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CRUISE REPORT

OASIS

Thriving Cold-Water Coral Reefs in the Mediterranean Sea

RV Pelagia, Cruise No. 64PE515

31/03/2023 – 12/04/2023, Malaga – Malaga (Spain)

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1 Summary

OASIS Cruise has been conceived to gain an advanced understanding of the functioning of Cabliers cold-water coral (CWC) reefs, in the eastern Alboran Sea, whose optimal state of conservation and large extension of trhiving scelaractinan communities make a unique and large biodiversity oasis compared to the entire Mediterranean deep-sea realm [1]. During OASIS, Cabliers reefs have been revisited at a distance of 8 years from the last survey to expand the area of study and to monitor, over a 1 year time span, the hydrographic, hydrodynamic and sedimentary processes maintaining these ecosystems in unexpected thriving conditions. Moreover, OASIS exploration has been extended to Catifas mound system, an analogous system located 13 nm East of Cabliers, which unveiled new thriving CWC communities. OASIS Cruise also hosted the scientist Dr Martina Piedromenico, in the frame of the EF+ Co-PI Project, conceived to develop a research project whose objectives were complementary with those of OASIS Cruise. The Co-PI Project UNSEEN (UNveiling microplaStic abundancE pattErNs on a pristine Cold Water Coral reefs), whose Dr Pierdomenico was the PI, aimed to assess the occurrence of microplastics within the water column and the surficial sediments of Cabliers CWC province.

Cold-water coral reefs and associated communitites are important hotspots of biodiveristy and provide several ecosystem services [2]. They are recognized by UN as Vulnerable Marine Ecosystem, due to the fragility of these long-lived organisms and to their exposition to threatening human activites such as fishing industry, which dramatically increase their vulnerability [3, 4, 5]. Governments and policy makers (e.g.: EU, UN, FAO) promoted new environmental policies requiring advanced science-based procedures to map, protect and monitor deep-sea ecosystems. Framework building CWCs in the Mediterranean Sea are generally represented by small populations or scattered patchy colonies, mainly located in submarine canyons [6], and are often found in a poor state of conservation due to the impact of fishing activities and pollution, or to natural changes of environmental conditions during past geologic periods [7]. On the other side, based on previous ROV (Remotely Operated Vehicle) video data, the exceptional and unique conservation value of the Cabliers reefs is reflected by the well preserved state of conservation and large extension (over 5 km) of scleractinians and associated communities, dimension of the largest colonies (*L. pertusa* colonies are up to 3 m large), and the occurrence of fish populations dominated by juveniles, demonstrating these reefs serve as nursery area for various species [1]. Moreover, many associated Mediterranean and Atlantic species (mainly belonging to the Phyla Porifera, Cnidaria and Echinodermata), reflecting the mixed oceanographic characteristic of the Alboran Sea, have been observed along the reefs [1], including a new species of black coral discovered for the first time in the Mediterranean, the anthipatarian Phanopates rigida [8]. The

Catifas Bank has been only visited in 2011 by the NGO OCEANA, and before OASIS, the dataset was limited to two shorts ROV video surveys, which show similar communitites and benthic assemblages of Cabliers reefs, although a substanstantual reduction of living scleractianans.

Nonetheless, most of Cabliers and Catifas reefs still need to be visited, and it is furthermore unclear which are the main physical processes of this region that provide the most suitable environmental conditions for well-preserved deep-sea benthic communities. Finally, the UN-General Fishery Commission for the Mediterranean (UN-GFCM), with the support of Spanish, Moroccan and Algerian Governments, recently proposed the closure of Cabliers reefs to fishing activities, with the institution of a UN Fishery Restricted Area (FRA). These findings, calling for urgent science-based measures for the management and protection of Cabliers reefs, motivated the scientific objectives of OASIS Cruise.

1.2 Relevance of the project

The added value of OASIS resides in its novel methodological approach, in the expected scientific and technological advances and in its implications for environmental policies.

1) One of the innovative aspects is the implementation of nested spatial scales, using seafloor observatories to measure concurrently multiple processes influencing Cabliers CWC habitats: mesoscale (hundreds of m scale - e.g., oceanographic fronts, eddies, internal waves and associated nepheloid layers), and fine-scale processes at the benthic boundary layer (tens of m to sub-metric scale - e.g., current shear stress values, turbulence, water turbidity);

2) Information from fine scale geomorphology and seafloor heterogeneity coupled with in-situ hydrodynamic measurements to begin to understand how seafloor complexity influences hydrodynamic patterns on CWCs, moving forward our current knowledge of CWC reef dynamics;

3) 3D photogrammetric reconstructions from ROV footage will provide valuable information on how CWC colonies distribute within the reefs and regulate their morphological variability;

4) Despite being subjected to the same large-scale oceanographic processes, the Cabliers and Catifas reef systems have the distinct characteristic of hosting both living and dead CWC reefs. Hence, simultaneous measurements of hydrodynamic variables on strategic sites, will allow discrimination of the fine-scale physical and biogeochemical mechanisms supporting CWCs health, providing significant insights into our understanding of CWC dynamics;

5) As added ecological benefits, video footage acquired during OASIS will define the composition and relative abundance of accompanying species for Mediterranean CWC, which preliminary results have demonstrated to be different from north Atlantic and African reefs. Data acquired from a stand-alone camera, mounted on the lander of the northern sector of Cabliers, will be used to classify and quantify fish and decapod fauna on the living reefs and relate it to inertial, tidal, day-night cycles and environmental variability as registered by OASIS observatories.

6) Collection of CWC samples will also support studies on genetic connectivity between Mediterranean and Atlantic deep-sea ecosystems, in the frame of collateral overarching projects where OASIS partners are involved;

7) From a more applied and societal-benefit perspective, OASIS will define the true extent and conservation value of possibly the largest thriving and pristine CWC ecosystem of the entire Mediterranean. Results of OASIS will be a valuable supporting material providing involved countries with solid background information for the Institution of a Fisheries Restricted Area in the Mediterranean promoted by UN-General Fishery Commission for the Mediterranean. In line with the monitoring procedures of VMEs envisaged by EU Conventions, we will revisit and assess changes in health status as well as evaluate possible evidence of human activities on the living reefs inspected in 2015.

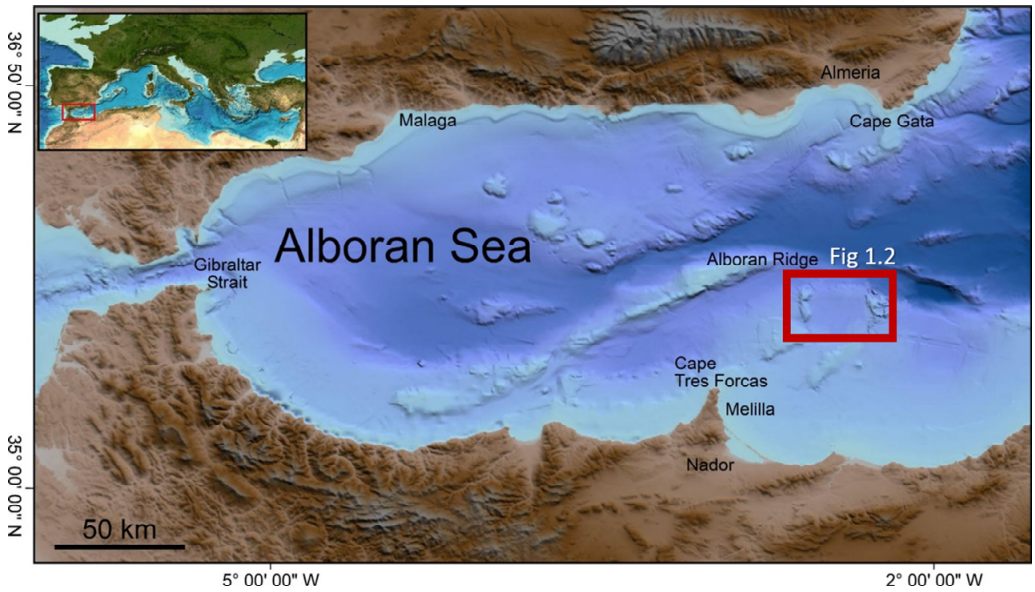

Fig. 1.1 : OASIS Cruise area (red inset), in the Eastern Alboran Sea (western Mediterranean). Bathymetry from European Marine Observation and Data Network (EMODnet) Digital Bathymetry.

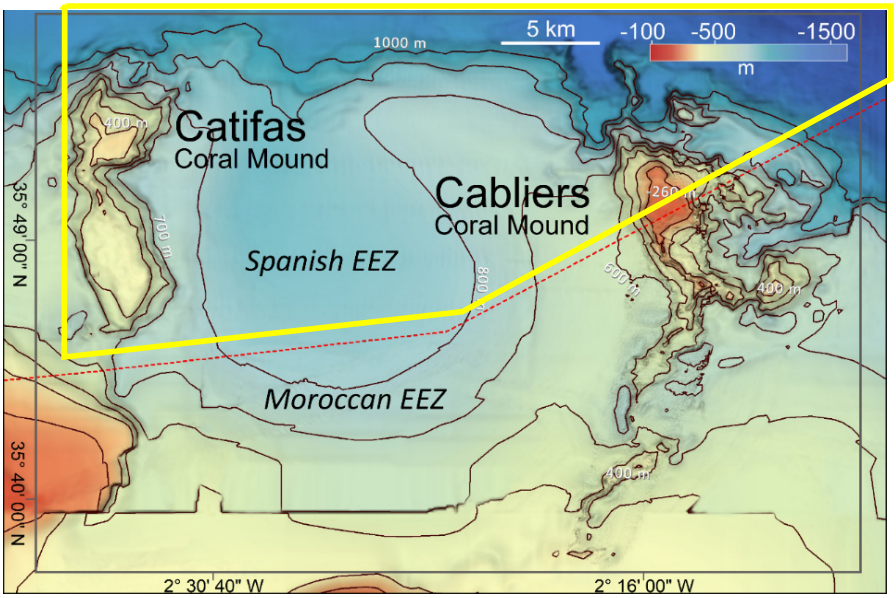

Fig. 1.2 : working area (yellow inset) of RV Pelagia during the 64PE515 EF+ OASIS Cruise. Bathymetry from Ercilla et al., 2016 [9] merged with European Marine Observation and Data Network (EMODnet) Digital Bathymetry.

2 Research Programme/Objectives

OASIS objectives onboard the RV Pelagia (Fig. 2.1) were addressed through the acquisition of (currently missing) oceanographic/hydrodynamic variables, coupled with extensive groundtruthing and swath mappping.

The following specific objectives have been:

Obj. 1 - Assess the occurrence of living CWC reefs and other well preserved deep-sea ecosystems in the northern sector of the Cabliers mound system and in the Catifas mound system.

Obj. 2- Explore the typology, occurrence and distribution of deep-sea benthic ecosystems in the Catifas Bank region.

Obj. 3 - Quantify, across multiple and interacting spatial scales, the oceanographic and hydrodynamic processes maintaining coral reefs and associated habitats in thriving conditions, being these processes responsible for CWC functioning.

Obj. 4 – Map the geomorphology and the extension of the northern sector of Cabliers and of the Catifas system through the use of a Multi Beam echosounder.

Fig. 2.1: The Research Vessel “Pelagia”.

3 Technical Equipment

EUROFLEETS+ Equipment (TNAs)

Equipment from RV Pelagia:

- Kongsberg EM302 Multibeam System
- CTD and Rosette sampler SBE 911 CTD with SBE 32 carousel (24 Bottle, 12L)
- ADCP Teledyne 150 kHz
- High Precision Acoustic Positioning system Kongsberg HiPAP 100, 12kHz
- Gravity corer (6m, 1.5 Tons head)
- Box Corer

*Equipment from Hellenic centre for Marine Research (**HCMR**)*

- Remotely Operated Vehicle (ROV) "Max Rover", equipped with a Hydrolek electro-hydraulic 5 function manipulator, 1 Colour CCD video camera (30x HQ zooms), HD cameras (1920×1080), green lasers system; Lights: 4 x 100 W HID lights and 2 x 150 W Quartz lights;

in-kind contribution from OASIS Partners

from the Spanish Institute of Marine Sciences (**ICM-CSIC**):

- 2 oceanographic moorings with: Acoustic Doppler Current Profilers (ADCP), currentmeters, CTDs, turbidimeters, oximeters, fluorometers, pelagic sediment traps

from the Spanish Marine Technology Unit (**UTM-CSIC**):

- L-ADCP to install on the CTD Rosette

from the Royal Netherlands Institute for Sea Research (**NIOZ**):

- 2 benthic landers with: Acoustic Doppler Current Profilers (ADCP), CTD, turbidimeter, fluorimeter, oximeter, Mc Lane particle pump, sediment traps, HD camera.

from the Italian National Research Council (**CNR**):

- 1 stand-alone HD camera for long-term observations of macrofauna

4 Narrative of the Cruise and Station list

Time in GMT (- 2 hours from local time)

31 March 2023

11:00 *Start of OASIS Cruise. Departure from Malaga and Transit to Cabliers mound system*

15:00 *Health and Safety training onboard RV Pelagia*

01 April

01:00 *Start of scientific activities. CTD for Sound Velocity Profile (SVP) calibration*

01:30 – 07:30 *MB mapping*

06:30 – 18:00 2 *ROV dives* (*Cabliers)*

18:30 – 00:00 *CTD-L-ADCP transect + water sampling (Cabliers)*

02 April

03:00 – 05:50 *MB mapping*

06:30 – 17:40 2 *ROV dives (Catifas)*

19:00 – 22:00 *CTD-L-ADCP transect + water sampling (Catifas)*

03 April

24:00 – 05:45 *MB mapping*

06:30 – 12:00 *ROV dive (Catifas)*

12:30 – 14:00 *Deployment Lander Catifas*

14:00 – 16:00 *Transit to Cabliers*

16:30 – 17:30 *ROV dive (Cabliers)*

18:00 – 19:30 *Deployment Lander Cabliers*

20:00 – 00:00 *CTD-L-ADCP transect + water sampling (Cabliers)*

04 April

00:30 – 05:45 *MB mapping*

06:00 – 10:00 ROV dive (Cabliers)

10:30 – 12:00 Deployment mooring Cabliers

12:30 – 14:00 Transit to Catifas

14:30 – 15:00 Deployment mooring Catifas

15:30 – 17:15 *ROV dive (Catfias)*

18:00- 22:30 *CTD-L-ADCP transect + water sampling (Catifas)*

05 April

23:00 (4 Aril) – 11:30 *MB mapping. MB mapping is the only activity due to increasing bad sea state.*

