z [m]
10	015˚21.598'E	37˚29.179'N	1919
11	015˚21.810'E	37˚29.164'N	1916
12	015˚21.763'E	37˚28.936'N	1921
13	015˚21.990'E	37˚28.995'N	1935
14	015˚21.907'E	37˚28.774'N	1924

Table 3: Location and depth of the Sonardyne AMT beacons.

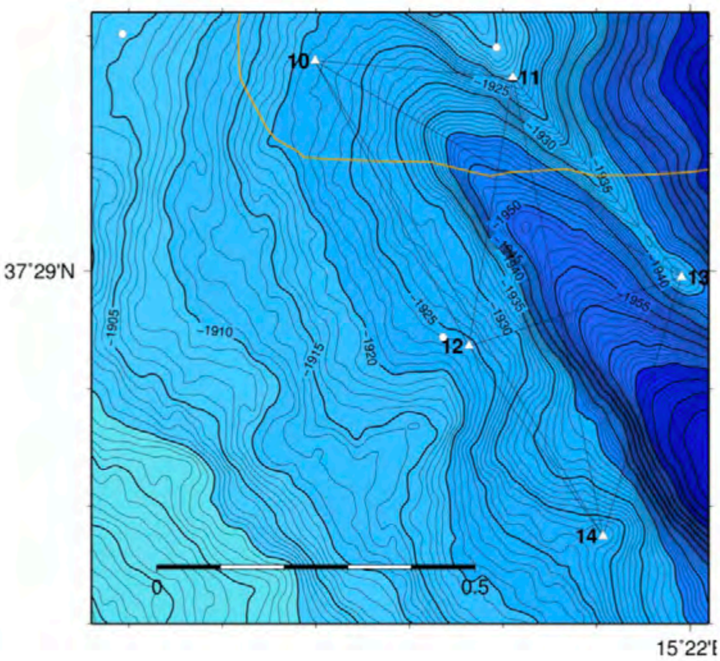


Figure G3: Sonardyne AMT beacon layout (triangles) and baselines. Canopus beacons are shown by circles. Bathymetric contours every meter. Scale bar is 500m long.

Below is a French language report of the work performed on the network of seafloor geodetic stations as well as information regarding the redeployment of the broad-band ocean-bottom seismometers

FOCUS X3

Mission océanographique du 13 au 28 Janvier 2022 à bord du N/O « Pourquoi Pas ? »

Expériences de géodésie et de sismologie

Rapport technique

David Graindorge, Edgar Lenhof, Charles Poitou & Christophe Prunier

Ingénieur support Sonardyne : Darren S. Murphy
Ingénieurs support Exail : Gregor Jamieson & Taru Ahopelto

Objectifs initiaux :

- Déploiement de cinq balises géodésiques de marque Sonardyne (modèle AMT)
- Redéploiement de huit balises géodésiques de marque Exail (modèle Canopus)
- Récupération et redéploiement de cinq sismomètres fond de mer de marque K.U.M. (modèle Nammu)

Déploiement de cinq stations géodésiques de marque Sonardyne

Ce réseau de balises a été déployé en vue de palier à un éventuel dysfonctionnement des balises géodésiques de marque iXblue (voir rapport mission précédente FOCUSX2). Par ailleurs, ce réseau parallèle (voir figure 1) permettra de comparer les performances de chacun des réseaux dans la partie sud. Une mission de téléchargement des données est prévue cet été (mission FOCUSG3 du 20 au 26 aout 2023 - Catane).

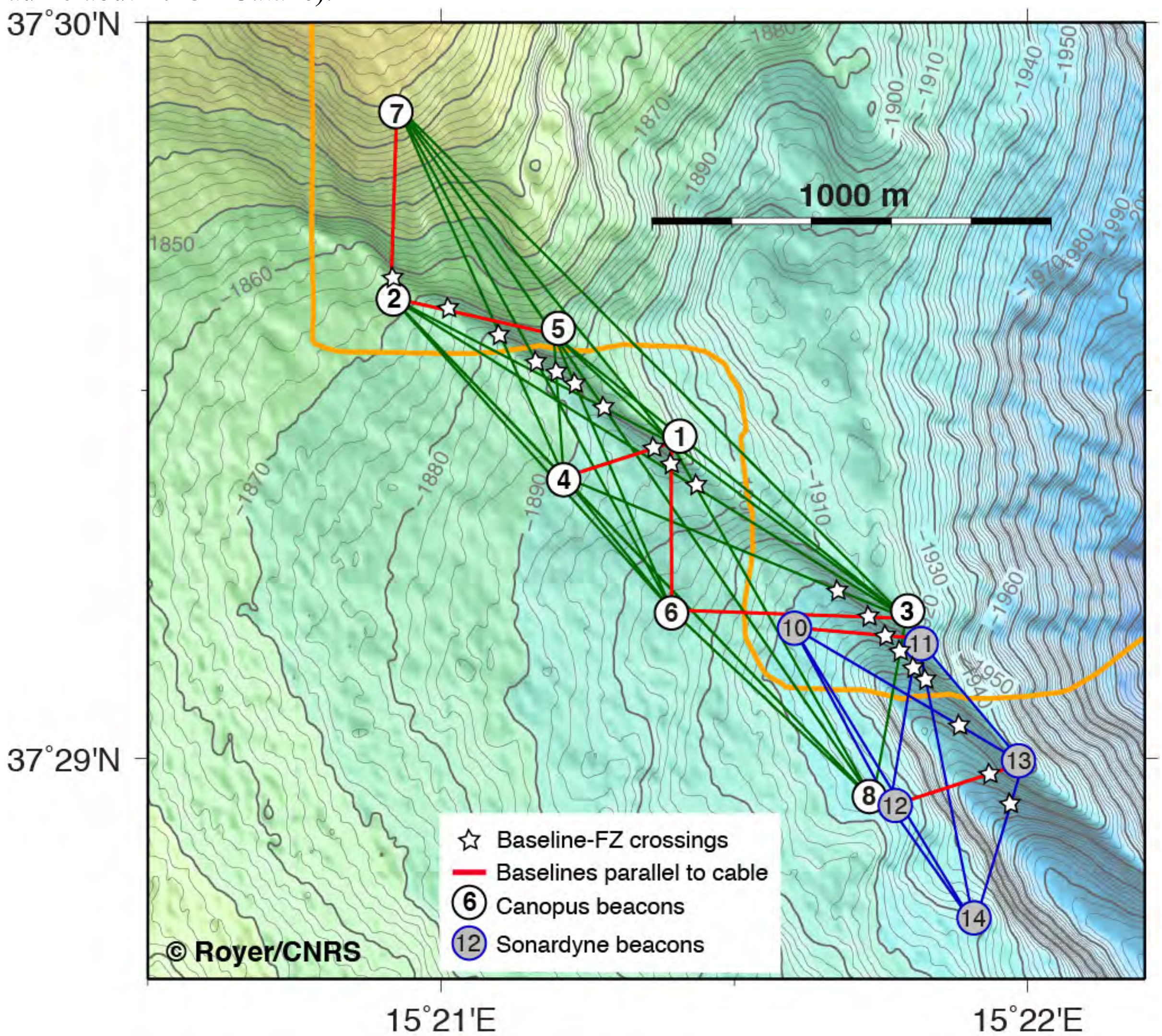


Figure 1 : Implantation des réseaux de balises géodésiques sur le site d'étude du projet FOCUS. La ligne jaune correspond au câble fibre optique déployée à l'automne 2020. Les ronds blancs correspondent aux sites d'implantation des stations géodésiques iXblue. Les ronds gris correspondent aux sites d'implantation des stations géodésiques Sonardyne.

Le réseau de balises géodésiques Sonardyne est prêté gracieusement par l'institut allemand GEOMAR (Kiel). Il permettra de compléter le jeu de données du réseau de balise géodésique iXblue. Un ingénieur support de chez Sonardyne s'est chargé de la configuration des balises (voir rapport dédié). Des trépieds ont été réalisé au dernier moment pour la mise à l'eau de ces instruments. Aucune info sur la façon de gréer ces instruments (voir figure 2) n'a été transmise par Geomar, mise à part le fait qu'il fallait intégrer la balise dans un cylindre en plastique. Il manquait les vis de fixation de ces chemises plastiques et celles-ci s'inséraient mal dans les têtes cylindriques des trépieds. Il a donc fallu les retravailler et les graisser pour qu'elles puissent rentrer. Les balises ont toutes été repérées avec un chiffre romain à la peinture noire et chaque trépied a été orienté avec l'ajout de réflexite (voir détails dans les fiches de déploiement dans le dossier /data/fiches manuscrites). Les trous de fixations des boulons ont été réalésés à l'aide d'un foret classique. Nous avons sans doute perdu la protection galvanique à ce niveau.

Lors des déploiements, chaque nouvelle balise posée au fond a été interrogée de façon à connaître son inclinaison. Nous vérifiions également que chaque balise pouvait interroger celles déjà déployées avant de lancer la commande de largage de la balise.