12:30 – 01:00 (06 April) YO-YO *CTD-L-ADCP* (Cabliers)

06 April

01:30-08:00 *MB mapping*

09:15 – 21:30 YO-YO *CTD-L-ADCP* (Catifas)

07 April

22:00 (6 April) – 08:00 *MB mapping*

08:30 - 12:20 *ROV Dive (Cabliers)*

13:00 – 14:30 *Recovery Lander Cabliers*

15:00 – 05:00 (8 April) *CTD-L-ADCP Transect + water sampling (Cabliers)*

08 April

07:00 – 10:30 *ROV Dive (Cabliers)*

11:00 – 18:00 *Box Cores (Cabliers)*

18:30 – 19:00 *CTD for Sound Velocity Profile (SVP) calibration*

19:30 – 05:30 (9 April) *MB mapping*

09 April

06:20 – 06:30 *Recovery Lander Catifas*

07:10 – 11:00 *ROV Dive (Catifas)*

11:45 – 13:30 *ROV Dive (Catifas)*

16:30 – 00:00 *CTD-L-ADCP Transect + water sampling (Catifas)*

10 April

00:00 – 05:30 *MB mapping*

07:00 – 12:30 *Gravity cores (Catifas)*

13:00 – 13:30 *Lander deployment Catifas*

14:00 – 15:00 *ROV Dive. Check on Catifas lander. The lander is on a steep terrain and needs to be collected*

16:00 – 17:00 *Recover Lander Catifas*

17:30 – 18:00 *Lander deployment Catifas (long term deployment)*

18:30 – 19:30 *ROV Dive (check lander postion, OK)*

20:30 – 21:00 *CTD for Sound Velocity Profile (SVP) calibration*

21:30 – 00:00 *MB acqusition for calibration of sensors attitude*

11 April

00:30 – 07:30 *MB mapping*

06:30 – 09:30 *Gravity cores (Catifas)*

10:00 – 11:45 *Box Cores (Catifas)*

12:30 – 13:30 *ROV Dive (Catifas)*

End of scientific activities

14:00 *OASIS Group photo and start of the transit to Malaga*

12 April

11:00 *Arrive to Malaga*

End of OASIS Cruise

Station	Activity	Day
	Transit to Cabliers	***31-Mar***
1	CTD (calibration of sound velocity profile)	
2	MB mapping	
3-4	ROV 1 and 2 (Cabliers)	***01-Apr***
5-10	CTD-Rosette-L-ADCP transect 1 Cabliers	
11	MB mapping	
12-13	ROV 3 and 4 (Catifas)	***02-Apr***
14-18	CTD-Rosette-L-ADCP transect 1 Catifas	
19	MB mapping	
20	ROV 5 (Catifas, Structure from Motion on small mound)	***03-Apr***
21	Deployment of Lander Catifas	
	Transit to Cabliers	
22	ROV 6 (location for lander Cabliers)	
23	Deployment of Lander Cabliers	
24-28	CTD-Rosette-L-ADCP transect 2 Cabliers	
29	MB mapping	
30	ROV 7 (vertical wall Cabliers)	***04-Apr***
31	Deployment of Mooring Cabliers	
	Transit to Catifas	
32	Deployment of Mooring Catifas	
33	ROV 8 (visit on lander Catifas)	
34-38	CTD-Rosette-L-ADCP transect 2 Catifas	
39	MB mapping	***05-Apr***
40	yo-yo CTD- L-ADCP + ADCP Cabliers 12 hours	
41	MB mapping	***06-Apr***
42	yo-yo CTD- L-ADCP + ADCP Catifas 12 hours	
43-44	MB mapping	***07-Apr***
45	ROV 9 (on Cabliers deep volcanic ridge)	
46	Recovery lander Cabliers	
47-70	CTD-L-ADCP transect + ADCP Cabliers 12 hours	
71	ROV 10 (second vertical wall Cabliers)	***08-Apr***
72-77	Box cores Cabliers	
78	CTD (svp)	
79	MB mapping	
80	Recovery lander Catifas	***09-Apr***
81	ROV 11 (location for lander Catifas and coring sites)	
82	ROV 12 (SfM on Catifas reefs)	
83-93	CTD-L-ADCP transect + ADCP Catifas regional	
94	MB mapping	***10-Apr***
95-97	Gravity cores Catifas	
98	Redploy lander Catifas	
99	ROV 13 (visit on lander Catifas)	
100	Recovery lander Catifas	
101	Re-deployment lander Catifas - DEF	
102	ROV 14 (visit on lander Catifas)	
103	CTD (svp)	

104	MB calibration and MB mapping	
105-106	Gravity cores Catifas	***11-Apr***
107-108	Box cores Catifas	
109	ROV 15 (vertical wall Catifas)	
	Transit to Malaga	
	Arrival at Malaga harbor	***12-Apr***

Table 4.1: Number of OASIS stations and activities. Coordinates of stations will be specified in the pragraphs related to the different OASIS activities.

5 Preliminary Results

5.1 Multi Beam mapping

System Overview

The MBES system installed on the RV Pelagia was the hull-mounted Kongsberg EM302, with a frequency of 30 kHz and emission of 432 soundings per swath. The swath coverage sector is of up to 5.5 times water depth, acquiring both equiangular either equidistant sounding patterns.

Description of the Survey

Detailed high-resolution surveys have been carried out using the equidistance mode and an average velocity of 6-7 knots. MB mapping was mainly conducted during night time both on north Cabliers and Catifas systems and in the slope sector connecting them (Fig. 5.1). Up to 450 km2 were covered with OASIS mapping. Minimum and maximum depths are 230 m and 1697 m respectively.

The acquired acoustic signal is of high quality, except the northernmost region, which was mapped during rough sea state, implying a deeper filtering and cleaning of the signal in a post-processing stage. The obtained spatial resolution of the DTMs was of 10 m, although a further processing of the acquired data will eventually allow to produce higher resolution maps of the surveyed seabed. The north Cabliers system showed volcanic banks and ridges, surrounded by steep walls up to 1000 m deep and linear coral mounds (Fig.5.2). Mapping of Catifas systems unveiled for the first time a new mound province, the Catifas Mound Province, consisting of ridge-like and dome-like mounds, some of them hosting thriving CWC communities (Fig. 5.3, Section 5.2).

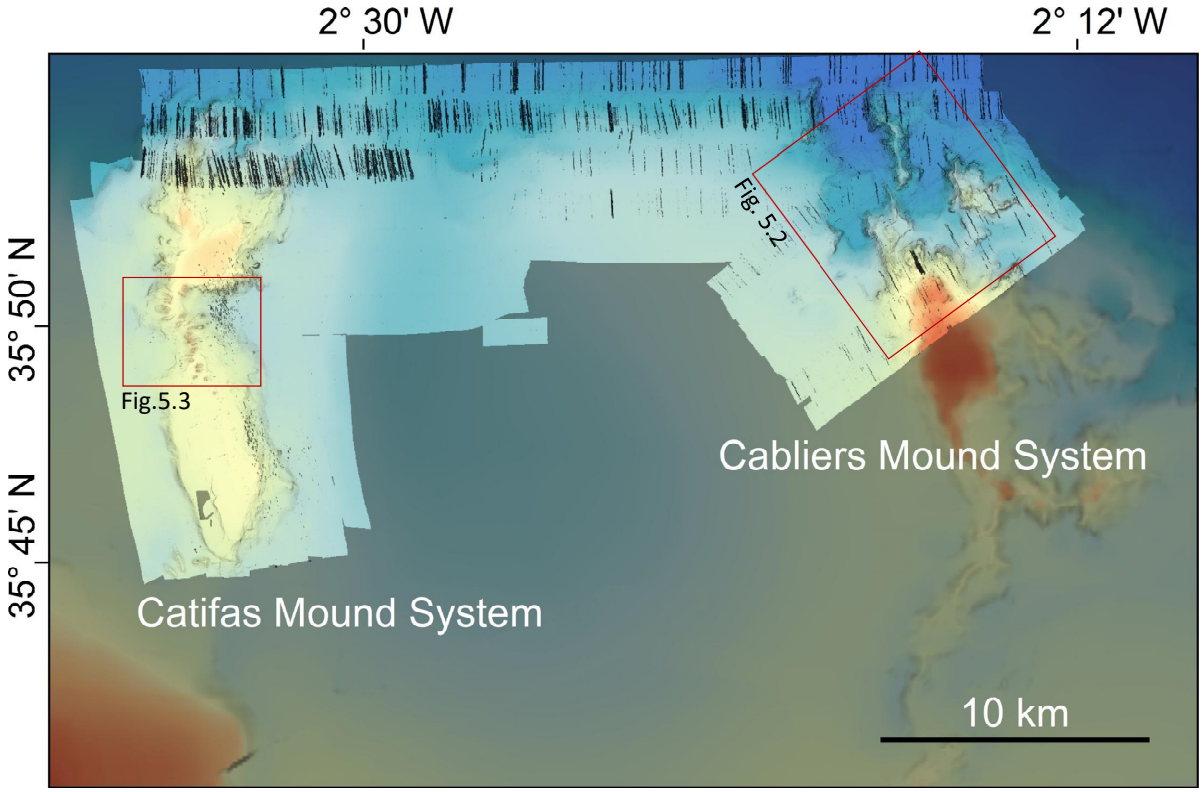

Figure 5.1: OASIS MB map (in bright color shades)

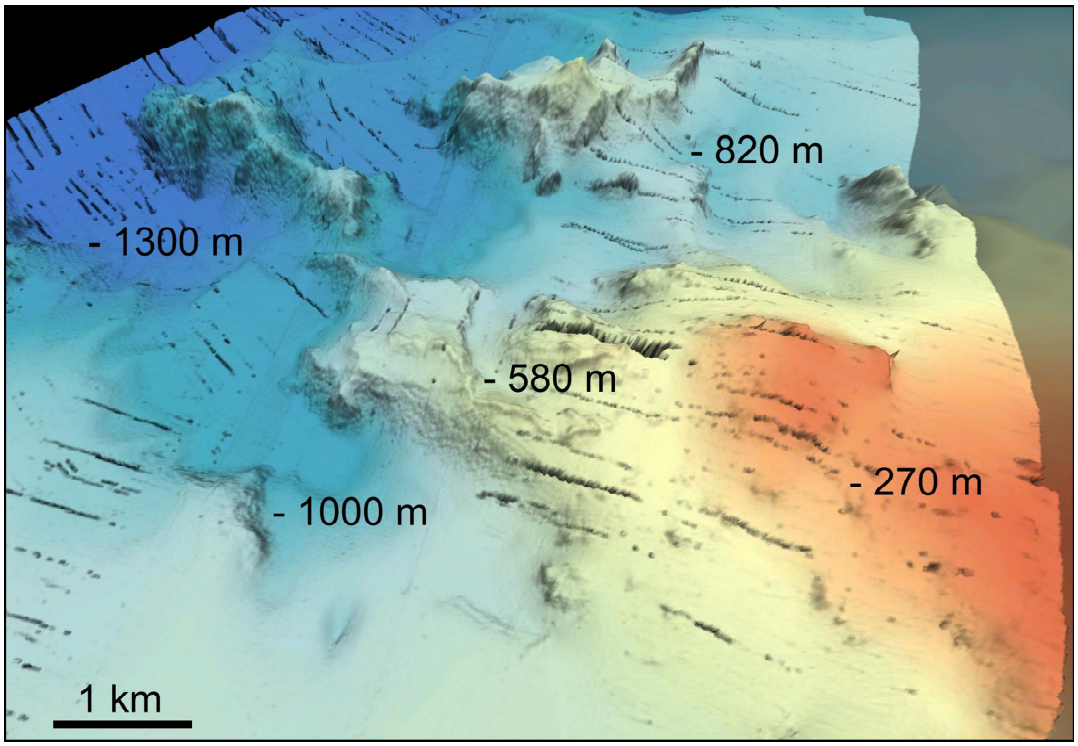

Figure 5.2: 3D MB model of the mapped region of Cabliers

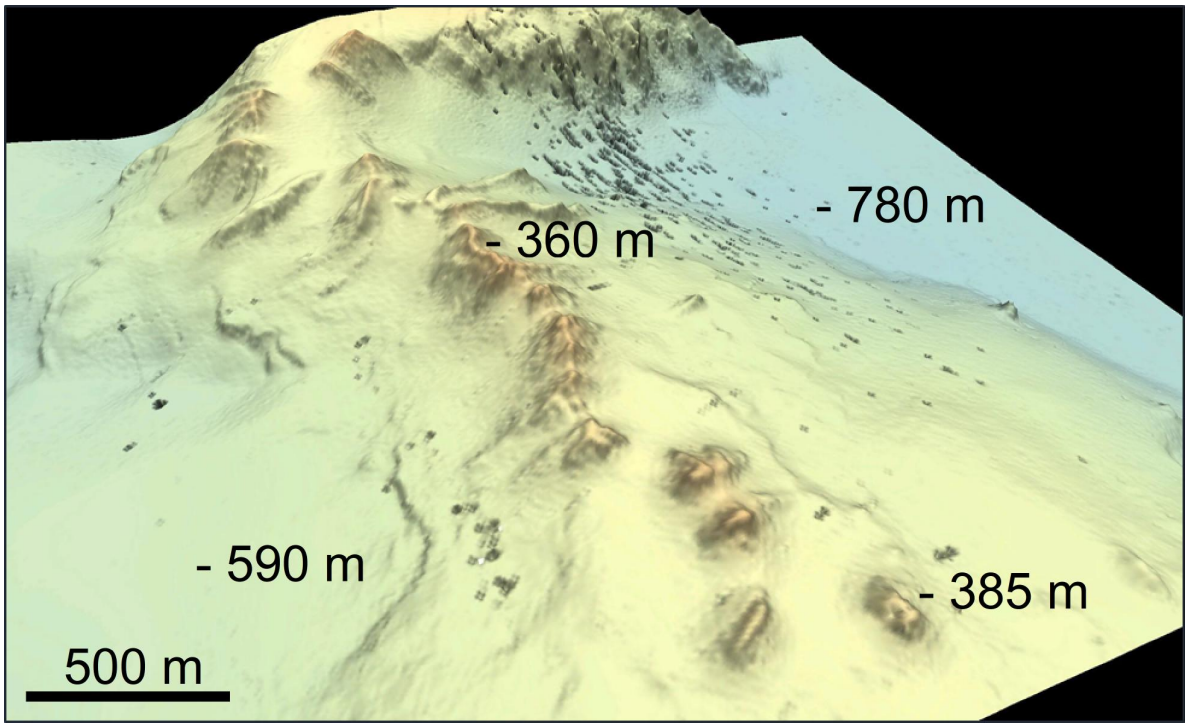

Figure 5.3: 3D MB model of the mapped region of the NEW Catifas cold-water coral mounds.

5.2 ROV dives

15 dives with a "Remotely operated Vehicle" (ROV) have been performed during OASIS Cruise on Cabliers and Catifas mound systems (Table 5.1). The ROV was the "Max Rover" from the Hellenic Center of Marine Research (HCMR) (Fig. 5.4). Max Rover, acquired in 1998 and updated in 2002 and 2009, has a maximum operating depth of 3000 m. It has 6 electric motors x 2.0 hp, for a resulting underwater speed of approximately 2.5 knots (fwd/rev) and 1.5 knots (vert/lat) with 160 kg bollard pull. Average transect speed on the seabed covers approximately 500 m in one hour without interruptions. The ROV has several cameras, with a full frame HDTV with zoom lens as main system. Two parallel red lasers with 10 cm separation are used as a spatial reference. Lights are 2 x 100 W HID and 4 x 150 W Quartz. The manipulators are 2 Hydrolek electro-hydraulic with 5 functions, and were used to collect biological samples from the seafloor. During the dives, samples were stored in a rigid plastic basket located at the base of the ROV frame, between the two manipulators (see Fig. 5.4). The main sensors of Max Rover are a pressure depth meter, an altimeter and a digital compass. Furthermore, a CTD (from HCMR) and an Oximeter (from NIOZ) were installed on the ROV during the dives. Video graphics overlay on surface video include date, time, gyro, dive number and depth. A Tritech Dual Frequency Scanning Sonar (675/910 KHz) was used to visualize possible obstacles during the dive. The positioning system is a Linkquest Tracklink Ultra Short Baseline (USBL), georeferenced through the Max-Sea software. A 50 m long soft fibre optical cable connects the ROV to a main depressor, connected to the onboard hydraulic winch (380 V, 25 hp) through a 2200 m long steel wire fibre optic and power cable. The depressor is generally maintained at a depth 20 m shallower than the ROV and is equipped with a second Tracklink positioning pinger. During the dive, the Max-Sea software allowed for the real-time visualization of the positions of the ROV, the depressor and surface vessel. Due to a unsteady functioning of the ROV-USBL, a different USBL, provided by NIOZ, has been installed on the ROV since the second dive. Biological samples collected during OASIS dives were treated with formol 4% and ethanol 96% for taxonomic and genetic studies respectively.

Figure 5.4: the HCMR ROV “Max Rover” on the deck of RV Pelagia.

5.2.1 Description of OASIS ROV dives

ROV dives were mainly dedicated to explore and characterize the benthic fauna composing the Cabliers and Catifas CWC reefs (Fig. 5.5) and covered a depth ranging from 280 m to 1200 m, for a total of 31 hours and 40 minutes of acquired videos. Few dives were also aimed to check the locations of deployed landers and opportunistically characterize the surrounding fauna, perform ROV coverage for Structure from Motion (SfM) 3D reconstructions of coral reefs, either to define the location of gravity cores which have been collected on small dead CWC reefs of Catifas province (see section 5.6.1). Main benthic assemblages found during the dives corresponds to living or dead CWC frameworks, mainly composed of *Lophelia pertusa* and several accompanying species. Living

CWC reefs were mostly found at the top of CWC mounds, for an average maximum depth of 380 m, and for deeper depths either along the mound flanks, were substituted by dead CWC frameworks, functioning as substrate for gorgonians (mainly *Acantogorgia hirsuta*) and glass sponges. A dense and pristine glass sponge grounds (*Asconema setubalense*) has been found on the shallower dive of Cabliers province. Furthermore, 4 vertical volcanic walls have been explored during OASIS, unveiling a dense, well grown and preserved assemblages of anthipatarians and gorgonians. Large individuals and total absence of litter or evidence of fishing activities confirm the extremely well preserved and not impacted status of conservation of these deep-sea oases.

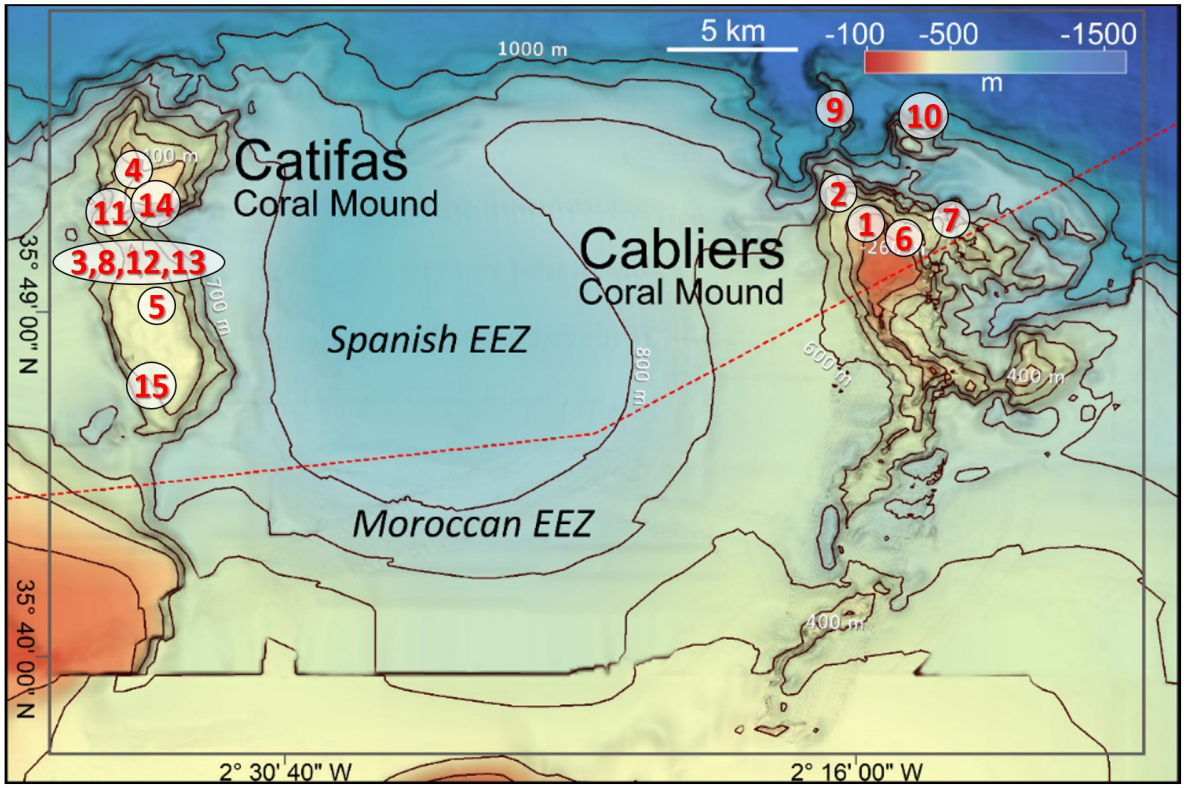

Figure 5.5: distribution of OASIS dives on Cabliers and Catifas CWC mound provinces.

OASIS 1 - Cabliers, crest of CWC ridge-like mound up to top of north volcanic bank							
Station	**Date**	**Depth start**	**Depth end**	**Lat Start**	**Long start**	**Lat start**	**Long end**
3	01/04/2023	-526 m	- 261 m	35.5138° N	2.1669° W	35.5070° N	2.1528° W
OASIS 2- Cabliers, crest of CWC ridge-like CWC mound, deep continuation of Dive 1							
4	01/04/2023	-683 m	-598 m	35.8678° N	2.2802° W	35.8621° N	2.2767° W
OASIS 3 - Catifas, crests of ridge-like CWC mound							
12	02/04/2023	-391 m	-344 m	35.8392° N	2.5786° W	35.8222° N	2.5718° W
OASIS 4 - Catifas, crest of deep CWC ridge-like mound up to a plateau							
13	02/04/2023	-431 m	-382 m	35.8883° N	2.5740° W	35.8707° N	2.5744° W
OASIS 5 - Catifas, SfM on a small CWC mound							
19	03/04/2023	-419 m	-374 m	35.8187° N	2.5692° W	35.8188° N	2.5683° W
OASIS 6 - Cabliers, sponge ground							
22	03/04/2023	-283 m	-254 m	35.8439° N	2.2535° W	35.8444° N	2.2547° W
OASIS 7 - Cablliers, vertical wall							
30	04/04/2023	-876 m	-631 m	35.8573° N	2.2255° W	35.8544° N	2.2251° W
OASIS 8 - Catifas, check short-term lander, fine!							
33	04/04/2023	-413 m	-359 m	35.8573° N	2.2255° W	35.8544° N	2.2251° W
OASIS 9 - Cabliers, deep dive on a volcanic ridge, vertical walls							
45	07/04/2023	-1263 m	-899 m	35.8981° N	2.2852° W	35.8960° N	2.2752° W
OASIS 10 - Cabliers, vertical wall							
71	08/04/2023	-808 m	-751 m	35.8831° N	-2.2363° W	36.8837° N	2.2348° W
OASIS 11 - Catifas, location for long-term deployment of lander and gravity coring							
81	09/04/2023	-403 m	-365 m	35.8506° N	-2.5749° W	36.8463° N	2.5826° W
OASIS 12 - Catifas, SfM on the ridge of a living CWC mound							
82	09/04/2023	-473 m	-340 m	35.8303° N	-2.5770° W	36.8313° N	2.5744° W
OASIS 13 - Catifas, check for lander (long-term) deployment - need to recover							
99	10/04/2023	-417 m	-333 m	35.8311° N	2.5742° W	35.8312° N	2.5744° W
OASIS 14 - Catifas, check for lander (long-term) deployment, fine!							
102	10/04/2023	-348 m	-336 m	35.8497° N	2.5767° W	35.8492° N	2.5771° W
OASIS 15 - Catifas, vertical wall							
108	11/04/2023	-508 m	-454 m	35.7724° N	2.5647° W	35.8492° N	2.5771° W

Table 5.1: main characteristics and coordinates of the 15 OASIS ROV dives.

Dive OASIS – 1

Area, date, time: Cabliers, 01 April, 10:06 - 14:23

Depth range: 640 m – 261 m **Length**: 2.6 km **Time at the bottom**: 04:17 hours

Main objectives of the dive: explore the crest of a ridge-like CWC mound in Cabliers north and the habitats at the top of the volcanic bank (Fig. 5.6).

Main findings of the dive: the crest of the mound consists of dead CWC framework, serving as substrate for dominant gorgonians (*Acantogorgia hirsuta*). The top of the bank is colonized by a well preserved glass sponge field of *Asconema setubalense*, with large and grown individuals (Figs. 5.7, 5.8).

Samples*: Asconema setubalense* and coral rubble (*L. pertusa*)

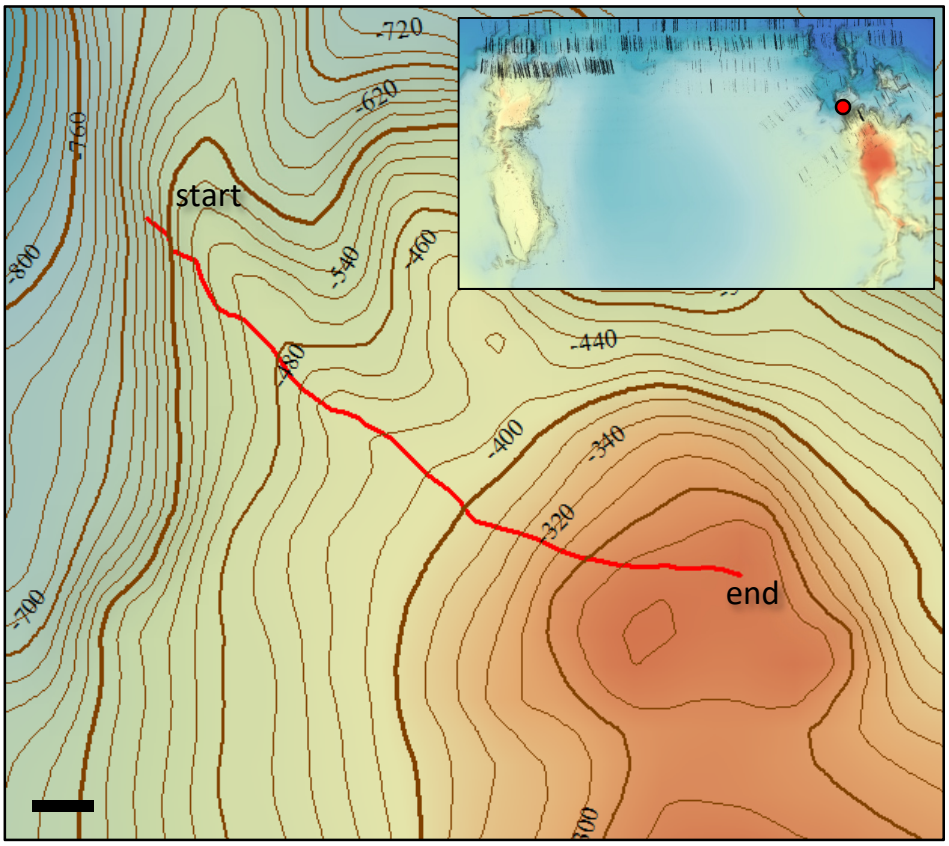

Figure 5.6: ROV track of dive OASIS – 1. Scale bar is 200 m long.