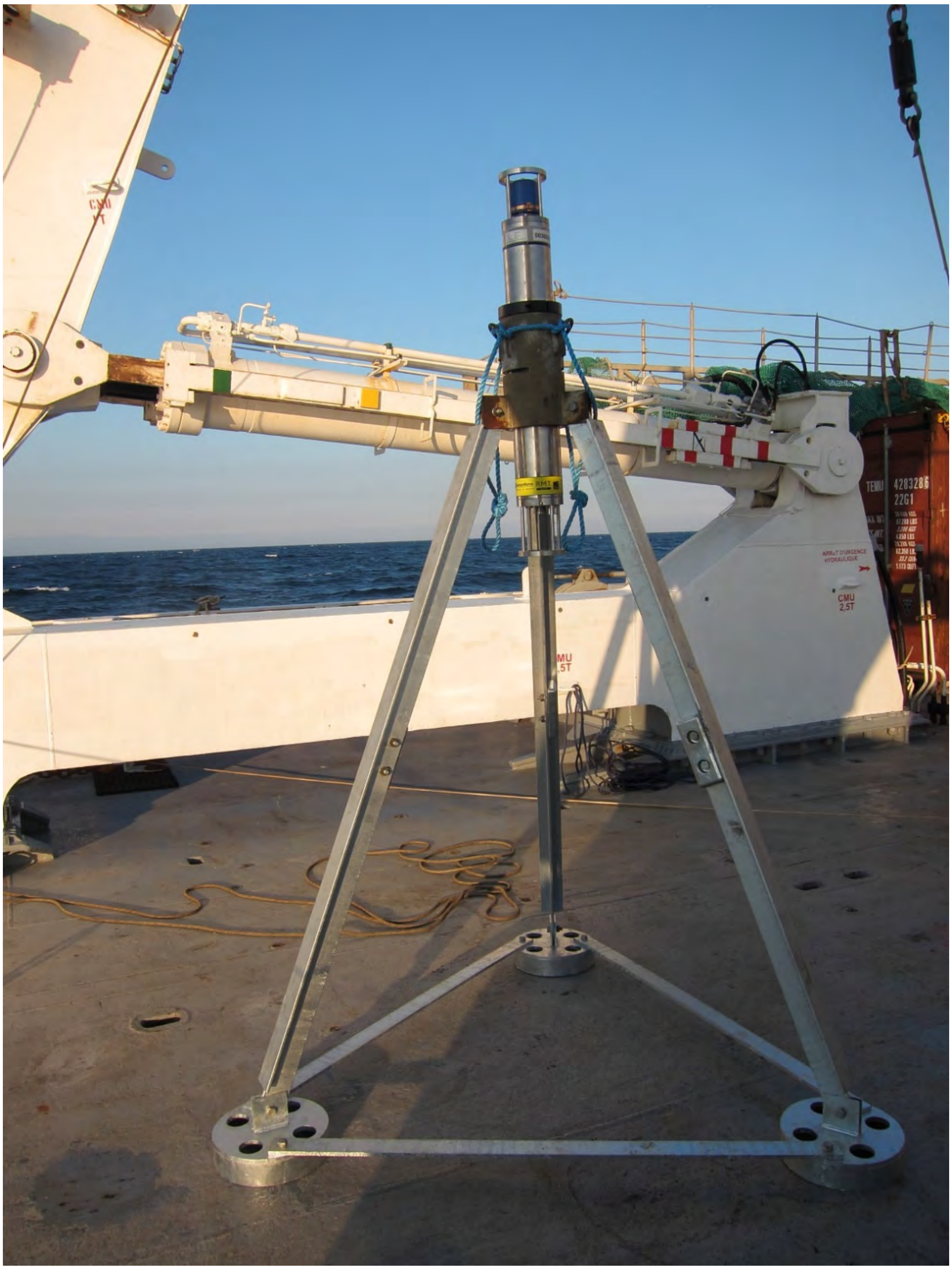


Figure 2 : balise géodésique Sonardyne prête à être déployée.

Remarque : Les pommes de Touline (monkey fist) n'ont pas été installées. Sans information, nous ne savions pas de quelle manière gréer ces objets sur les balises Sonardyne. Le temps était compté et nous n'avions pas non plus de matériel pour gréer la station géodésique dans son ensemble sur la ligne de déploiement. Il a fallu improviser avec le bout à disposition.
Les positions des stations géodésiques après déploiement sont indiquées dans le tableau suivant :

Station	S/N	Date	Heure UTC	Lat.	Long.	Prof.
TP10	0036DB	18/02/2023	19h45	37°29,1769'N	15°21,6048'E	1889m.
TP11	003787	18/02/2023	23h52	37°29,1557'N	15°21,8119'E	1884m.
TP12	003911	19/02/2023	11h38	37°28,9378'N	15°21,7609'E	1891m.
TP13	003793	19/02/2023	16h21	37°28,9941'N	15°21,9902'E	1903m.

TP14	0030B6	19/02/2023	20h53	37°28,7985'N	15°21,8980'E	1892m.

Redéploiement de huit stations géodésiques de marque iXblue

Suite aux dysfonctionnements des balises géodésiques iXblue, ces instruments ont dû être récupérés et réparés. Le logiciel a été mis à jour ainsi qu'une partie de l'électronique. Les détails du gréement et de la préparation de ces stations géodésiques (voir figure 3) sont disponibles dans le rapport de la mission FOCUS X1. Comme pour les balises Sonardyne, avant de lancer la commande de largage, nous vérifiions l'inclinaison de la balise et la communication avec les autres instruments précédemment déployés. Les détails des résultats de mesure sont reportés dans les fiches manuscrites de déploiement.

Figure 3 : Stations géodésiques iXblue prêtes à être déployées

Remarque : cette année, nous n'avons pas rajouté de sac de lest (25kg) et tout s'est très bien passé. Les détails des opérations sont compilés dans les fiches de déploiements manuscrites (/data/fiches manuscrites). La vitesse de filage a été augmentée à 0,4 m.s^{-1} sans aucun problème.

Les positions des stations géodésiques après déploiement sont indiquées dans le tableau suivant :

Station	S/N	Date	Heure UTC	Lat.	Long.	Prof.
TP1	1906-001	22/02/2023	18h21	37°29,4268'N	15°21,3908'E	1850m.
TP2	1906-002	22/02/2023	22h47	37°29,6288'N	15°20,9135'E	1834m.
TP3	1906-003	22/02/2023	05h34	37°29,1902'N	15°21,7996'E	1879m.
TP4	1906-004	23/02/2023	14h52	37°29,3756'N	15°21,2094'E	1857m.
TP5	1906-005	23/02/2023	20h05	37°29,5720'N	15°21,1973'E	1839m.
TP6	1906-006	24/02/2023	07h31	37°29,1984'N	15°21,3910'E	1859m.
TP7	1906-007	24/02/2023	12h18	37°29,8843'N	15°20,9276'E	1778m.
TP8	1906-008	24/02/2023	16h55	37°28,9403'N	15°21,7455'E	1888m.

Récupération et redéploiement de cinq sismomètres fond de mer large bande

Récupération :
Les cinq sismomètres fond de mer large bande de marque K.U.M. ont tous été récupérés. La vitesse de remontée moyenne est de 1 $m.s^{-1}$. Il est à noter qu'une seule des cinq balises radio n'a pas émis de signal. Les tests sur paillasse n'ont pas montré de dysfonctionnement majeur. Sans doute s'agissait-il d'un état d'usure prématuré des piles. Sans instrument de remplacement, décision a été prise de réutiliser cette balise.
Les données ont toutes été extraites et archivées sur trois disque dur distinct. Les données sur les cartes mémoires seront conservées jusqu'au prochain déploiement des OBS large bande.
Redéploiement :
Lors de la reprogrammation des sismomètres fond de mer, nous avons perdu l'accès à l'interface web pour deux enregistreurs numériques (S/N 61607222 et 61607223). La version du firmware de ces appareils via l'interface série (1.3.2 du 15 Janvier 2019) est différente de celles des enregistreurs numériques qui fonctionnent bien en Wifi (1.3.9 du 21 mars 2020). Ce qui est encore plus surprenant c'est que cette différence n'avait pas été noté lors du précédent déploiement (connexion Wifi pour tous les instruments). Tous les sismomètres indiquaient une version du firmware 1.3.9… Affaire à suivre… Il est à noter que ces deux versions du firmware dépendent également de la source d'information (connexion série ou Wifi). Les scans des feuilles de déploiement des OBS sont dans le dossier \data\fiches manuscrites.
Les positions de redéploiement des sismomètres fond de mer sont répertoriées ci-dessous :

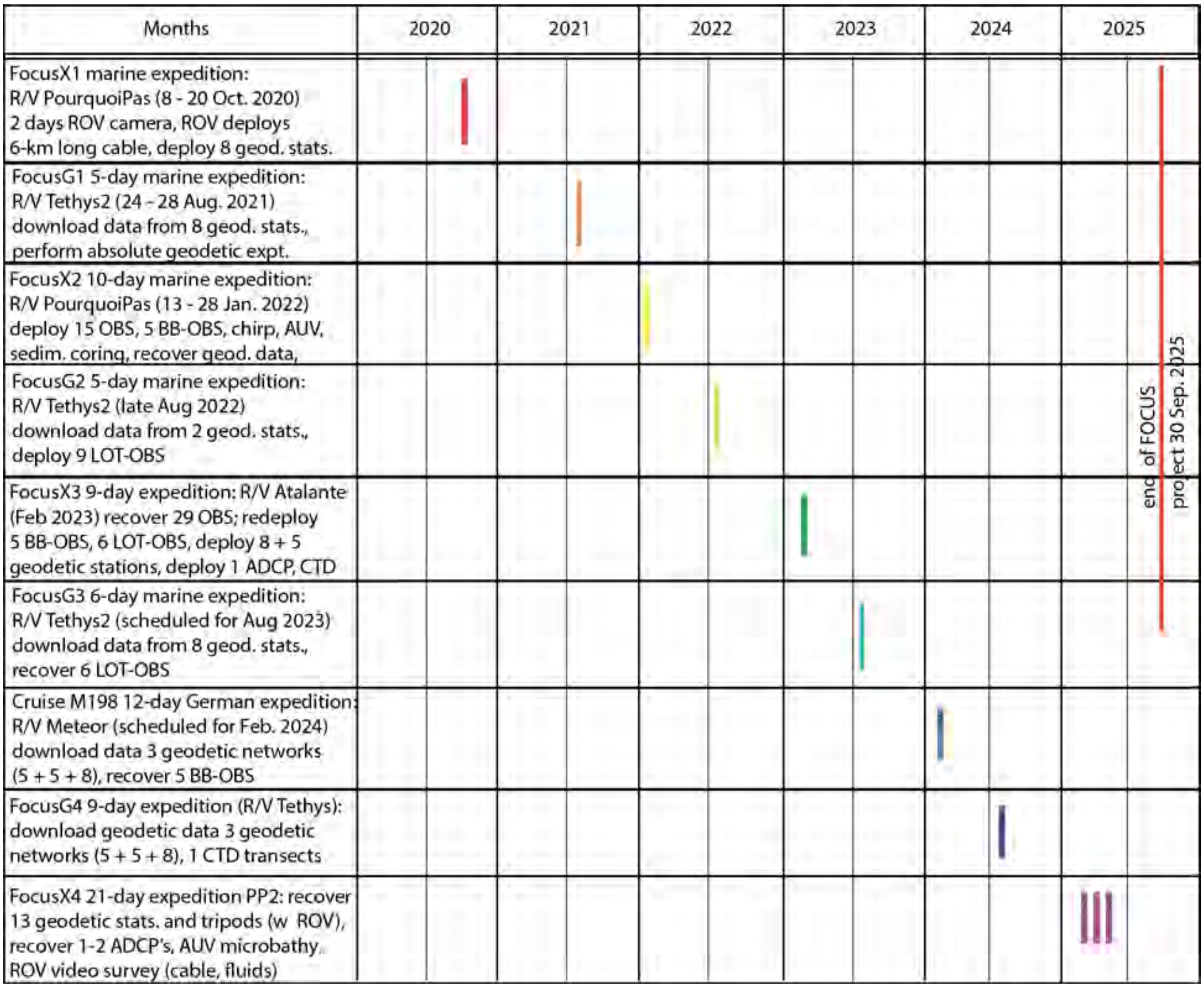
Site	S/N	Date	Heure UTC	Lat.	Long.	Prof.
OBS15-b	BB#3	25/02/2023	09h30	37°30,4654'N	15°53,2518'E	2099m.
OBS10-b	BB#2	25/02/2023	04h14	37°44,2141'N	15°29,4021'E	1525m.
OBS03-b	BB#4	23/02/2023	11h30	37°28,5886'N	15°20,3449'E	1771m.
OBS26-b	BB#1	22/02/2023	11h05	37°09,0831'N	15°34,1680'E	2190m.
OBS17-b	BB#5	21/02/2023	11h02	37°30,9833'N	15°31,1848'E	1951m.