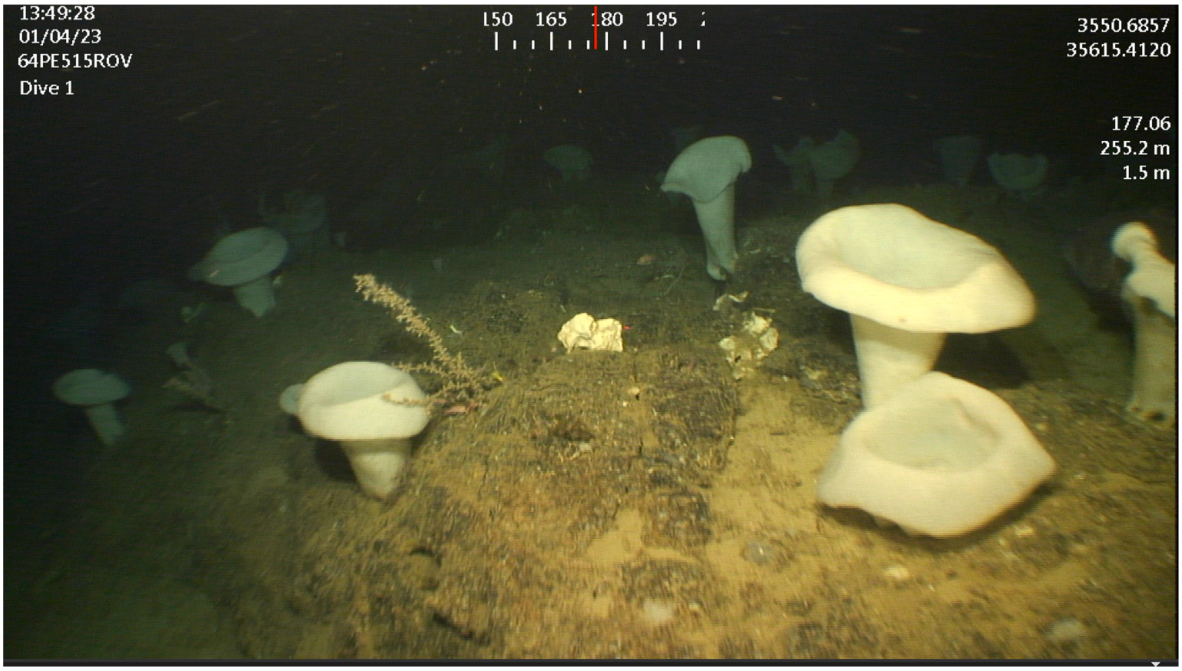

Figure 5.7: video frame from the ROV dive OASIS-1 showing glass sponges *A. setubalense* on volcanic substrate.

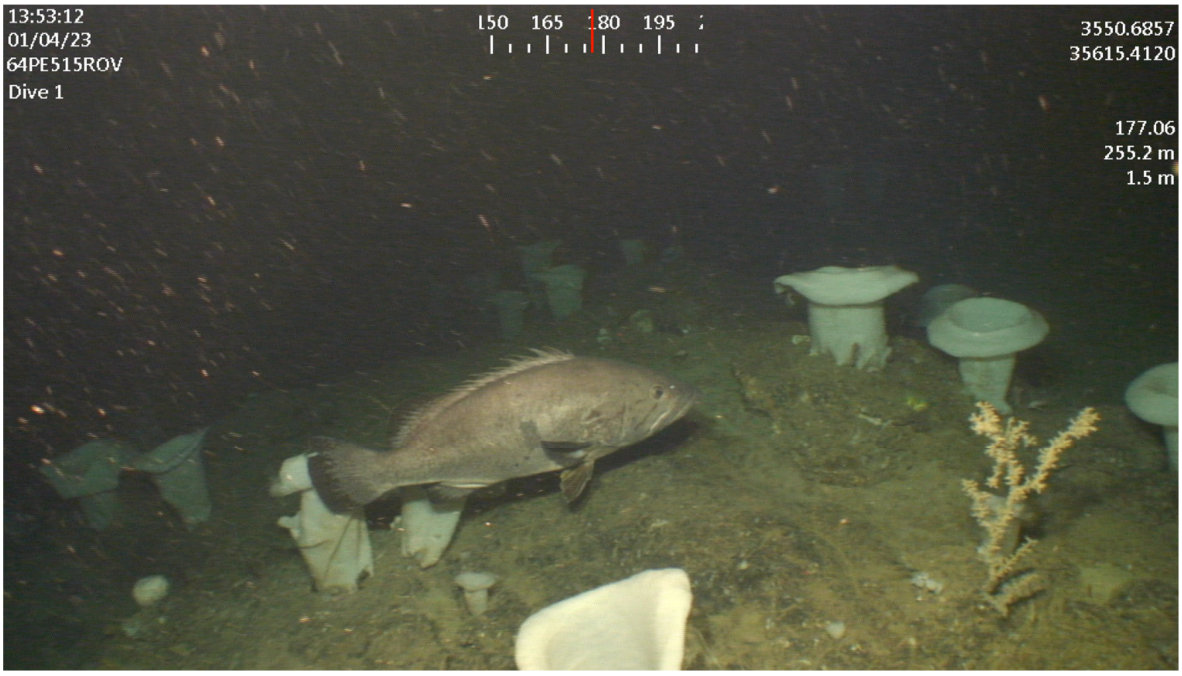

Figure 5.8: video frame from the ROV dive OASIS-1 showing glass sponges *A. setubalense* on volcanic substrate and a deep-sea grouper (*Epinephelus marginatus*?).

Dive OASIS – 2

Area, date, time: Cabliers, 01 April, 15:37 – 17:13

Depth range: 683 m – 598 m **Length**: 1.2 km **Time at the bottom**: 01:35 hours

Main objectives of the dive: explore the crest of a ridge-like CWC mound in Cabliers north – deeper portion of the mound explored in Dive 1 (Fig. 5.9).

Main findings of the dive: dead CWC frameworks with gorgonians (*A. hirsuta*) alternated to fine sediment portions (Figs. 5.10, 5.11).

Samples: piece of CWC framework

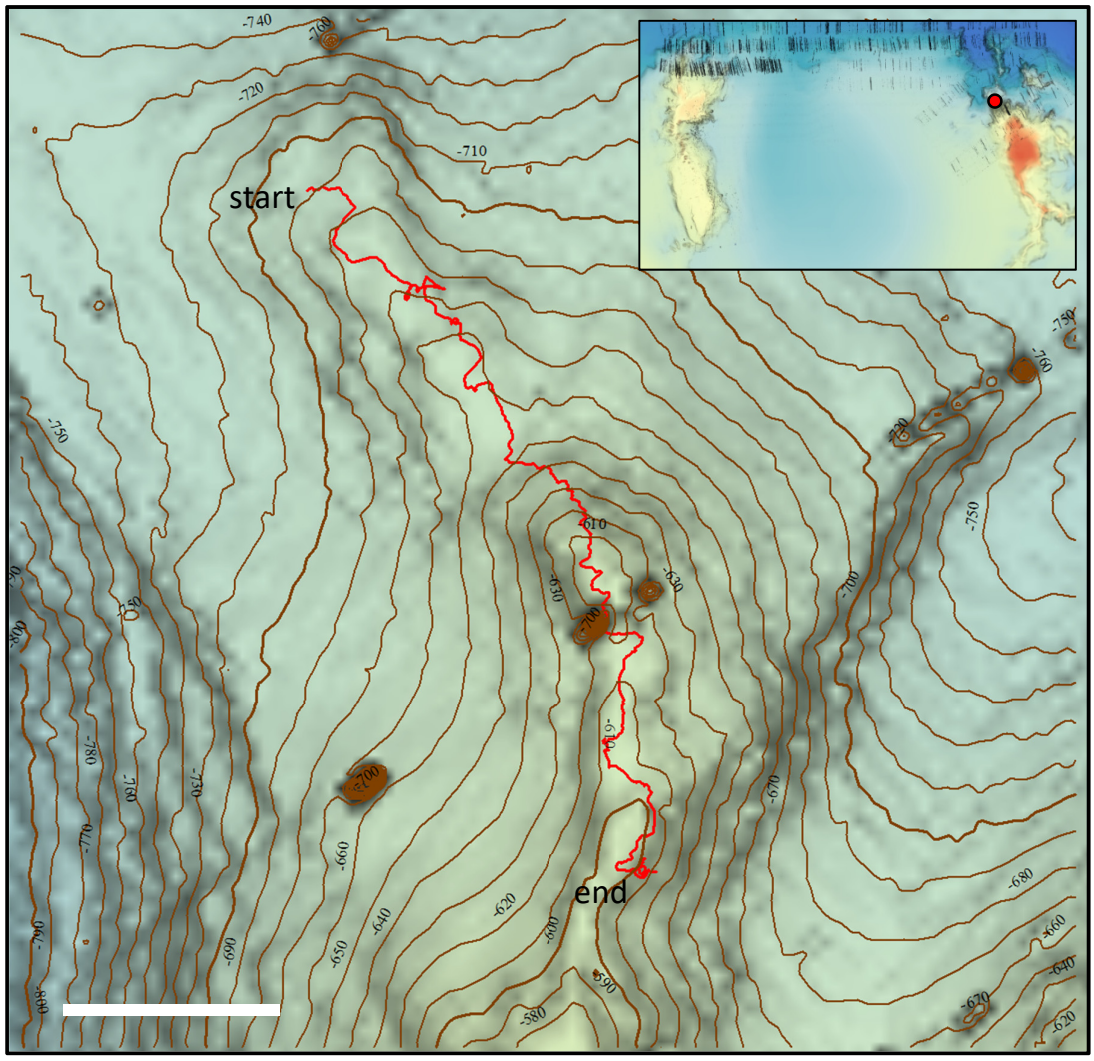

Figure 5.9: ROV track of dive OASIS – 2. Scale bar is 200 m long.

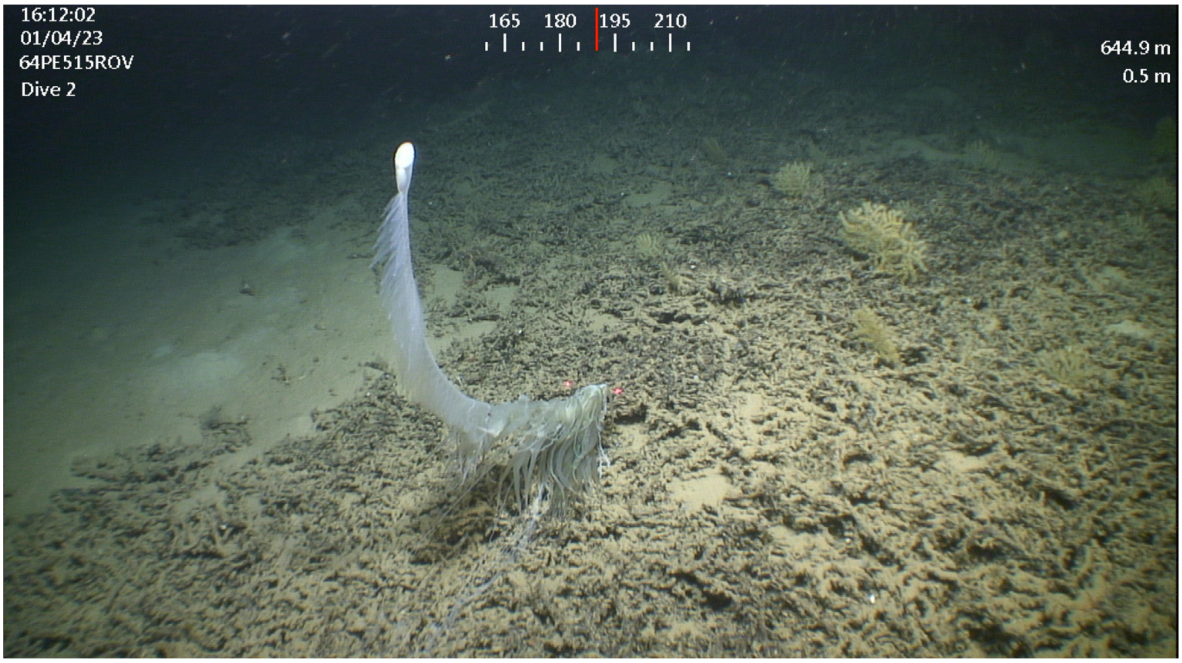

Figure 5.10: video frame from the ROV dive OASIS-2 showing a substrate of dead CWC frameworks and the siphonophorae *Bathyphysa conifera*.

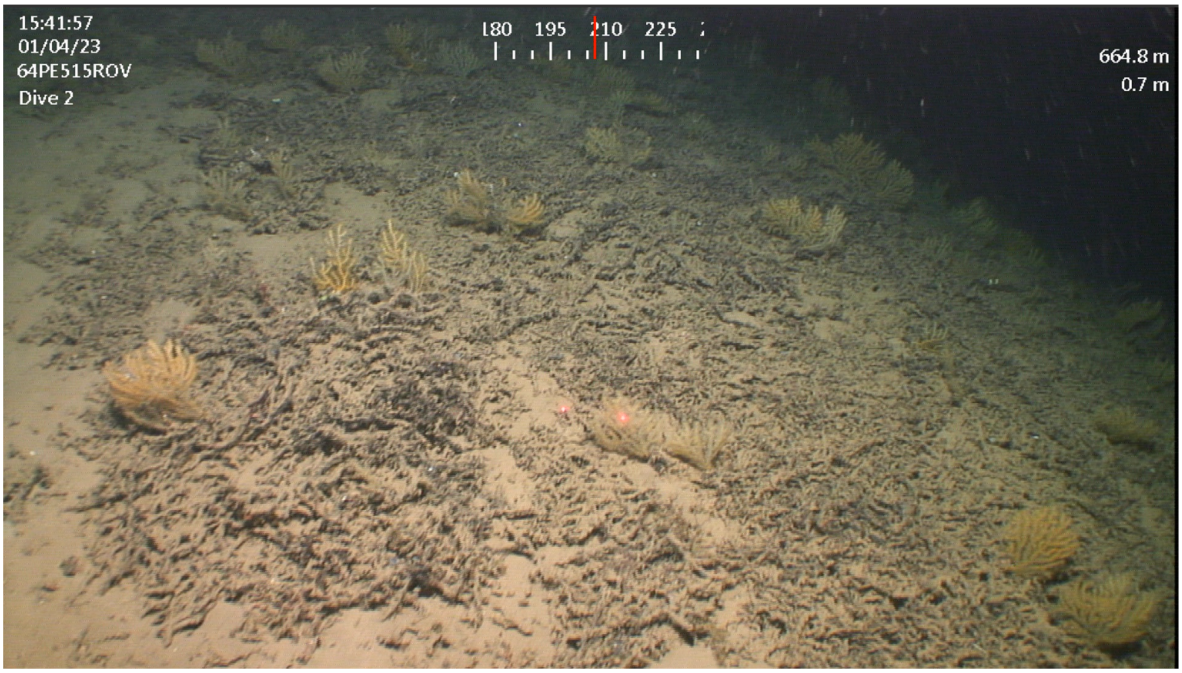

Figure 5.11: video frame from the ROV dive OASIS-2 showing a substrate of dead CWC frameworks with several colonies of the gorgonian *A. hirsuta*.

Dive OASIS – 3

Area, date, time: Catifas, 02 April, 06:55 – 12:30

Depth range: 391 m – 344 m **Length**: 4.1 km **Time at the bottom**: 05:34 hours

Main objectives of the dive: explore the crest of Catifas CWC mounds (Fig. 5.12).

Main findings of the dive: CWC framework colonized by gorgonians (*Acantogorgia*) and few glass sponges (*Asconema setubalense*). At the shallowest depths of the dive (around 350 m) dominant living CWC assemblages, mainly *Lophelia pertusa* (large bush-like colonies) and *Madrepora oculata (isolated colonies)* (Figs. 5.13, 5.14).

Samples: Black coral (*Parantiphates larix*)

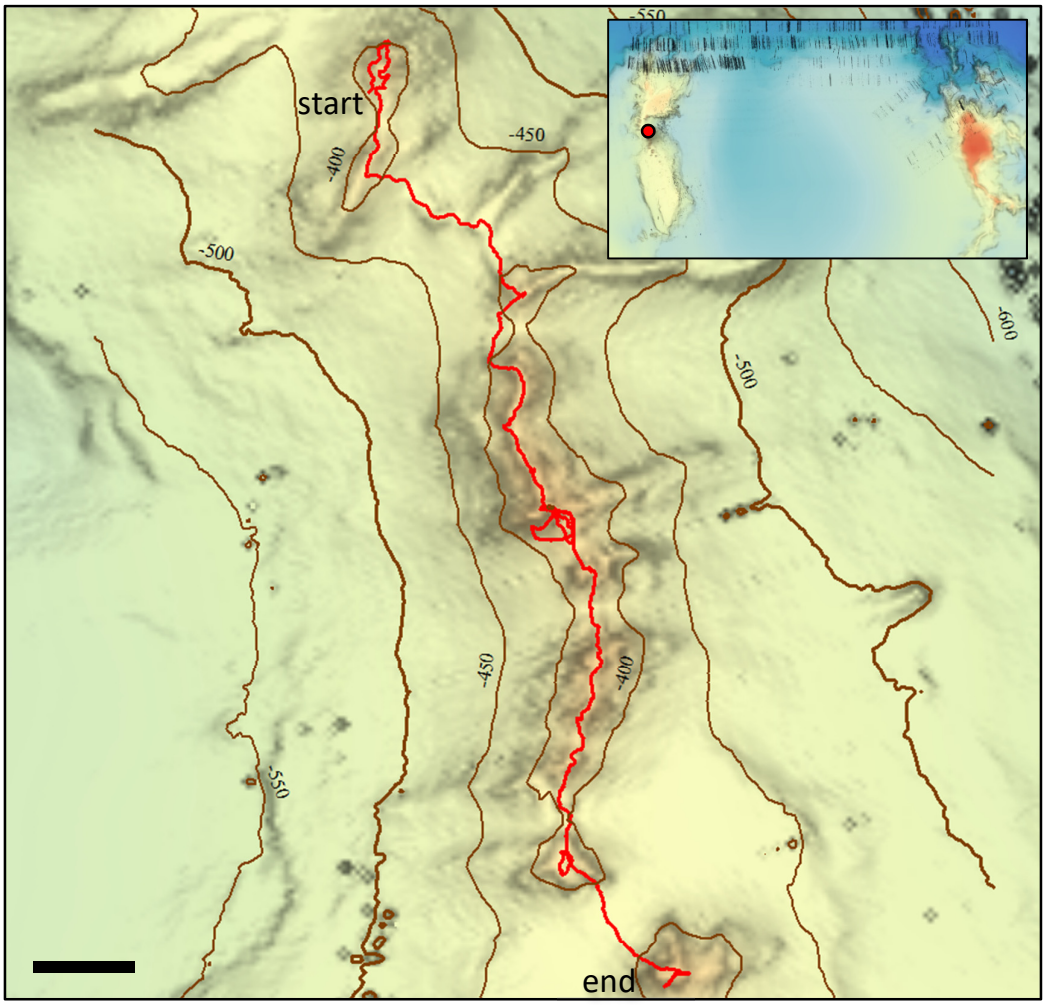

Figure 5.12: ROV track of dive OASIS – 3. Scale bar is 200 m long.

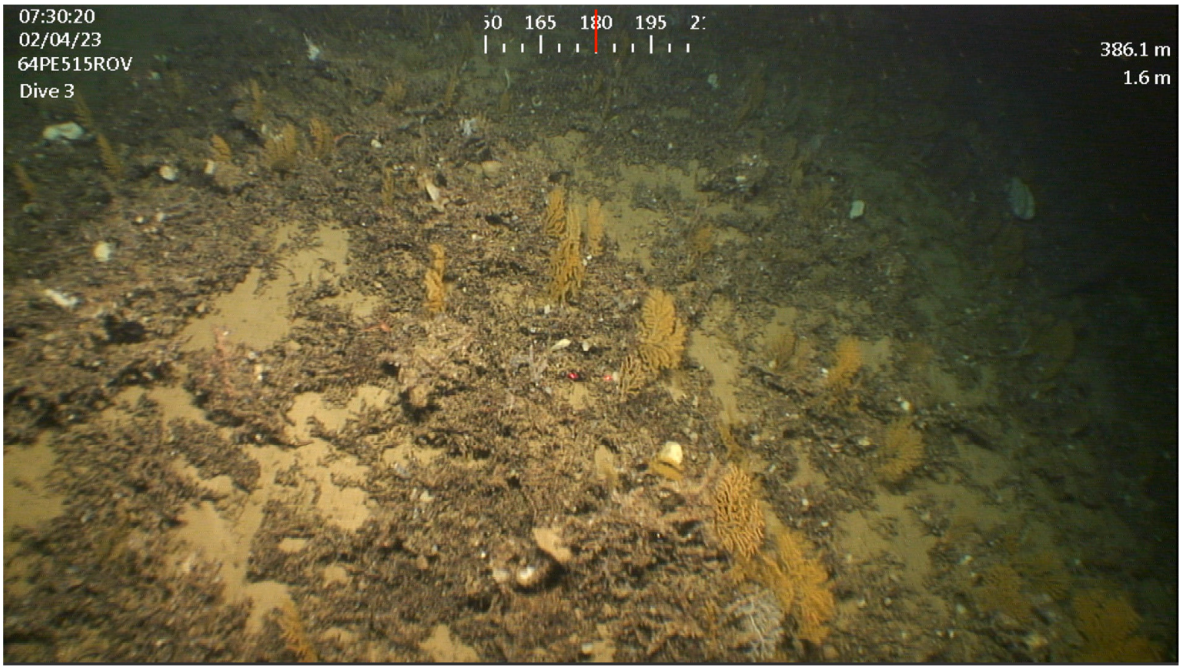

Figure 5.13: video frame from the ROV dive OASIS-3 showing a substrate of dead CWC frameworks with several colonies of the gorgonian *A. hirsuta*.

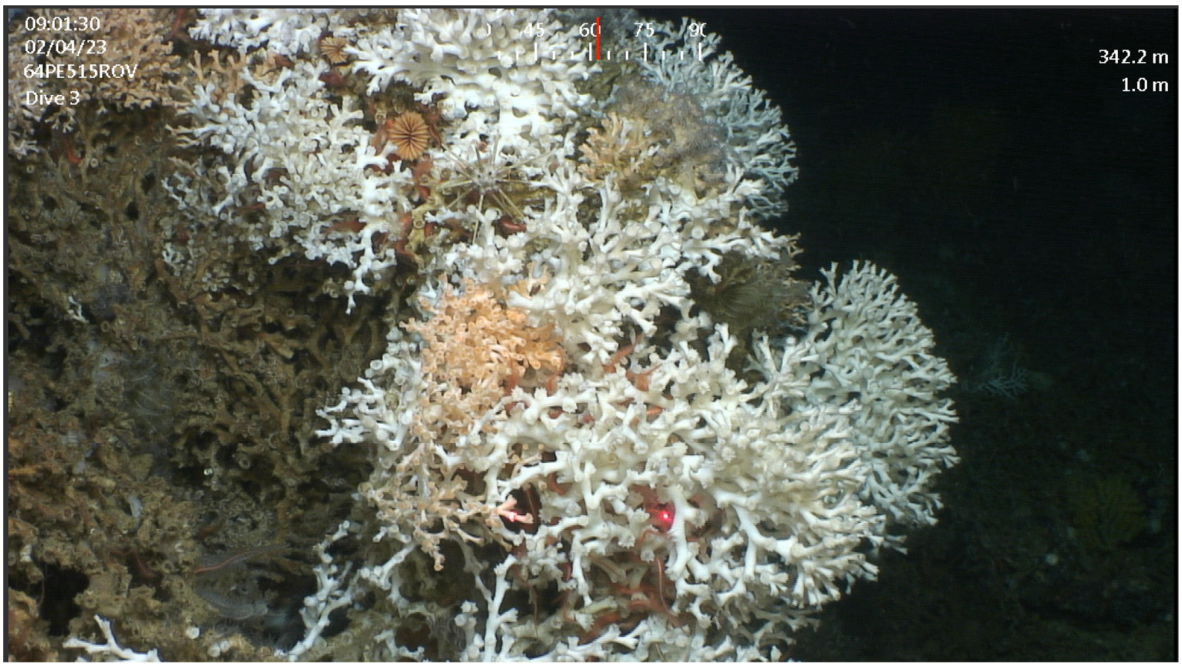

Figure 5.14: video frame from the ROV dive OASIS-3 showing thriving colonies of *L. pertusa.*

Dive OASIS – 4

Area, date, time: Catifas, 02 April, 14:26 – 17:24

Depth range: 431 m – 382 m **Length**: 2.5 km **Time at the bottom**: 02:57 hours

Main objectives of the dive: explore the crest of a linear Catifas CWC mound (Fig. 5.15)

Main findings of the dive: CWC framework colonized by gorgonians (*Acantogorgia*) and glass sponges (*A. setubalense*). Massive presence of *P. norvegicus*, including tens of molts (Figs. 5.16, 5.17).

Samples: gorgonians, living colonies of *M. oculata,* small individual of *Asconema setubalense*

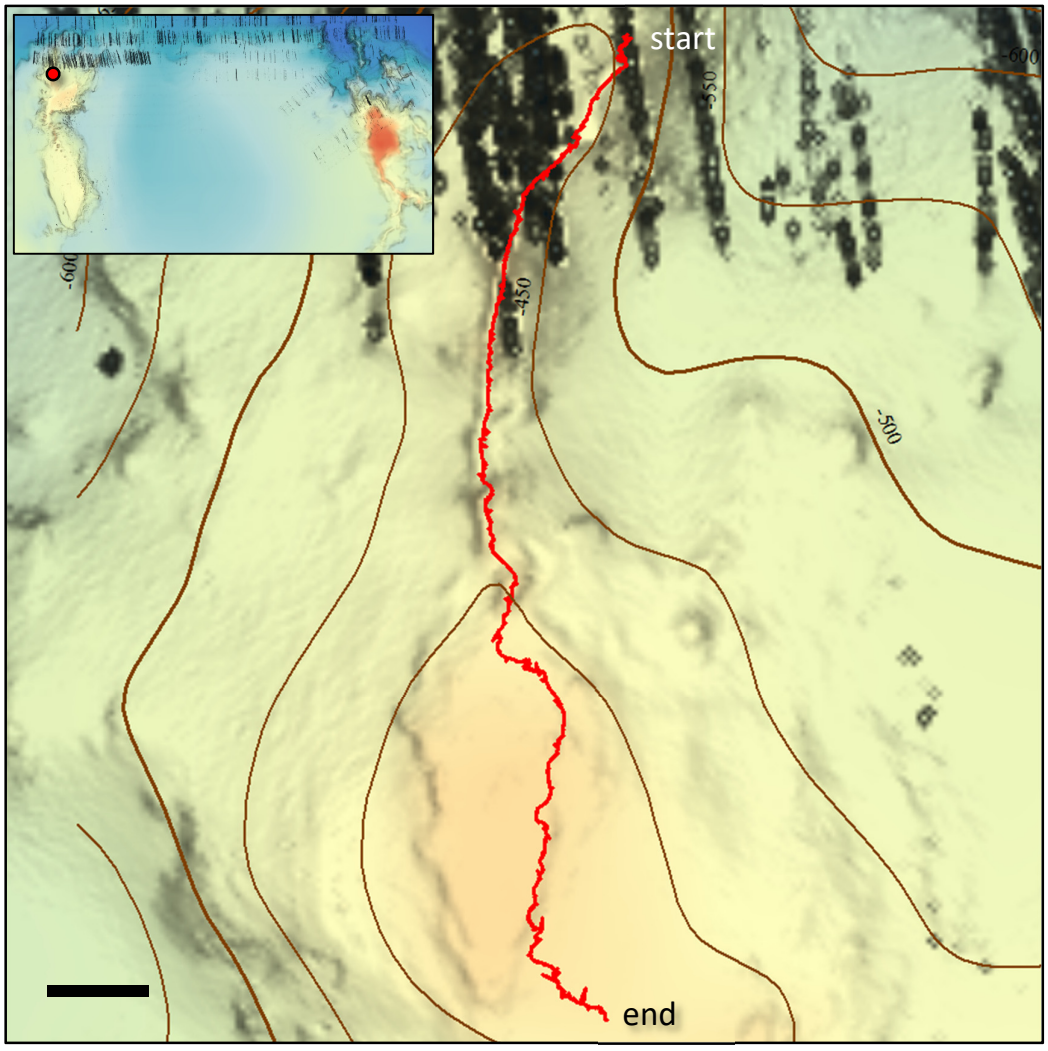

Figure 5.15: ROV track of dive OASIS – 4. Scale bar is 200 m long.