Attention : Prévoir un adaptateur pour communication série pour le calcul de dérive des OBS à la récupération en 2024. Sinon cela sera impossible à déterminer correctement par la suite.
Tous les déploiements (voir figure 4) des OBS NAMMU (30 kg dans l'eau) ont été effectué par filage jusqu'à 50 mètres du fond à la vitesse de 0,4 $m.s^{-1}$. Le largage a été effectué après relevé de la position BUC.

Figure 4 : déploiement d'un OBS large bande NAMMU. Le treuil hydro est équipé d’un largueur BUC. La position du point de déploiement est celle relevée au point de largage à 50 mètres du fond.

Remarque : un drapeau K.U.M. comme sur l’image ci-dessus a été cassé. Il a été remplacé par un drapeau de l’équipe OBS de l’IFREMER. Nous les en remercions.
Autre remarque : la Dirc box était resté sans alimentation et la batterie s’est déchargée. Nous avons alors perdu le signal GPS et la LED ne s’allumait plus. Tout est rentré dans l’ordre en éteignant le GPS et en le laissant se recharger tranquillement pendant une nuit.

Series of marine expeditions:



Timetable indicating the sequence of marine expeditions planned for the duration of the FOCUS ERC project, beginning with the 10-day FocusX1 expedition in October 2020, with the main operations to be performed.

Partnerships, national and international research framework:

The FocusX1, FocusX2 and FocusX3 expeditions are the operational and experimental portion of the **ERC Advanced Grant project FOCUS (funded for 3.5 million € which began on 1 Oct. 2018)**, with numerous national and international partners. National (French) partners include: Ifremer Geo-Ocean (formerly GM - Géosciences Marines) and RDT (Laboratoire Recherche et Développement Technologique); IDIL (small to medium sized private company in fiber optics in Lannion). **International partners include: Geomar, Helmholtz Centre for Ocean Research, Kiel, Germany; Univ. Kiel, Germany; INGV, Italy; Univ. Catania, Italy, INFN-LNS (Physics Institute), Catania, Italy.**

The **INGV, Italy** is responsible for seismological and volcanological monitoring and early warning in Italy. They are also one of the leading Italian institutes in earth science research. They operate, together with the partners **INGV Catania** (seismology partner Luciano Scarfi) the network of permanent seismic stations in Italy and in the Sicily – Calabria area. **INGV Rome** (Lucia Margheriti and Milena Moretti) are in charge of the deployment of temporary seismic stations on land during the passive seismological experiment. They already collaborated with Brest (Univ. Brest - CNRS lab and Ifremer) and Geomar during the Dionysus wide-angle seismology experiment (Dellong et al., 2018; Dannowski et al., 2019) PI - Heidrun Kopp Geomar, Meteor Expedition M111 in Nov. 2014. Cooperations between the German and French seafloor geodetic networks are planned with **INGV Catania** (Mimmo Palano) as well as **Univ. Catania** (Giorgio DeGuidi), who have already conducted on land GPS studies of the SE flank faults of Mt. Etna (De Guidi et al., 2018).

Geomar Helmholtz Research Centre, Kiel, Germany has a long history of close collaboration with PI Gutscher (see Dionysus survey mentioned above) provided 15 OBS for the passive seismological experiment as well as coordinate data acquisition and interpretation from their 6-station seafloor geodetic network as described in the introduction above.

Most of the other international partners (**Geomar, Kiel; Univ. Catania**) have previously conducted research with PI Gutscher on the seismicity, tectonics, crustal structure and deformation in the Ionian Sea - East Sicily / Calabria region (see list of recent marine expeditions and reference list). The ERC project (FOCUS), the marine expedition FocusX1 and this ship time proposal (FocusX2) are the product of many years of scientific cooperation.

The **Italian Physics Institute (INFN-LNS)**, operator of the cable infrastructure in Sicily (Catania and Capo Passero) have been collaborating since 2017 with PI Gutscher and IDIL to perform preliminary experiments. They were closely involved in the FocusX1 expedition (April 2020) and provided logistical and operational support during the expedition and in particular the operations of cable deployment and cable connection. Since late 2022 they are a fourth official funded partner of the FOCUS ERC project.

A private company, **IDIL fiber optics, Lannion is a partner of the ERC project FOCUS** and conducted preliminary experiments on the INFN-LNS cable infrastructure together with PI Gutscher (in the framework of a Brittany Region funded BoostERC project - pre-FOCUS in 2017). **L Quetel** is in charge of the laser reflectometry measurements to be performed over several years on the EMSO Catania cable and the 6-km long extension (dedicated fiber optic strain cable).

GFZ Potsdam is a pioneer in the field of DAS (distributed acoustic sensing) for seismic studies. Philippe Jousset is the leader of this effort and has obtained funding and purchased two DAS laser reflectometry interrogators (from the company Silixa). He has worked on Iceland demonstrating the application of DAS for land-based seismology (Jousset et al., 2018) and for 2 years has begun DAS work in Catania Sicily, both on land (on Mount Etna) and offshore on the submarine fiber-optic cable run by INFN-LNS. The FOCUS team is in close contact with Jousset and project members (Gutscher, Quetel and Murphy) have assisted several of his experiments on Etna and the submarine cable. He performed a first DAS acquisition during the cable deployment operations of the FocusX1 expedition and a second DAS acquisition during the sandbag drop operations in Sept. 2021 (Gutscher et al., EPSL in press).

Summary / Outlook:

The ultimate goal of the ERC project FOCUS is the demonstration of BOTDR laser reflectometry, combined with seafloor geodetic measurements, to observe and quantify slip on the seafloor along the active North Alfeo fault. However, given the slow and probably sporadic movements along the studied fault, acquisition of a long time series (~3 years) will be necessary before significant results can be obtained. The fiber-optic and acoustic geodetic observations (begun in October 2020) will now be supplemented by other geophysical (seismic recordings and imaging), sedimentological (rheology, fluid geochemistry) and oceanographic (salinity, temperature and current meter) observations. Only by combining these complementary types of data can we learn about the long-term behavior of faults and the different expressions of strain, e.g. seismic or aseismic (slow slip / creeping). If successful, the work performed during the FocusX1, FocusX2 and FocusX3 expeditions will contribute to improving the natural hazard assessment related to a newly mapped active fault, 20 km east of a major urban center of 1 million people (Catania).

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Outreach, Press

Prior to, during and following the FocusX3 expedition a concerted effort made to provide information on the cruise itself, as well as information about the Focus project to the media and to the general public. Before the cruise, in early February 2023 a Press Communique was drafted and published/transmitted by the CNRS. This led to two radio interviews (with Swiss Radio and with Radio France Info). Two journalists embarked for the first four days of the cruise : Vincent Bordenave (journalist from Le Figaro) and Sonia Collavizza (camera-woman from CNRS Images). This led to a full page article published in Le Figaro on 24 Feb. 2023 and to a 7-min documentary film (published online simultaneously by CNRS Le Journal, Le Monde.fr and on YouTube on 6 April 2023). The references and links to these media contributions are listed below:

Radio Télévision Suisse, émission CQFD, 13 Fév. 2023
Interview sur la campagne océanographique FocusX3 : La faille sous-marine de l'Etna (10:05-10:15) *(producteur Stéphane Déletroz)*
https://pages.rts.ch/la-1ere/programmes/cqfd/13-02-2023

Radio France Info, émission Le billet Sciences, 17 Fév. 2023
Séismes : une étude lancée pour mieux connaître la faille au large de la Sicile (anim. Anne LeGall)
https://www.francetvinfo.fr/replay-radio/le-billet-vert/seismes-une-etude-lancee-pour-mieux-connaitre-la-faille-au-large-de-la-sicile_5636960.html

Le Figaro 24 Fev. 2023 p. 18
A bord de l'Atalante pour traquer les séismes en Méditerranée (journaliste Vincent Bordenave)
https://www.lefigaro.fr/sciences/a-bord-de-l-atalante-pour-traquer-les-seismes-en-mediterranee-20230223

Film documentaire de 7-min diffusé le 6 Avril 2023
Au large de la Sicile, une faille sous haute surveillance (journaliste Sonia Collavizza)
CNRS Le Journal : https://lejournal.cnrs.fr/videos/au-large-de-la-sicile-une-faille-sous-haute-surveillance
Le Monde : https://www.lemonde.fr/sciences/video/2023/04/07/une-faille-sous-haute-surveillance-au-large-de-la-sicile_6168654_1650684.html
Youtube : https://www.youtube.com/watch?v=K_x9vdLuzrw

Finally, a 14 page daily diary or on-board journal, was prepared by Walter Roest (Ifremer) in collaboration with Matthieu Ravaud (chief editor of CNRS Le Journal and Carnets de Science). A printed version will soon be published and sold in book shops across France. It is illustrated with photos taken onboard and with hand drawn sketches and water-colors (by artist/scientist Walter Roest).

Table of participants (shipboard party)

Family name	First name	M / F	DISCIPLINE[(2)]	Employer / Legs (1, 2)
GUTSCHER	Marc-André	M	geophysics	CNRS / 1,2
MURPHY	Shane	M	geophysics	Ifremer / 1,2
GRAINDORGE	David	M	geophysics	Univ. Brest / 1,2
POITOU	Charles	M	instrumentation	CNRS / 1,2
PRUNIER	Christophe	M	instrumentation	Univ. Brest / 1,2
LENHOF	Edgar	M	geophysics	Univ. Brest / 1,2
PADRON	Crelia	F	geophysics	CNRS / 1,2
CAPPELLI	Giuseppe	M	geophysics	IDIL, Univ. Brest / 1,2
ROEST	Walter	M	geophysics	Ifremer / 1,2
PELLEAU	Pascal	M	instrumentation	Ifremer / 1,2
GUYAVARCH	Pierre	M	instrumentation	Ifremer / 1,2
GAMBINO	Salvatore	M	geology	Univ. Catania / 1,2
PONTE	Michela	F	geophysics	Univ. Calabria / 1,2
KLEIN	Johanna	F	geophysics	Geomar, Kiel / 1,2
BERNDT	Janine	F	instrumentation	Geomar, Kiel / 1,2
SCHWARZ	Ralf	M	oceanography	Geomar, Kiel / 1
BUSSE	Marc	M	oceanography	Geomar, Kiel / 1
MURPHY	Darren	M	instrumentation	Sonardyne / 1
COLLAVIZZA	Sonia	F	journalist	CNRS Images / 1
BORDENAVE	Vincent	M	journalist	Le Figaro / 1
JAMIESON	Gregor	M	instrumentation	iXblue/exail / 2
OHAPALTO	Taru	F	instrumentation	iXblue/exail / 2

Extract from vessel's electronic logbook – Casino (times and exact coordinates of all operations)

Date	Heure	Latitude	Longitude	Sonde (m)	Nom Phase	Type De Phase	Nom Appareil	Nom Action	Observation
17/02/2023	15:39:02	N 37° 29,73065'	E 15° 5,7536'		PROFIL 1	PROFIL			
17/02/2023	17:54:59	N 37° 29,42719'	E 15° 14,86491'	1147	OBS1	STATION			Recovery
17/02/2023	18:40:28	N 37° 29,17118'	E 15° 15,12064'				OBS	En surface	OBS 1
17/02/2023	18:51:02	N 37° 29,03597'	E 15° 15,12254'				OBS	A bord	
17/02/2023	18:53:34	N 37° 28,98485'	E 15° 15,10202'	1208	PROFIL 2	PROFIL			
17/02/2023	19:40:25	N 37° 25,33387'	E 15° 17,25779'	1331	OBS2	STATION			Recovery
17/02/2023	19:42:35	N 37° 25,32213'	E 15° 17,28296'	1334			OBS	En surface	OBS 25
17/02/2023	20:01:06	N 37° 25,40623'	E 15° 17,37807'	1339			OBS	A bord	
17/02/2023	20:01:27	N 37° 25,40539'	E 15° 17,37971'	1338	PROFIL 3	PROFIL			
17/02/2023	21:19:10	N 37° 25,27541'	E 15° 24,50042'	2072	OBS4	STATION			Recovery
17/02/2023	21:19:52	N 37° 25,28255'	E 15° 24,49494'	2072			OBS	En surface	OBS 4
17/02/2023	21:30:32	N 37° 25,20523'	E 15° 24,43353'	2072			OBS	A bord	
17/02/2023	21:31:20	N 37° 25,19222'	E 15° 24,43498'	2072	PROFIL 4	PROFIL			
17/02/2023	22:33:10	N 37° 27,68898'	E 15° 26,78125'	2012	OBS5	STATION			Recovery
17/02/2023	22:40:47	N 37° 27,75786'	E 15° 26,79419'				OBS	En surface	OBS 5
17/02/2023	22:52:26	N 37° 27,85915'	E 15° 26,8679'	2011			OBS	A bord	
17/02/2023	22:53:22	N 37° 27,84018'	E 15° 26,86736'	2011	PROFIL 5	PROFIL			
18/02/2023	00:09:09	N 37° 30,52625'	E 15° 31,10942'	1945	OBS17	STATION			Recovery
18/02/2023	00:12:41	N 37° 30,5584'	E 15° 31,18288'	1945			OBS	En surface	OBS 17
18/02/2023	01:43:55	N 37° 30,11246'	E 15° 30,23524'	1937			OBS	A bord	
18/02/2023	01:44:10	N 37° 30,10825'	E 15° 30,23192'	1937	PROFIL 6	PROFIL			
18/02/2023	03:04:47	N 37° 32,06667'	E 15° 20,49475'	1799	OBS6	STATION			Recovery
18/02/2023	03:09:19	N 37° 32,17624'	E 15° 20,34031'	1801			OBS	En surface	OBS 6
18/02/2023	03:25:27	N 37° 32,13535'	E 15° 20,39137'	1796			OBS	A bord	
18/02/2023	03:25:41	N 37° 32,13362'	E 15° 20,39455'	1798	PROFIL 7	PROFIL			
18/02/2023	04:12:01	N 37° 34,13651'	E 15° 17,51099'	1034	OBS7	STATION			Recovery
18/02/2023	04:12:27	N 37° 34,13998'	E 15° 17,50932'	1020			OBS	En surface	OBS 7
18/02/2023	04:32:22	N 37° 34,14118'	E 15° 17,28672'	965			OBS	A bord	
18/02/2023	04:33:44	N 37° 34,08918'	E 15° 17,23017'	960	PROFIL 8	PROFIL			
18/02/2023	06:06:59	N 37° 29,10335'	E 15° 21,82379'	1891	ADCP	STATION			Interruption d'operation
18/02/2023	06:38:15	N 37° 28,93065'	E 15° 21,24776'	1846	PROFIL 9	PROFIL			
18/02/2023	07:05:29	N 37° 28,61524'	E 15° 20,47256'	1779	OBS3	STATION			Recovery
18/02/2023	07:33:48	N 37° 28,68847'	E 15° 20,36642'	1781			OBS	En surface	OBS 3
18/02/2023	08:00:54	N 37° 28,78601'	E 15° 20,65901'	1805			OBS	A bord	
18/02/2023	08:15:48	N 37° 28,92867'	E 15° 20,84365'	1823	PROFIL 10	PROFIL			
18/02/2023	08:38:56	N 37° 29,09247'	E 15° 21,80279'	1886	ADCP Second Attempt	STATION			Deployment
18/02/2023	09:42:03	N 37° 29,08617'	E 15° 21,77344'				ADCP	Mise à l'eau	ADCP placed in water

18/02/2023	13:02:07	N 37° 29,11126'	E 15° 21,76349'	1913			ADCP	au Fond	Position 37°N 29,0997 15°E 21,7957 Depth 1913.43m
18/02/2023	15:29:34	N 37° 29,16874'	E 15° 21,6766'	1873			ADCP	Fin d'operation	ADCP10 weight on board
18/02/2023	16:51:33	N 37° 29,15356'	E 15° 21,64555'	1877	GDS10	STATION			Deployment
18/02/2023	16:51:35	N 37° 29,15356'	E 15° 21,64555'	1877			Station Géodésique	Mise à l'eau	Sonardyne GDS10
18/02/2023	19:19:35	N 37° 29,2168'	E 15° 21,61955'	1889			Station Géodésique	au Fond	BUC location: 37N 29,1769 15E 21,6048 Depth: 1889,12
18/02/2023	20:56:40	N 37° 29,17456'	E 15° 21,76306'	1867			Station Géodésique	Fin d'operation	Deadweight back onboard
18/02/2023	21:03:42	N 37° 29,16869'	E 15° 21,78983'	1867	PROFIL 11	PROFIL			
18/02/2023	21:37:00	N 37° 28,93825'	E 15° 21,70954'	1872	GDS11	STATION			Deployment
18/02/2023	21:37:09	N 37° 28,94305'	E 15° 21,71153'	1872			Station Géodésique	Mise à l'eau	Sonardyne GDS11
18/02/2023	23:33:31	N 37° 29,19904'	E 15° 21,80744'				Station Géodésique	au Fond	BUC 37°N 29,1557 15°E 21,8134
19/02/2023	01:38:19	N 37° 29,21651'	E 15° 21,75581'	1866	PROFIL 12	PROFIL			
19/02/2023	03:03:02	N 37° 40,64891'	E 15° 21,44906'	1550	OBS8	STATION			Recovery
19/02/2023	03:27:33	N 37° 40,75984'	E 15° 21,09482'				OBS	En surface	OBS 8
19/02/2023	03:47:02	N 37° 41,10681'	E 15° 21,27664'				OBS	A bord	
19/02/2023	03:47:23	N 37° 41,11078'	E 15° 21,2756'		PROFIL 13	PROFIL			
19/02/2023	04:40:54	N 37° 44,2711'	E 15° 29,03995'		OBS10	STATION			Recovery
19/02/2023	05:10:37	N 37° 44,13319'	E 15° 29,10514'				OBS	En surface	OBS 10
19/02/2023	05:21:47	N 37° 44,16933'	E 15° 29,3194'				OBS	A bord	
19/02/2023	07:10:51	N 37° 43,8653'	E 15° 29,30438'		PROFIL 14	PROFIL			
19/02/2023	08:51:10	N 37° 29,01066'	E 15° 22,11097'		PROFIL 15	PROFIL			
19/02/2023	08:51:35	N 37° 29,00714'	E 15° 22,0995'		GDS12	STATION			Deployment
19/02/2023	09:03:42	N 37° 28,98398'	E 15° 21,96043'				Station Géodésique	Mise à l'eau	Sonardyne GDS 12
19/02/2023	11:14:47	N 37° 28,93494'	E 15° 21,73656'				Station Géodésique	au Fond	BUC 37°N 28,934 15°E 21,7610 1891 m
19/02/2023	13:20:15	N 37° 28,89781'	E 15° 21,8228'	1874	PROFIL 16	PROFIL			
19/02/2023	13:42:01	N 37° 28,9948'	E 15° 21,98009'	1889	GDS13	STATION			Deployment
19/02/2023	13:43:00	N 37° 28,9961'	E 15° 21,98028'	1890			Station Géodésique	Mise à l'eau	Sonardyne GDS 13
19/02/2023	16:01:28	N 37° 29,02462'	E 15° 22,00848'				Station Géodésique	au Fond	BUC 37°N 28,9941 15°E 21,9902 1903 m
19/02/2023	18:08:09	N 37° 29,05184'	E 15° 22,17674'	1910	PROFIL 17	PROFIL			
19/02/2023	18:41:53	N 37° 28,77353'	E 15° 21,89855'	1876	GDS14	STATION			Deployment