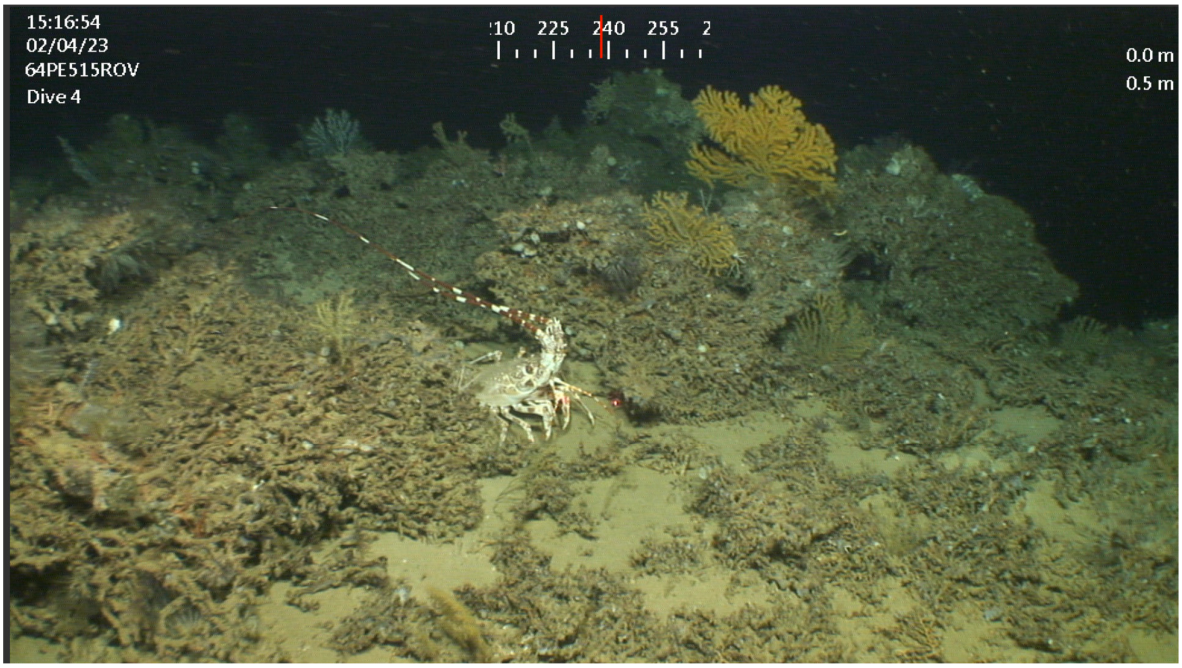

Figure 5.16: video frame from the ROV dive OASIS-4 showing a substrate of dead CWC frameworks with colonies of the gorgonian *A. hirsute* and a lobster (*P. mauritanicus*).

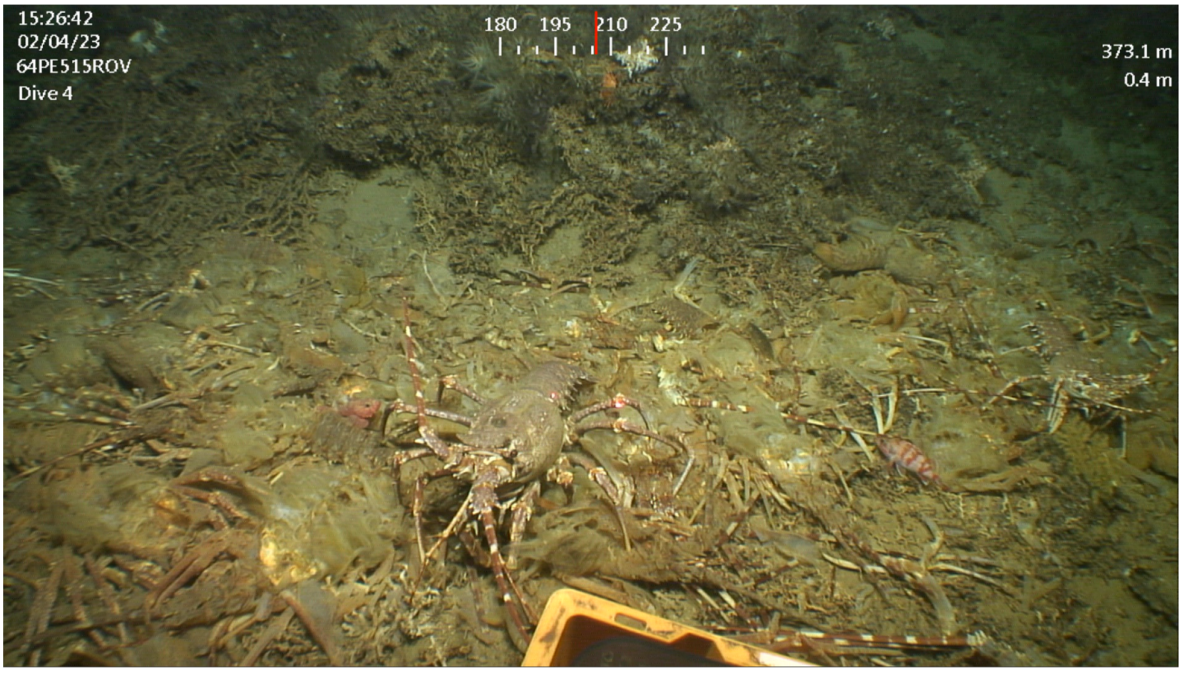

Figure 5.17: video frame from the ROV dive OASIS-4 showing several molts of *P. mauritanicus*

Dive OASIS – 5

Area, date, time: Catifas, 03 April, 07:16 – 09:41

Depth range: 419 m – 374 m **Length**: 2.3 km **Time at the bottom**: 02:25 hours

Main objectives of the dive: Structure from Motion reconstruction of a CWC mound (Fig. 5.18).

Main findings of the dive: CWC framework colonized by gorgonians (*Acantogorgia*) and glass sponges (*Asconema setubalense*). The ROV is almost unable to navigate laterally and obtain a good coverage of the seafloor for performing SfM modelling (Figs. 5.19, 5.20).

Samples: none

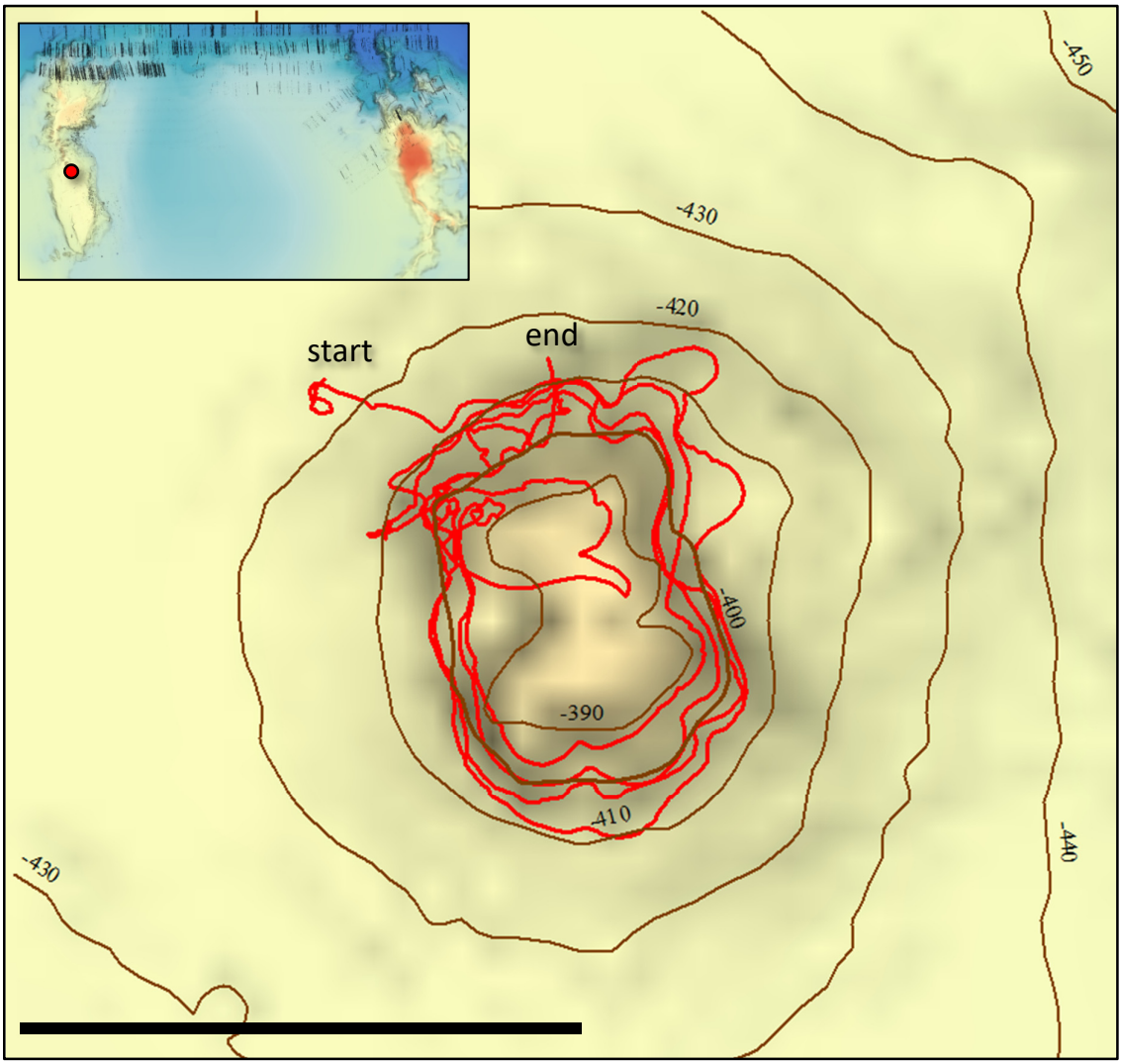

Figure 5.18: ROV track of dive OASIS – 5. Scale bar is 200 m long.

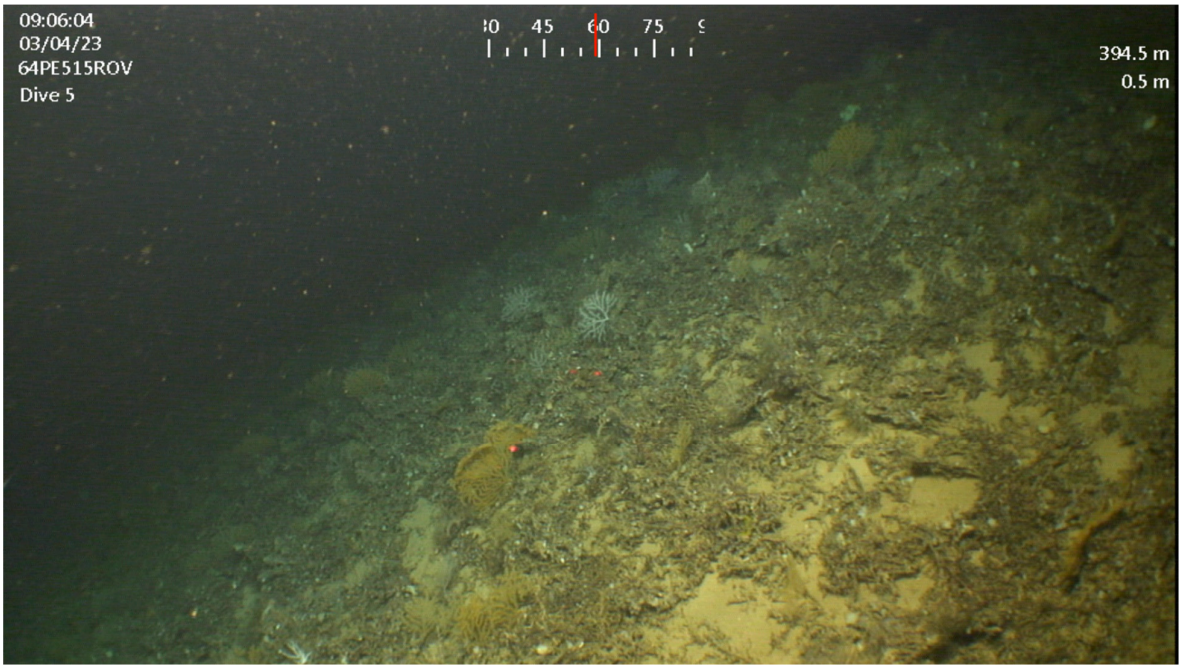

Figure 5.19: video frame from the ROV dive OASIS-5 showing a substrate of dead CWC frameworks with several colonies of the gorgonian *A. hirsuta*.

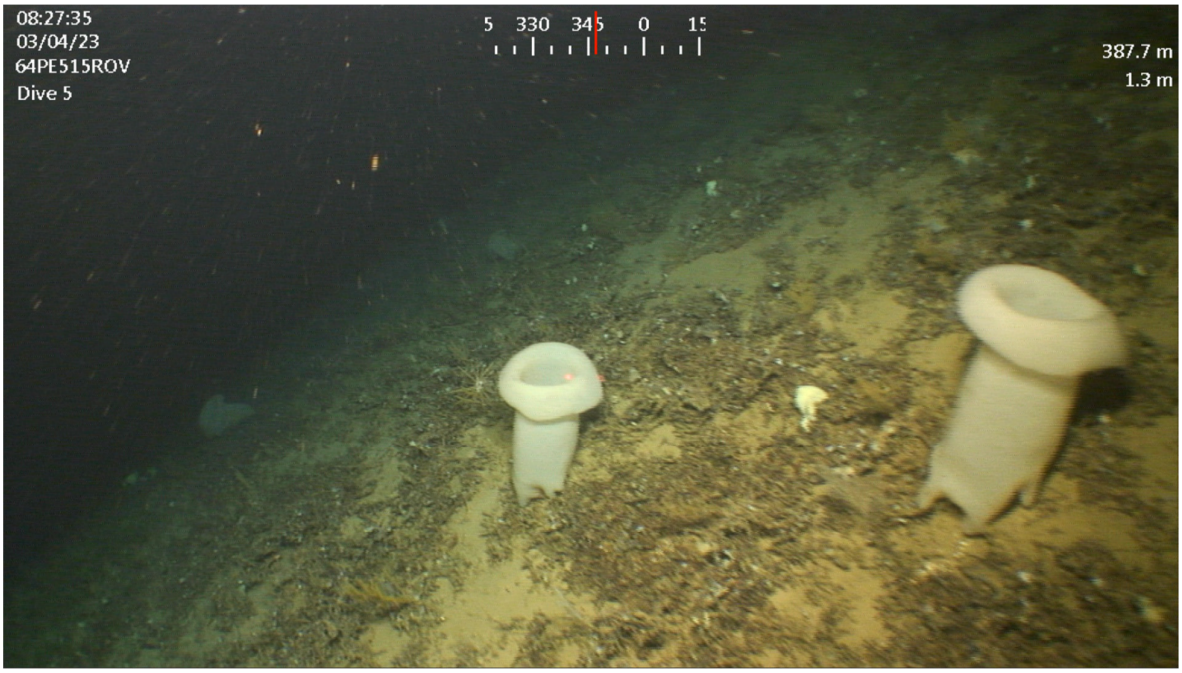

Figure 5.20: video frame from the ROV dive OASIS-5 showing a substrate of dead CWC frameworks with several colonies of the sponge *A. setubalense*.