19/02/2023	18:42:32	N 37° 28,77189'	E 15° 21,89702'	1879			Station Géodésique	Mise à l'eau	Sonardyne GDS 14
19/02/2023	20:28:02	N 37° 28,81795'	E 15° 21,91985'				Station Géodésique	au Fond	BUC 37°N 28,7795 15°E 21,9054 1891 m
19/02/2023	22:08:03	N 37° 29,28401'	E 15° 22,07566'	1909			Station Géodésique		Dead weight back on board
19/02/2023	22:14:06	N 37° 29,23126'	E 15° 22,06629'	1905			Station Géodésique		Release onboard
19/02/2023	22:16:55	N 37° 29,19962'	E 15° 22,0841'	1908	TRANSIT1	TRANSIT			
19/02/2023	23:26:33	N 37° 19,81487'	E 15° 24,41859'		OBS18	STATION			Recovery
19/02/2023	23:31:00	N 37° 19,81179'	E 15° 24,37088'				OBS	Activate Release	OBS 18
20/02/2023	00:05:31	N 37° 19,8091'	E 15° 24,41355'				OBS	En surface	
20/02/2023	00:21:16	N 37° 19,83972'	E 15° 24,64348'				OBS	A bord	
20/02/2023	00:29:18	N 37° 19,80038'	E 15° 24,6802'		PROFIL 18	PROFIL			
20/02/2023	01:55:23	N 37° 7,65188'	E 15° 24,96109'		OBS27	STATION			Recovery
20/02/2023	01:55:52	N 37° 7,65349'	E 15° 24,96116'				OBS	Activate Release	OBS 27
20/02/2023	02:34:00	N 37° 8,54969'	E 15° 25,605'				OBS	En surface	
20/02/2023	02:43:00	N 37° 8,62377'	E 15° 25,64189'				OBS	A bord	
20/02/2023	02:43:17	N 37° 8,62314'	E 15° 25,64287'		PROFIL 19	PROFIL			
20/02/2023	03:43:11	N 37° 8,77492'	E 15° 34,03496'	2190	OBS26	STATION			Recovery
20/02/2023	04:19:45	N 37° 8,92747'	E 15° 33,96745'				OBS	En surface	OBS BB26
20/02/2023	04:30:10	N 37° 9,06959'	E 15° 34,15363'				OBS	A bord	
20/02/2023	04:36:26	N 37° 9,33117'	E 15° 34,40792'		PROFIL 20	PROFIL			
20/02/2023	04:38:41	N 37° 9,57113'	E 15° 34,60413'		PROFIL 21	PROFIL			
20/02/2023	04:38:44	N 37° 9,57113'	E 15° 34,60413'						Phase changed to PROFILE at 04:38:41
20/02/2023	05:18:54	N 37° 15,19415'	E 15° 39,56595'	2241					OBS20 released 5 miles before the position
20/02/2023	06:56:53	N 37° 19,27079'	E 15° 43,35283'		OBS20	STATION			Recovery
20/02/2023	06:56:53	N 37° 19,27079'	E 15° 43,35283'				OBS	En surface	OBS LT20
20/02/2023	07:10:15	N 37° 19,39616'	E 15° 43,29481'				OBS	A bord	
20/02/2023	07:10:39	N 37° 19,39194'	E 15° 43,30039'		PROFIL 22	PROFIL			
20/02/2023	07:22:24	N 37° 19,40692'	E 15° 43,38346'		Test	STATION			
20/02/2023	07:29:04	N 37° 19,44696'	E 15° 43,30582'	2235					début test étanchéité bouteille GEOMAR
20/02/2023	08:21:15	N 37° 19,88241'	E 15° 43,07944'	2194					début test étanchéité bouteille GEOMAR
20/02/2023	08:29:03	N 37° 20,10662'	E 15° 42,85978'	2177	PROFIL 23	PROFIL			
20/02/2023	10:30:49	N 37° 28,72967'	E 15° 21,85801'	1873	STATION GDS Test Communication	STATION			
20/02/2023	10:31:44	N 37° 28,74119'	E 15° 21,84926'				Station Géodésique	Incident	Start baseline test

20/02/2023	11:32:24	N 37° 28,7489'	E 15° 21,28208'	1833	PROFIL 24	PROFIL			
20/02/2023	15:07:59	N 37° 28,83835'	E 15° 8,18498'	72	PROFIL 25	PROFIL			
20/02/2023	18:04:58	N 37° 43,36103'	E 15° 40,9585'	1628	OBS 11	STATION			Recovery
20/02/2023	18:32:52	N 37° 43,58665'	E 15° 41,08148'				OBS	En surface	OBS11
20/02/2023	18:50:07	N 37° 43,59179'	E 15° 40,94735'				OBS	A bord	
20/02/2023	18:53:35	N 37° 43,52096'	E 15° 40,98853'		PROFIL 26	PROFIL			
20/02/2023	19:50:55	N 37° 43,01409'	E 15° 52,24787'		OBS12	STATION			Recovery
20/02/2023	20:00:14	N 37° 43,02427'	E 15° 52,4375'				OBS	Activate Release	OBS 12
20/02/2023	20:29:49	N 37° 43,09257'	E 15° 52,2732'				OBS	En surface	
20/02/2023	20:56:15	N 37° 43,4738'	E 15° 52,09228'				OBS	A bord	
20/02/2023	21:05:37	N 37° 43,43275'	E 15° 52,48018'	1635	PROFIL 27	PROFIL			
20/02/2023	22:10:53	N 37° 43,23485'	E 16° 3,12306'	1667	OBS13	STATION			Recovery
20/02/2023	22:15:16	N 37° 43,19697'	E 16° 3,13593'				OBS	Activate Release	OBS 13
20/02/2023	22:47:25	N 37° 43,205'	E 16° 3,12725'				OBS	En surface	
20/02/2023	23:12:06	N 37° 43,00353'	E 16° 3,10862'				OBS	A bord	
20/02/2023	23:12:17	N 37° 43,00332'	E 16° 3,10667'		PROFIL 28	PROFIL			
21/02/2023	00:33:43	N 37° 31,66604'	E 16° 3,83645'		OBS14	STATION			Recovery
21/02/2023	00:43:00	N 37° 31,54738'	E 16° 3,82112'				OBS	Activate Release	OBS 14
21/02/2023	01:29:17	N 37° 31,17117'	E 16° 3,65686'				OBS	En surface	
21/02/2023	01:43:41	N 37° 31,27502'	E 16° 3,53188'	1987			OBS	A bord	
21/02/2023	01:51:31	N 37° 31,28512'	E 16° 3,211'	1999	PROFIL 29	PROFIL			
21/02/2023	03:31:03	N 37° 31,10834'	E 15° 42,80875'	2085	OBS16	STATION			Recovery
21/02/2023	04:19:34	N 37° 31,16915'	E 15° 42,46706'				OBS	En surface	OBS 16
21/02/2023	04:39:56	N 37° 31,19815'	E 15° 42,84985'				OBS	A bord	
21/02/2023	04:45:17	N 37° 31,2657'	E 15° 43,05641'		PROFIL 30	PROFIL			
21/02/2023	05:02:19	N 37° 31,01275'	E 15° 46,97109'		OBS15	STATION	OBS		Recovery
21/02/2023	06:32:46	N 37° 30,44234'	E 15° 53,72035'	2127			OBS	En surface	OBS 15
21/02/2023	06:42:04	N 37° 30,40078'	E 15° 53,37431'	2104			OBS	A bord	
21/02/2023	06:43:42	N 37° 30,39421'	E 15° 53,37351'	2104	PROFIL 31	PROFIL			
21/02/2023	08:32:08	N 37° 30,9442'	E 15° 31,09054'	1946	OBS BB 17B	STATION			Deployment
21/02/2023	08:58:39	N 37° 30,97988'	E 15° 31,15558'	1952			OBS	Mise à l'eau	OBS BB 17B
21/02/2023	11:00:28	N 37° 30,99778'	E 15° 31,19929'				OBS	Au fond	BUC 37°N 30,9830 15°E 31,1844 depth BUC 1852 (50m above seafloor)
21/02/2023	12:15:48	N 37° 30,94388'	E 15° 31,29287'	1961	PROFIL 32	PROFIL			
21/02/2023	14:49:08	N 37° 20,42792'	E 15° 54,70322'		OBS21	STATION			Recovery
21/02/2023	14:59:50	N 37° 20,43651'	E 15° 54,61956'				OBS	Activate Release	OBS 21
21/02/2023	15:30:00	N 37° 19,95396'	E 15° 54,16121'				OBS	En surface	
21/02/2023	15:47:53	N 37° 20,06176'	E 15° 54,48352'				OBS	A bord	
21/02/2023	15:53:40	N 37° 20,16065'	E 15° 54,48076'		PROFIL 33	PROFIL			
21/02/2023	16:51:16	N 37° 20,24855'	E 16° 3,65471'	2440	OBS22	STATION			Recovery
21/02/2023	17:15:08	N 37° 20,24225'	E 16° 3,75973'	2489			OBS	En surface	OBS 22

21/02/2023	17:33:38	N 37° 19,9789'	E 16° 3,99518'	0			OBS	A bord	
21/02/2023	17:38:39	N 37° 19,7041'	E 16° 4,00995'	2453	PROFIL 34	PROFIL			
21/02/2023	18:48:59	N 37° 10,10853'	E 16° 4,73141'	0	OBS23	STATION			Recovery
21/02/2023	18:59:09	N 37° 9,57064'	E 16° 4,59585'	2260			OBS	En surface	OBS 23
21/02/2023	19:16:05	N 37° 9,36194'	E 16° 4,2109'	2441			OBS	A bord	
21/02/2023	19:16:57	N 37° 9,36572'	E 16° 4,21879'	2434	PROFIL 35	PROFIL			
21/02/2023	20:38:13	N 37° 3,99157'	E 16° 4,95692'	2466	OBS30	STATION			Recovery
21/02/2023	20:39:09	N 37° 4,00337'	E 16° 4,96602'	2481			OBS	Activate Release	OBS 30
21/02/2023	21:26:38	N 37° 4,02472'	E 16° 4,65313'	2446			OBS	En surface	
21/02/2023	21:48:44	N 37° 3,75954'	E 16° 4,53663'	2451			OBS	A bord	
21/02/2023	21:59:14	N 37° 3,68063'	E 16° 4,5661'	2576	PROFIL 36	PROFIL			
21/02/2023	23:03:06	N 37° 1,32519'	E 15° 56,34661'	2487	OBS29	STATION			Recovery
21/02/2023	23:03:36	N 37° 1,32392'	E 15° 56,34077'	0			OBS	En surface	OBS 29
21/02/2023	23:22:37	N 37° 1,51859'	E 15° 55,80425'	2525			OBS	A bord	
21/02/2023	23:46:00	N 37° 1,2771'	E 15° 55,82684'	2380	OBS29B	STATION	OBS		Deployment
21/02/2023	23:46:00	N 37° 1,2771'	E 15° 55,82684'	2380			OBS	Mise à l'eau	OBS 29B
21/02/2023	23:50:34	N 37° 1,26035'	E 15° 55,69555'	2328	PROFIL 37	PROFIL			
22/02/2023	01:31:28	N 36° 58,14067'	E 15° 45,79138'	2433	OBS28	STATION			Recovery
22/02/2023	01:37:18	N 36° 58,17949'	E 15° 45,72311'				OBS	Activate Release	OBS 28
22/02/2023	02:12:36	N 36° 58,15696'	E 15° 45,68659'				OBS	En surface	
22/02/2023	02:53:50	N 36° 58,08212'	E 15° 45,26682'				OBS	A bord	
22/02/2023	02:53:50	N 36° 58,08212'	E 15° 45,26682'						
22/02/2023	04:24:46	N 37° 9,49125'	E 15° 55,81871'	2368	OBS24	STATION			Recovery
22/02/2023	05:13:01	N 37° 9,41678'	E 15° 55,30765'				OBS	En surface	OBS 24
22/02/2023	05:27:17	N 37° 9,23361'	E 15° 54,9674'				OBS	A bord	
22/02/2023	05:32:52	N 37° 9,28259'	E 15° 54,6607'		PROFIL 38	PROFIL			
22/02/2023	06:21:59	N 37° 9,13321'	E 15° 43,88576'		OBS25	STATION			Recovery
22/02/2023	07:05:44	N 37° 9,03503'	E 15° 44,11013'				OBS	En surface	OBS 25
22/02/2023	07:24:30	N 37° 9,296'	E 15° 44,13197'				OBS	A bord	
22/02/2023	07:28:04	N 37° 9,30623'	E 15° 44,00568'	2382	PROFIL 39	PROFIL			
22/02/2023	08:27:43	N 37° 9,08062'	E 15° 34,15541'	2194	OBS BB 26B	STATION			Deployment
22/02/2023	09:00:57	N 37° 8,98355'	E 15° 34,22268'	2190			OBS	Mise à l'eau	OBS BB 26B
22/02/2023	11:05:03	N 37° 9,08599'	E 15° 34,13419'				OBS	Au fond	BUC 37°N 09,0832 15°E 34,1694 Depth of largage: 2083
22/02/2023	11:54:49	N 37° 9,09348'	E 15° 34,14209'	2195	PROFIL 40	PROFIL			
22/02/2023	13:09:19	N 37° 20,04563'	E 15° 32,17153'	2161	OBS19	STATION			Recovery
22/02/2023	13:10:00	N 37° 20,04336'	E 15° 32,17724'				OBS	Activate Release	OBS 19
22/02/2023	13:40:20	N 37° 20,21245'	E 15° 32,22969'				OBS	En surface	
22/02/2023	14:00:45	N 37° 20,12593'	E 15° 32,49215'				OBS	A bord	
22/02/2023	14:30:25	N 37° 23,44937'	E 15° 28,45832'	2144	PROFIL 41	PROFIL			
22/02/2023	15:51:38	N 37° 29,60345'	E 15° 21,17785'	1813	Canopus tripod 1	STATION			Deployment

22/02/2023	15:53:41	N 37° 29,58688'	E 15° 21,20467'	1817			Station Géodésique	Mise à l'eau	CANOPUS 1
22/02/2023	18:21:36	N 37° 29,41627'	E 15° 21,43574'				Station Géodésique	au Fond	BUC 37°N 29,4268 15°E 21,3908 1850 m
22/02/2023	19:51:25	N 37° 29,31446'	E 15° 21,28883'	1851			Station Géodésique	Incident	Deadweight back onboard
22/02/2023	20:00:09	N 37° 29,3179'	E 15° 21,28501'	1850			Station Géodésique	Incident	Realeaser on board
22/02/2023	20:03:01	N 37° 29,32012'	E 15° 21,30329'	1851	PROFIL 42	PROFIL			
22/02/2023	20:29:07	N 37° 29,68251'	E 15° 20,68702'	1809	Canopus tripod 2	STATION			Deployment
22/02/2023	20:29:18	N 37° 29,68251'	E 15° 20,68702'	1809			Station Géodésique	Mise à l'eau	CANOPUS 2
22/02/2023	20:39:28	N 37° 29,65173'	E 15° 20,81218'	1805			Station Géodésique	Incident	Deadweight in water
22/02/2023	21:01:02	N 37° 29,62123'	E 15° 20,95063'	1814			Station Géodésique	Incident	Stop cable at 300m for hydrophone test with geodetic station
22/02/2023	21:35:58	N 37° 29,62127'	E 15° 20,95075'	1814			Station Géodésique	Mise à l'eau	Finished testing connection with station; restarting deploying. Back winch used due to side winch not working
22/02/2023	22:47:47	N 37° 29,62454'	E 15° 20,96846'				Station Géodésique	au Fond	BUC 37°N 29.6280 E 15°E 20.9131 Depth : 1834 m
22/02/2023	22:54:52	N 37° 29,62498'	E 15° 20,96507'				Station Géodésique	Incident	Hydrophone placed in water to test geodetic stations
23/02/2023	00:30:55	N 37° 29,45747'	E 15° 21,10297'		PROFIL 43	PROFIL			
23/02/2023	01:03:32	N 37° 29,19728'	E 15° 21,9328'		Canopus tripod 3	STATION			
23/02/2023	01:07:13	N 37° 29,19939'	E 15° 21,79195'				Station Géodésique	Mise à l'eau	
23/02/2023	02:03:30	N 37° 29,17425'	E 15° 21,67174'						Archivage suspendu: pas de navigation.
23/02/2023	02:10:32	N 37° 29,15933'	E 15° 21,63326'				Station Géodésique	Incident	Probleme de systeme de navigation: operations en attente reparation Cinna
23/02/2023	04:02:00	N 37° 29,18826'	E 15° 21,80114'						Archivage suspendu: pas de navigation.
23/02/2023	04:53:30	N 37° 29,18186'	E 15° 21,84442'						Archivage suspendu: pas de navigation.