Dive OASIS – 6

Area, date, time: Cabliers, 03 April, 16:55 – 17:36

Depth range: 283 m – 254 m **Length**: 0.34 km **Time at the bottom**: 00:40 hours

Main objectives of the dive: Explore the top of Cabliers volcanic bank (Fig. 5.21).

Main findings of the dive: Dense sponge ground (*Asconema setubalense*), with patches of whip coral *Viminella flagellum*, gorgonian *Acanthogorgia hirsuta* and soft sediment areas. Site for lander deployment (Figs. 5.22, 5.23).

Samples: piece of sponge (und.), whip coral V. *flagellum*

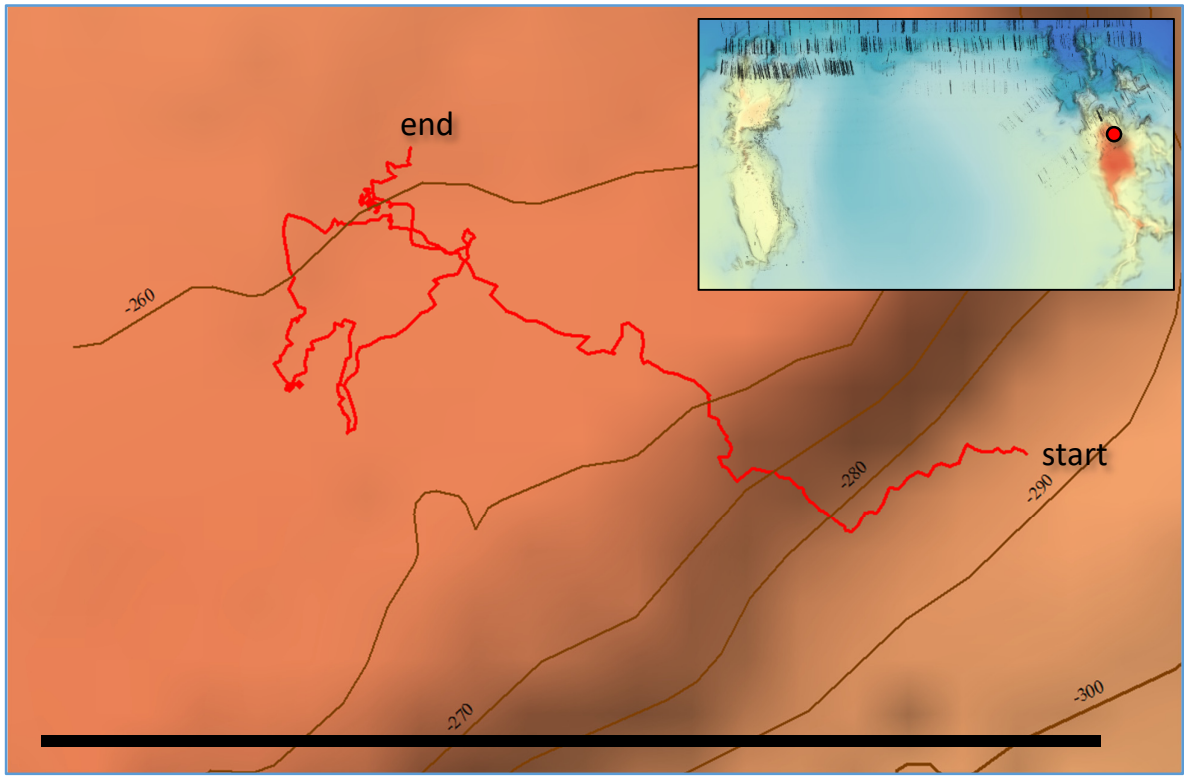

Figure 5.21: ROV track of dive OASIS – 6. Scale bar is 200 m long.

Figure 5.22: video frame from the ROV dive OASIS-6 showing glass sponges A. setubalense on a volcanic substrate.

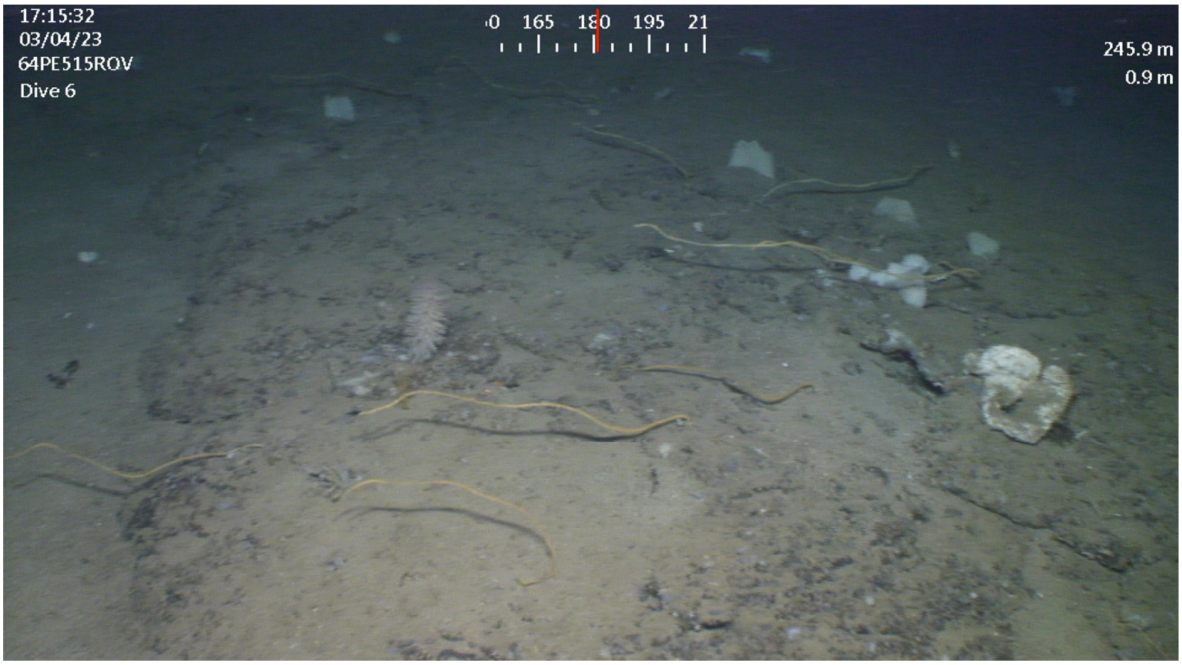

Figure 5.23: video frame from the ROV dive OASIS-6 showing a volcanic substrate with several individuals of the black coral *Viminella flagellum* and unidentified sponges.

Dive OASIS – 7

Area, date, time: Cabliers, 04 April, 07:16 – 09:40

Depth range: 876 m – 631 m **Length**: 1.23 km **Time at the bottom**: 02:23 hours

Main objectives of the dive: explore deep vertical walls of a volcanic ridge in Cabliers Bank (5.24)

Main findings of the dive: steep overhanging volcanic walls with hanging coral gardens (mainly gorgonians and black corals) and deep-sea oysters (*Neopycnodonte zibrowii*) (Figs. 5.25, 5.26).

Samples: none

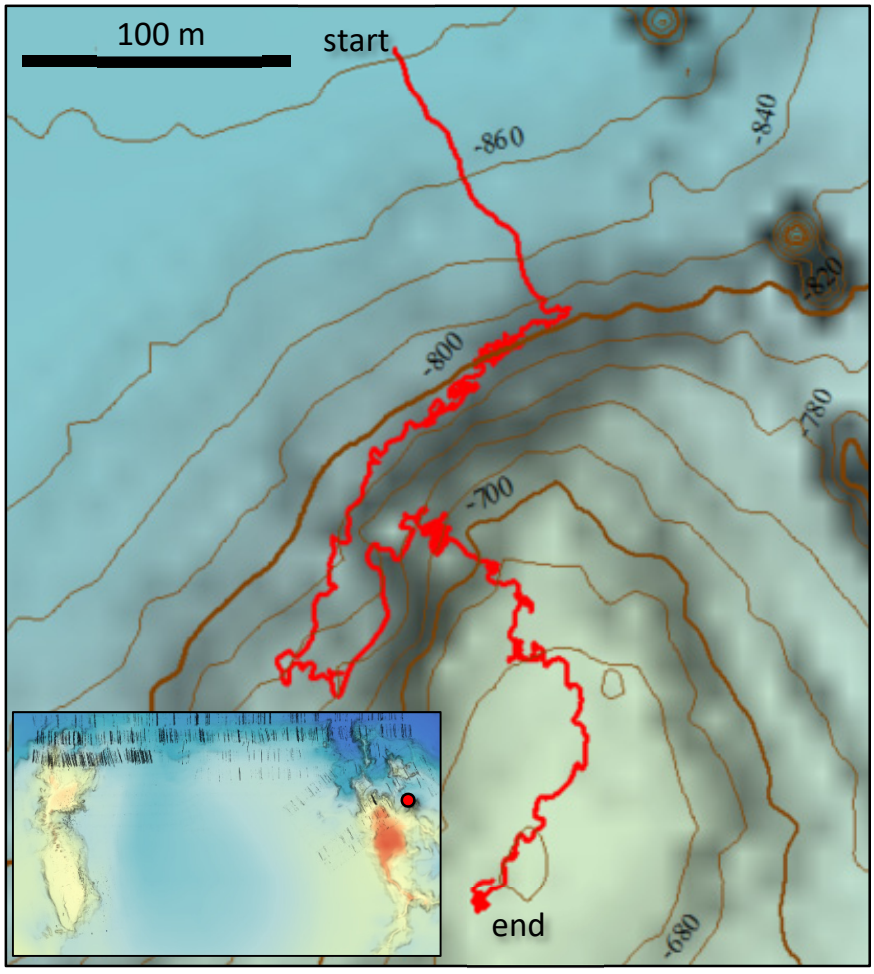

Figure 5.24: ROV track of dive OASIS – 7.

Figure 5.25: video frame from the ROV dive OASIS-7 showing a dense community of the deep-sea oyster *Neopycnodonte zibrowii*.

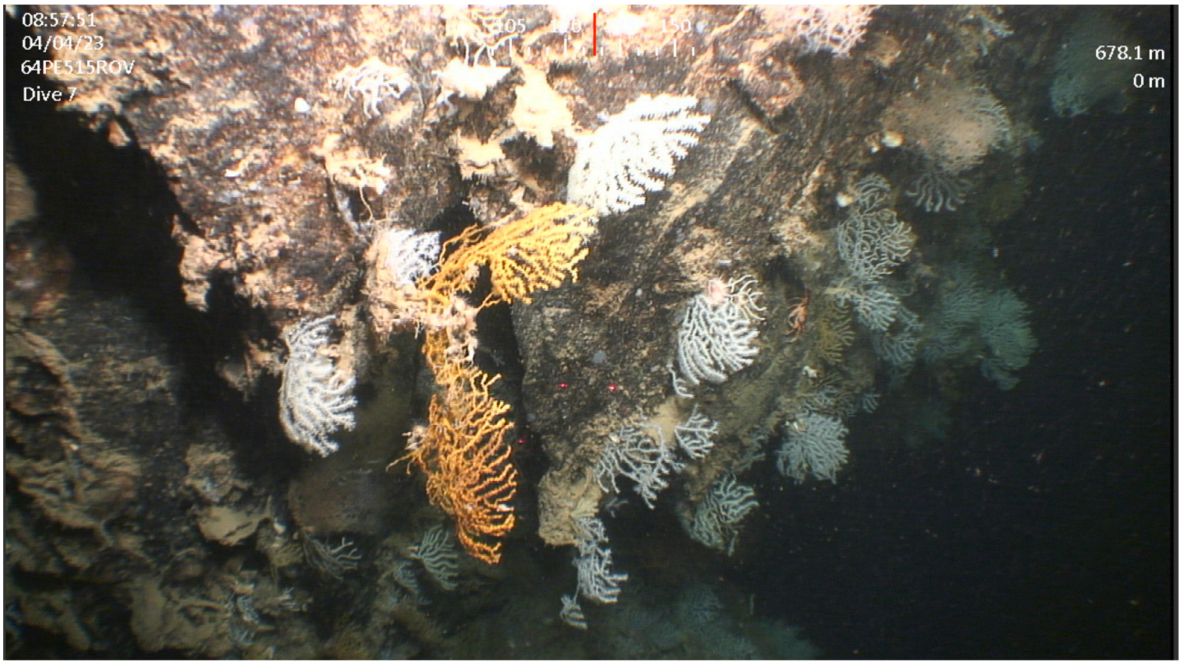

Figure 5.26: video frame from the ROV dive OASIS-7 showing a dense aggregations of gorgonians (including *Muriceides lepida*).

Dive OASIS – 8

Area, date, time: Cabliers, 04 April, 15:52 – 17:14

Depth range: 413 m – 359 m **Length**: 0.85 km **Time at the bottom**: 01:21 hours

Main objectives of the dive: check of Catifas Lander (short-deployment) (Fig. 5.27)

Main findings of the dive: Lander is deployed on a sub-horizontal substrate (top of a CWC mound), surrounded by dead CWC framework, living bush-like colonies of *L. pertusa*, gorgonians fields (*A. hirsuta*), several small sponges (*A. setubalense*) (Figs. 5.28, 5.29).