23/02/2023	05:34:11	N 37° 29,1798'	E 15° 21,85204'				Station Géodésique	au Fond	CANOPUS3
23/02/2023	07:39:03	N 37° 28,81322'	E 15° 21,04912'				Station Géodésique	à bord	Deadweight onboard
23/02/2023	07:48:03	N 37° 28,71016'	E 15° 20,90666'				Station Géodésique	à bord	Releaser onboard
23/02/2023	07:49:06	N 37° 28,69713'	E 15° 20,88563'		PROFIL 44	PROFIL			
23/02/2023	08:40:20	N 37° 28,52729'	E 15° 20,31524'	1770	OBS BB 3B	STATION			Deployment
23/02/2023	08:45:43	N 37° 28,52496'	E 15° 20,3328'				OBS	Mise à l'eau	OBS BB 3B
23/02/2023	10:28:53	N 37° 28,57136'	E 15° 20,35863'				OBS	Au fond	BUC 37°N 25.5640 15°E 20.3388 Depth 1771 m (at start of deployment; EK80 turned off due to interference with BUC)
23/02/2023	11:10:13	N 37° 28,77373'	E 15° 20,34001'	1789	PROFIL 45	PROFIL			
23/02/2023	11:45:38	N 37° 29,39609'	E 15° 20,9426'	1833	Canopus tripod 4	STATION			Deployment
23/02/2023	11:46:16	N 37° 29,39717'	E 15° 20,94893'	1833			Station Géodésique	Mise à l'eau	CANOPUS 4
23/02/2023	15:14:48	N 37° 29,37317'	E 15° 21,27479'				Station Géodésique	au Fond	BUC 37°N 29.3760 15°E 21.2046
23/02/2023	15:20:00	N 37° 29,37202'	E 15° 21,27475'				Station Géodésique		Archivage suspendu: pas de navigation.
Absence de Navigation Probleme CINNA Pas d'Archivage									
23/02/2023	18:09:10	N 37° 29,61844'	E 15° 20,97638'		Canopus tripod 5	STATION	Station Géodésique	Mise à l'eau	CANOPUS 5
23/02/2023	20:05:46	N 37° 29,55172'	E 15° 21,26642'				Station Géodésique	au Fond	BUC 37°N 29.5720 15°E 21.1972 Depth 1814 m
23/02/2023	21:43:19	N 37° 29,85908'	E 15° 21,14957'	1785			Station Géodésique	Incident	Deadweight on board; EK80 turned on
23/02/2023	21:51:04	N 37° 29,98366'	E 15° 21,17996'	1779			Station Géodésique	Incident	Releaser on board
23/02/2023	21:54:46	N 37° 30,12484'	E 15° 21,12764'	1769	PROFIL 46	PROFIL			
23/02/2023	22:19:46	N 37° 32,27653'	E 15° 20,29724'	1808	OBS 6B	STATION			Deployment
23/02/2023	22:26:19	N 37° 32,28776'	E 15° 20,36204'	1805			OBS	Mise à l'eau	LotOBS
23/02/2023	22:39:00	N 37° 32,26654'	E 15° 20,37184'				OBS	Incident	probleme de demarrage de la BUC: arret de fillage
23/02/2023	22:44:55	N 37° 32,24736'	E 15° 20,38223'				OBS	Incident	BUC fonctionne fillage repris

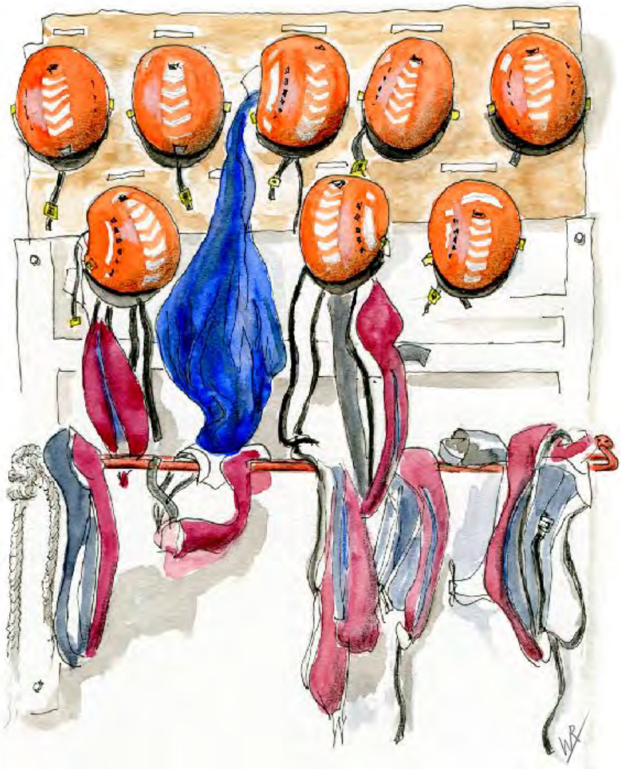
24/02/2023	00:23:00	N 37° 32,28056'	E 15° 20,33543'	1804			OBS	Au fond	BUC 37 32,2738 15 20,3304 1738m BUC Profondeur 1804m
24/02/2023	01:06:57	N 37° 32,27244'	E 15° 20,34757'		PROFIL 47	PROFIL			
24/02/2023	02:20:41	N 37° 25,60369'	E 15° 17,45904'	1332	LOTOBS2		OBS	Mise à l'eau	
24/02/2023	03:55:29	N 37° 25,59557'	E 15° 17,4521'	1333			OBS	Au fond	LOT-OBS2
24/02/2023	04:34:54	N 37° 25,81126'	E 15° 17,03684'	1304	PROFIL 48	PROFIL			
24/02/2023					Canopus tripod 6	STATION			Deployment
24/02/2023							Station Géodésique		CANOPUS 6
24/02/2023	07:25:00						Station Géodésique		BUC 27°N 29,1974 15°E 21,3963 1870 m
24/02/2023					TRANSIT	TRANSIT			
24/02/2023	12:46:19	N 37° 29,85528'	E 15° 20,98228'		Canopus tripod 7	STATION			Deployment
24/02/2023	12:48:28	N 37° 29,85621'	E 15° 20,98136'				Station Géodésique	au Fond	largage a 13h40: Casino a redemarre a 13h43... Position BUC: 37°N 29,8843 15°E 20,9276 1778 m BUC
24/02/2023					Canopus Test	STATION	Station Géodésique		
24/02/2023	14:33:01	N 37° 29,6116'	E 15° 21,30283'		PROFIL 49	PROFIL			
24/02/2023	14:56:46	N 37° 29,10615'	E 15° 21,59713'		Canopus tripod 8	STATION			Deployment
24/02/2023	14:57:13	N 37° 29,09963'	E 15° 21,59806'				Station Géodésique	Mise à l'eau	CANOPUS 8
24/02/2023	16:54:42	N 37° 28,90715'	E 15° 21,81245'				Station Géodésique	au Fond	BUC 37°N 28,9404 15°E 21,7456 1888 m
24/02/2023	19:39:47	N 37° 28,86187'	E 15° 21,54813'				Station Géodésique	Incident	Deadweight on board
24/02/2023	19:47:35	N 37° 28,83682'	E 15° 21,56354'				Station Géodésique	Incident	Releaser on board
24/02/2023	20:01:05	N 37° 28,87133'	E 15° 21,52756'		PROFIL 50	PROFIL			
24/02/2023	20:50:59	N 37° 25,43432'	E 15° 24,46297'	2066	LOTOBS4B	STATION			Deployment
24/02/2023	21:00:49	N 37° 25,34024'	E 15° 24,51222'	2072			OBS	Mise à l'eau	LOTOBS 4B
24/02/2023	23:13:37	N 37° 25,36439'	E 15° 24,59567'				OBS	Au fond	BUC 4°N 37 25.3446 15°E 24.5328 1964 m
24/02/2023	23:58:39	N 37° 25,23435'	E 15° 24,91413'		PROFIL 51	PROFIL			

25/02/2023	02:16:49	N 37° 44,19563'	E 15° 29,43455'	1524	OBSBB10B	STATION			Deployment
25/02/2023	02:21:55	N 37° 44,21292'	E 15° 29,40209'	1524			OBS	Mise à l'eau	OBS BB 10B
25/02/2023	04:14:11	N 37° 44,21105'	E 15° 29,41741'				OBS	Au fond	BUC 37°N 44,2142 15°E 29,4022 1525 m
25/02/2023	04:49:00	N 37° 43,79758'	E 15° 29,44271'		PROFIL 52	PROFIL			
25/02/2023	07:15:14	N 37° 30,4777'	E 15° 53,30327'	2098	OBSBB15B	STATION			Deployment
25/02/2023	07:27:54	N 37° 30,44585'	E 15° 53,29709'	2099			OBS	Mise à l'eau	OBS BB 15B
25/02/2023	09:30:17	N 37° 30,47713'	E 15° 53,26222'				OBS	Au fond	BUC 37°N 30.4659 15°E 53.2521 E Immersion 1996 (50m above seafloor)
25/02/2023	10:22:27	N 37° 30,10736'	E 15° 53,33693'		PROFIL 53	PROFIL			
25/02/2023	12:05:20	N 37° 19,96855'	E 16° 3,78084'	2283	LOTOBS22B	STATION			Deployment
25/02/2023	12:06:08	N 37° 19,97003'	E 16° 3,78311'	2282			OBS	Mise à l'eau	Position Vessel at Free Fall: 37°N 19,9700 16°E 03,7831 2283 m
25/02/2023	12:08:32	N 37° 19,97132'	E 16° 3,77221'	2285	PROFIL 54	PROFIL			
25/02/2023	14:15:00	N 37° 19,38909'	E 15° 43,26813'	2236	LOTOBS 20B	STATION			Deployment
25/02/2023	14:21:00	N 37° 19,37506'	E 15° 43,24522'	2236			OBS	Mise à l'eau	Position Vessel at Free Fall: 37°N 19.3037 15°E 43.2154 2236 m
25/02/2023	14:33:37	N 37° 19,44646'	E 15° 43,08178'	2238	PROFIL 55	PROFIL			
25/02/2023	17:08:23	N 37° 29,54818'	E 15° 21,9132'		Canopus Test	STATION			
25/02/2023	20:25:52	N 37° 29,81321'	E 15° 21,13181'		Transit to CTD 1	PROFIL			
25/02/2023	21:13:34	N 37° 29,10558'	E 15° 23,98896'		TEST CTD	STATION			
25/02/2023	22:07:01	N 37° 29,02145'	E 15° 24,02399'				Bathysonde	Mise à l'eau	
25/02/2023	22:09:30	N 37° 29,032'	E 15° 24,00844'		CTD 1	STATION			
25/02/2023	23:09:51	N 37° 29,14963'	E 15° 24,00614'				Bathysonde	Au fond	
26/02/2023	00:21:23	N 37° 29,08976'	E 15° 24,00734'				Bathysonde	A bord	
26/02/2023	00:21:23	N 37° 29,08976'	E 15° 24,00734'	2054	Transit to CTD 2	PROFIL			
26/02/2023	01:02:46	N 37° 29,10935'	E 15° 21,79541'		CTD 2	STATION	Bathysonde	Mise à l'eau	
26/02/2023	01:48:27	N 37° 29,09621'	E 15° 21,79778'				Bathysonde	Au fond	BUC 37−29.1094 15−21.7858 prof: 1889.8
26/02/2023	02:36:41	N 37° 29,08972'	E 15° 21,80074'				Bathysonde	A bord	
26/02/2023	02:38:40	N 37° 29,086'	E 15° 21,80318'	1915	Transit to CTD 3	PROFIL			
26/02/2023	04:03:54	N 37° 29,22383'	E 15° 19,97408'		CTD 3	STATION	Bathysonde	Au fond	inmersion • 1793 m
26/02/2023	04:03:58	N 37° 29,22373'	E 15° 19,97369'				Bathysonde	En surface	
26/02/2023	04:50:19	N 37° 29,32231'	E 15° 19,99489'	1819			Bathysonde	A bord	

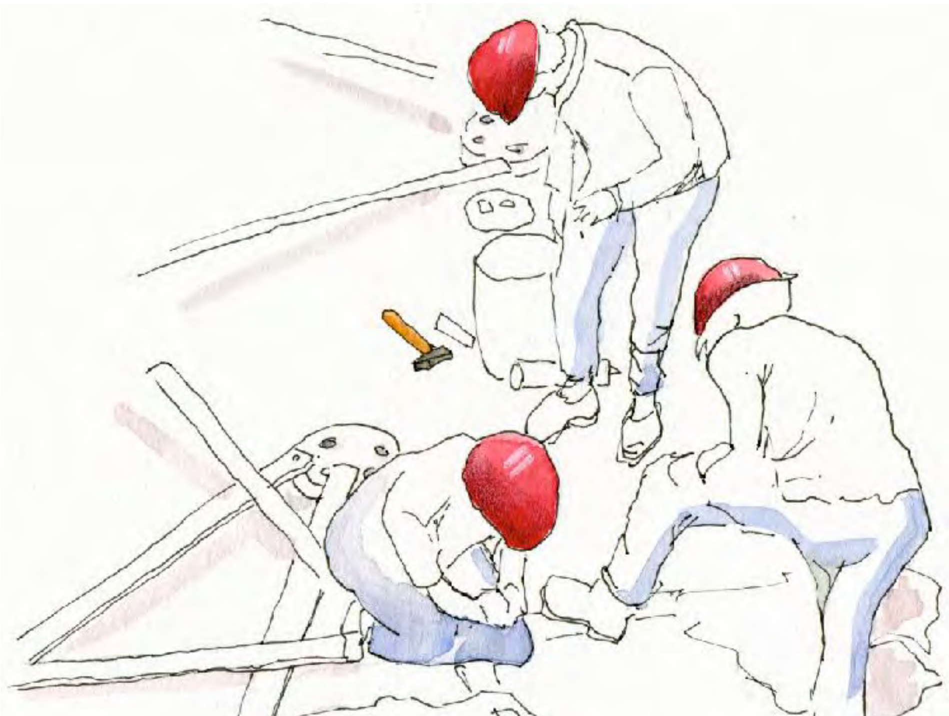
26/02/2023	04:50:19	N 37° 29,32231'	E 15° 19,99489'	1819	Transit to CTD 4	PROFIL			
26/02/2023	05:17:31	N 37° 29,13864'	E 15° 17,99777'		CTD 4	STATION	Bathysonde	Mise à l'eau	CTD-4
26/02/2023	05:17:35	N 37° 29,13834'	E 15° 17,99747'				Bathysonde	Au fond	
26/02/2023	06:06:37	N 37° 29,1465'	E 15° 18,04519'				Bathysonde	Incident	Winch stopped due to technical problems
26/02/2023	08:46:05	N 37° 29,05312'	E 15° 17,9849'				Bathysonde	A bord	
26/02/2023	08:47:13	N 37° 29,05627'	E 15° 17,92131'		Transit to CTD 5	PROFIL			
26/02/2023	09:07:16	N 37° 29,11455'	E 15° 16,01407'	1369	CTD 5	STATION			
26/02/2023	09:08:21	N 37° 29,11745'	E 15° 16,01643'	1364			Bathysonde	Mise à l'eau	CTD 4
26/02/2023	09:49:33	N 37° 29,07805'	E 15° 16,04338'				Bathysonde	Au fond	CTD 4 max depth 1343.77m N 37−29.0889 E 15−16.0121
26/02/2023	10:21:06	N 37° 29,07921'	E 15° 15,99249'	1369			Bathysonde	A bord	CTD 4 - on board
26/02/2023	10:21:55	N 37° 29,07689'	E 15° 15,98192'	1365	Transit to CTD 6	PROFIL			
26/02/2023	11:03:56	N 37° 32,64594'	E 15° 16,23305'		CTD 6	STATION			
26/02/2023	12:47:56	N 37° 29,10141'	E 15° 14,01908'	1011			Bathysonde	Mise à l'eau	
26/02/2023	13:37:59	N 37° 29,07666'	E 15° 14,00361'				Bathysonde	A bord	
26/02/2023	13:39:19	N 37° 29,09145'	E 15° 13,97948'	1005	Transit to CTD 7	PROFIL			
26/02/2023	14:07:25	N 37° 29,12794'	E 15° 11,98252'		CTD 7	STATION	Bathysonde	Mise à l'eau	
26/02/2023	14:23:28	N 37° 29,06065'	E 15° 11,98369'				Bathysonde	Au fond	
26/02/2023	14:46:39	N 37° 29,09516'	E 15° 11,96765'	663			Bathysonde	A bord	
26/02/2023	14:47:09	N 37° 29,09072'	E 15° 11,97312'	675	Transit to CTD 8	PROFIL			
26/02/2023	15:13:41	N 37° 29,09368'	E 15° 10,01434'		CTD 8	STATION	Bathysonde	Mise à l'eau	mise ▪ l'eau CTD-8
26/02/2023	15:24:06	N 37° 29,10331'	E 15° 10,01422'				Bathysonde	Au fond	
					Transit to CTD 9	PROFIL			
26/02/2023	15:55:29	N 37° 29,12101'	E 15° 8,51365'	175	CTD 9	STATION	Bathysonde	Mise à l'eau	(175 meters?)
26/02/2023	15:59:50	N 37° 29,08981'	E 15° 8,51557'				Bathysonde	Au fond	
26/02/2023	16:04:57	N 37° 29,07367'	E 15° 8,49692'				Bathysonde	A bord	
26/02/2023	16:04:57	N 37° 29,07367'	E 15° 8,49692'		Fin des operations				

Watercolor artwork of shipboard operations (artist - Walter Roest)

Broad-band OBS (Nammu)

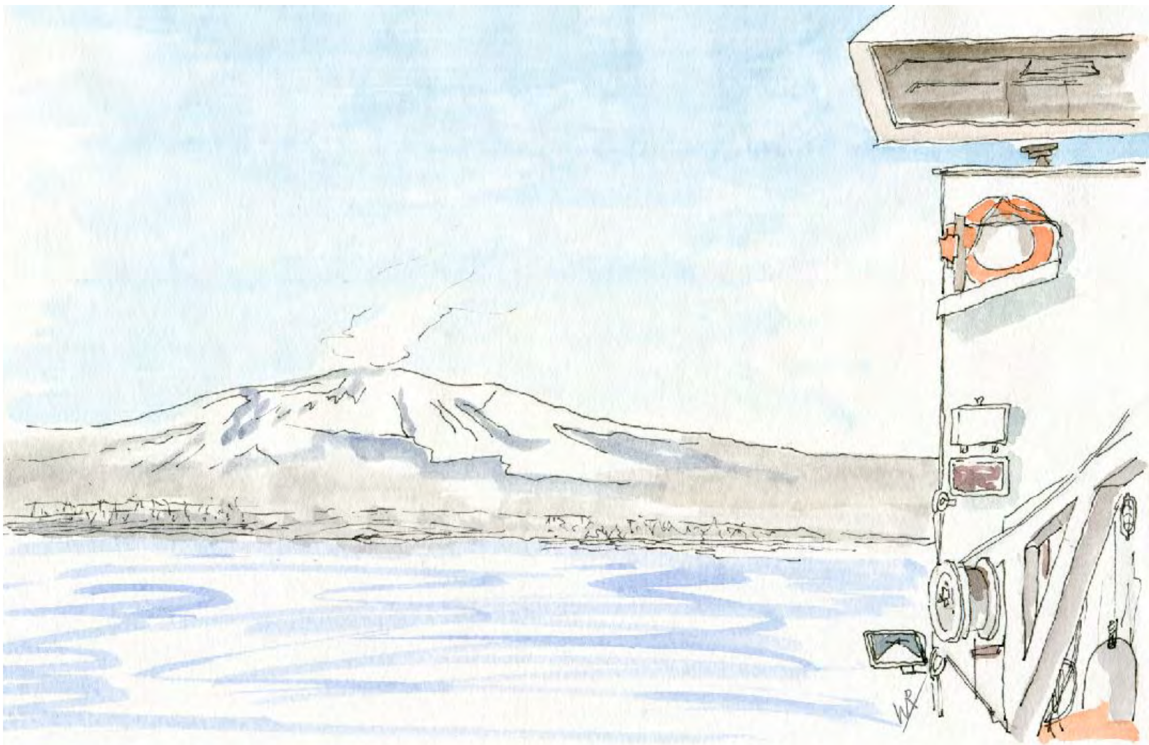


Safety helmets and life-vests



Assembling the tripods

Canopus acoustic beacons (seafloor geodetic stations)



Mount Eta in the distance (snow covered in February)