Samples: none

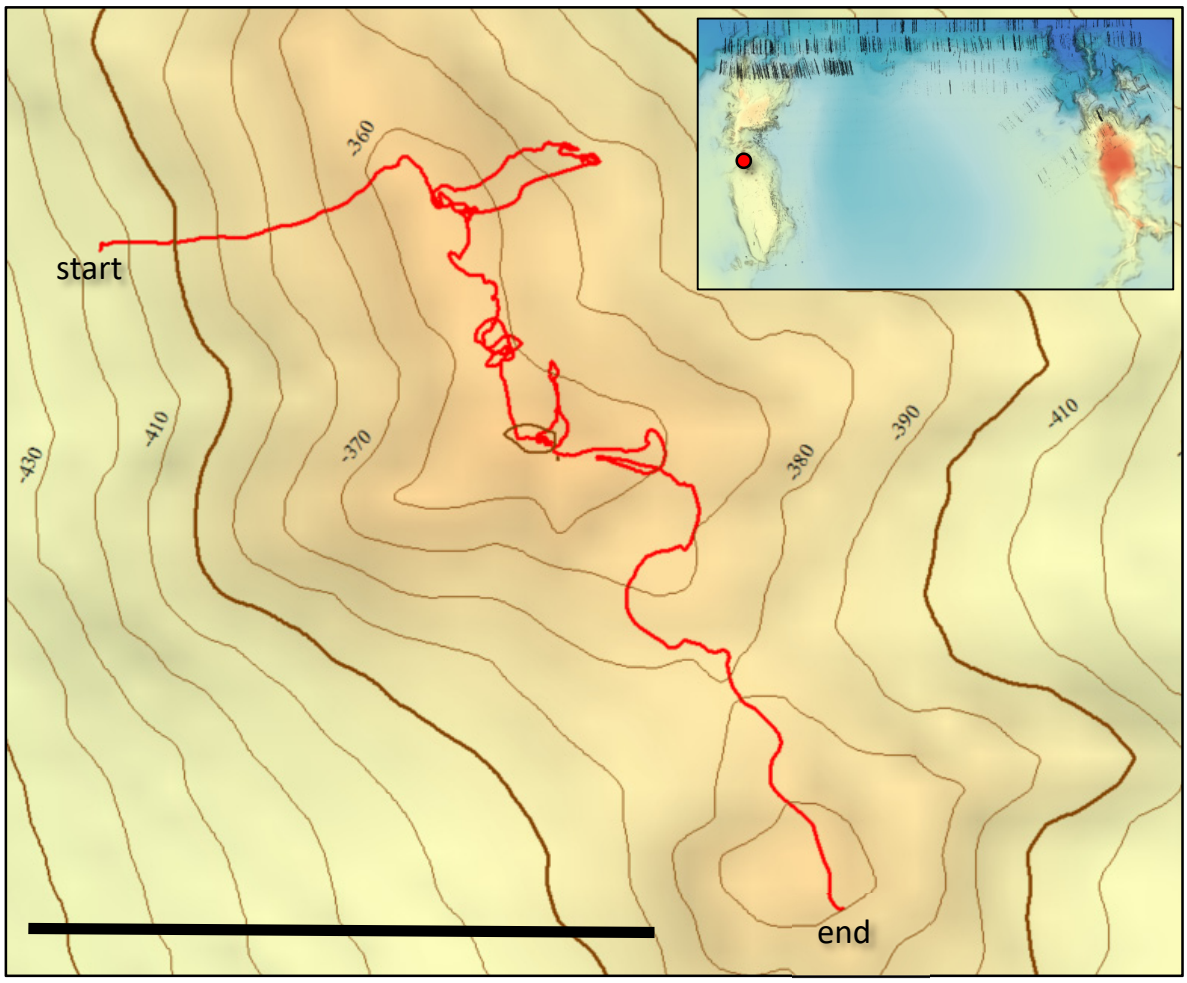

Figure 5.27: ROV track of dive OASIS – 8. Scale bar is 200 m long.

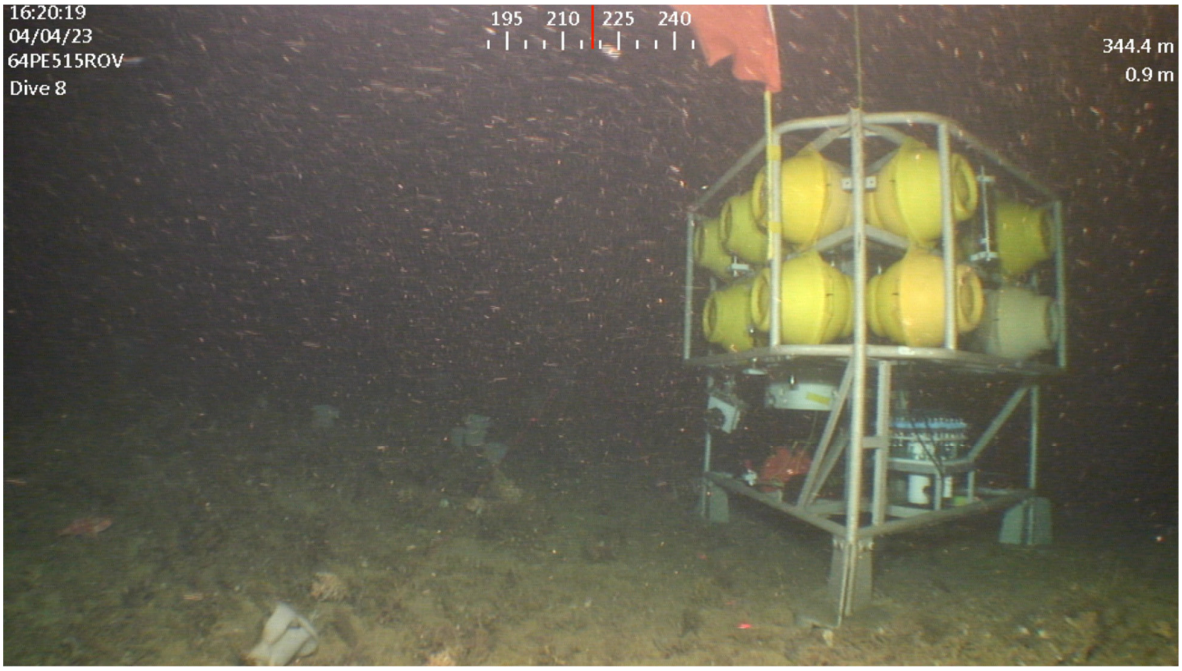

Figure 5.28: video frame from the ROV dive OASIS-8 showing the ALBEX benthic lander on the Catifas short-term deployment site.

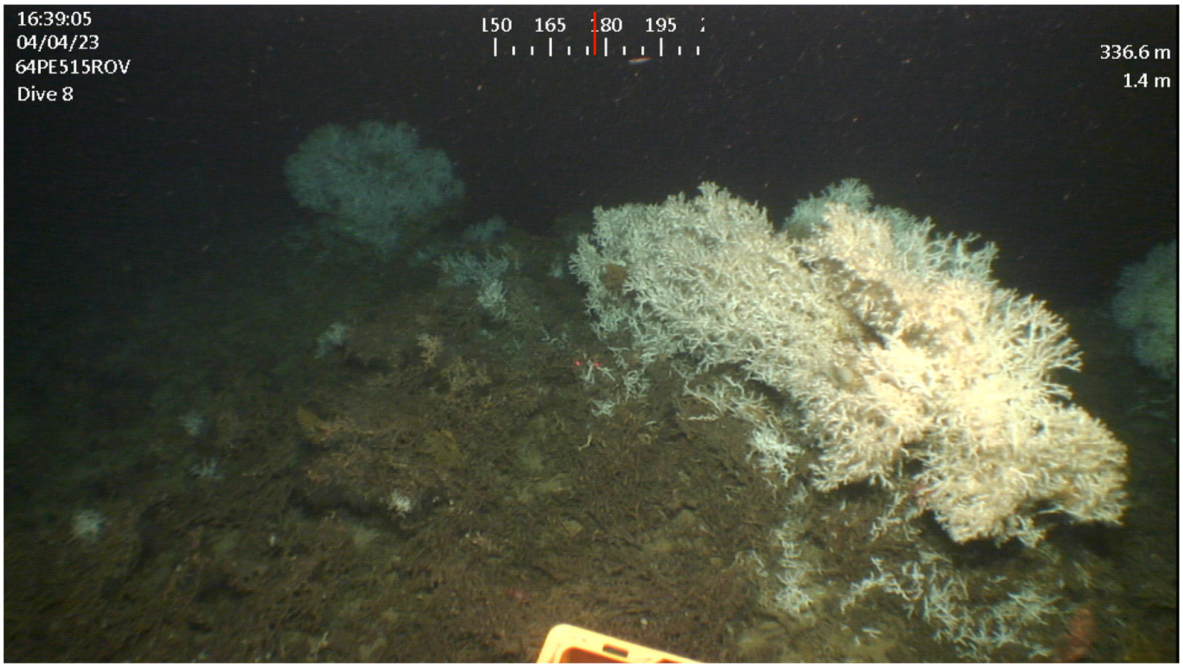

Figure 5.29: video frame from the ROV dive OASIS-8 showing *L. pertusa* colonies few meters from the ALBEX benthic lander (Catifas short-term).

Dive OASIS – 9

Area, date, time: Cabliers, 07 April, 09:36 – 12:30

Depth range: 1263 m – 899 m **Length**: 2.04 km **Time at the bottom**: 02:43 hours

Main objectives of the dive: explore deep vertical walls of a volcanic ridge in Cabliers Bank (Fig. 5.30)

Main findings of the dive: the dive starts on deep (>1000 m) sediment area and flows up with very steep volcanic walls, colonized by patchy aggregations of gorgonian *A. hirsute* (Figs. 5.31, 5.32).

Samples: CWC framework

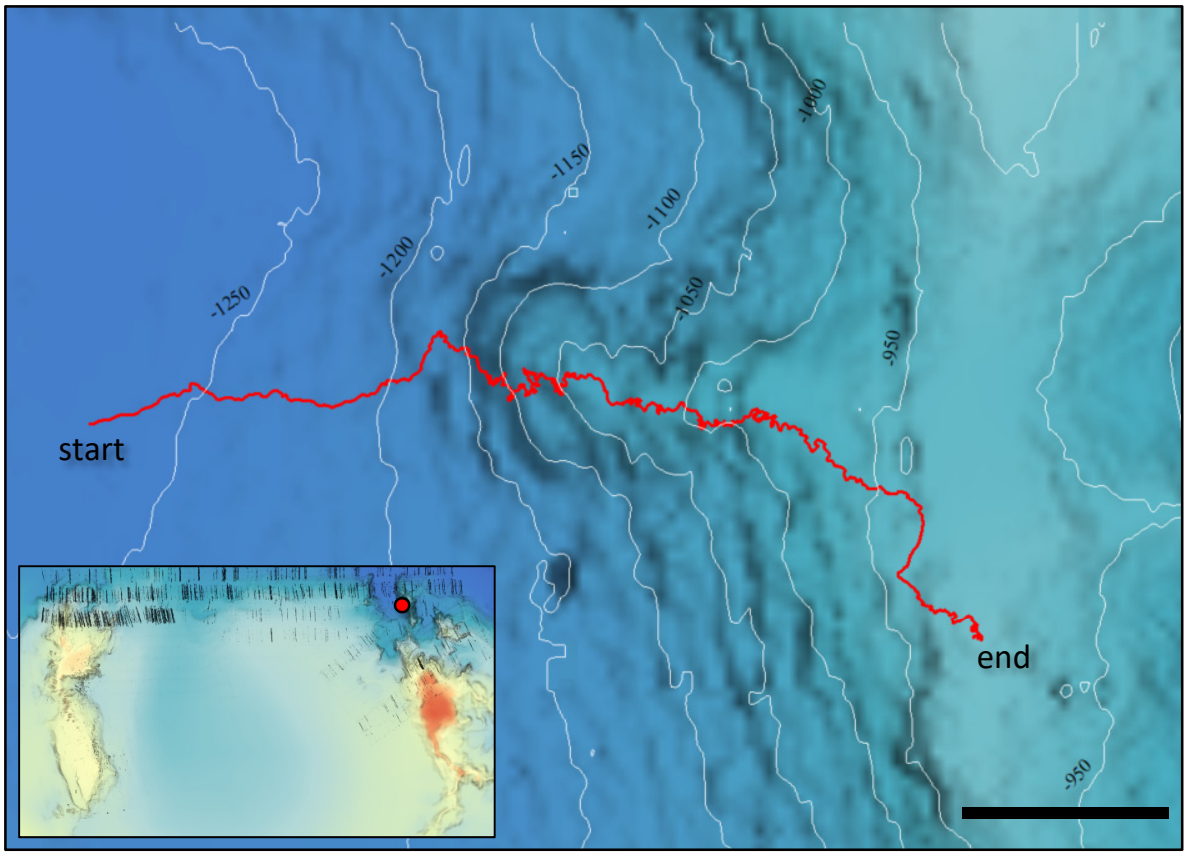

Figure 5.30: ROV track of dive OASIS – 9. Scale bar is 200 m long.

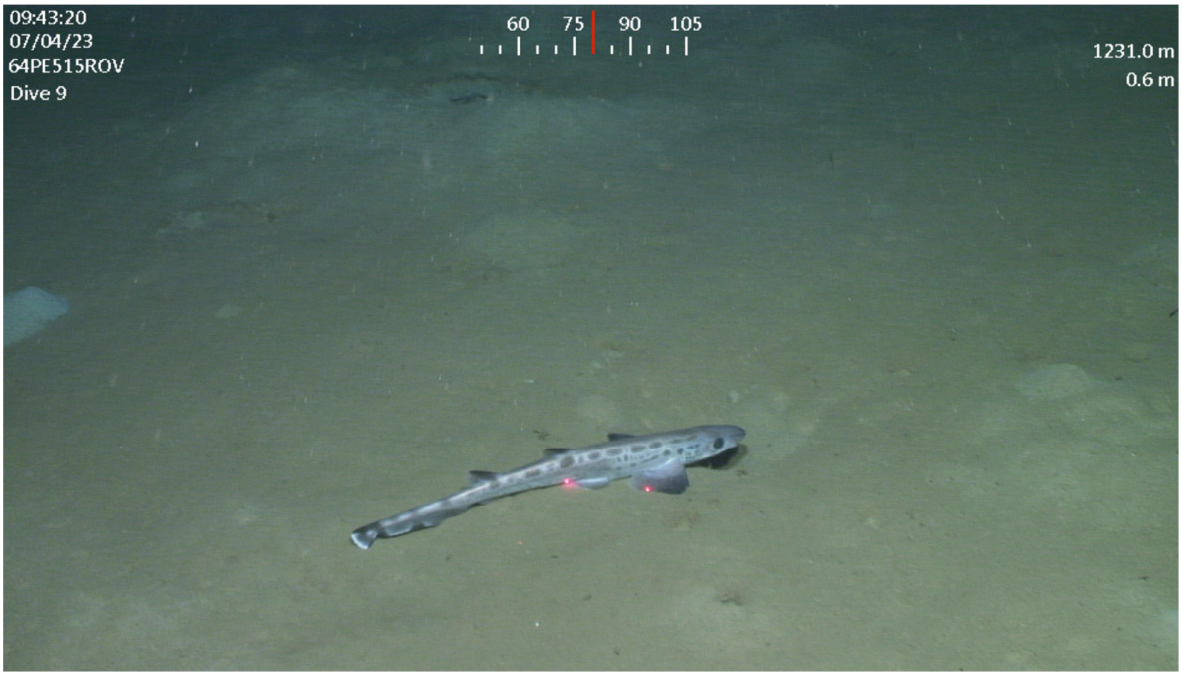

Figure 5.31: video frame from the ROV dive OASIS-9 showing a deep-sea shark on soft-sediment substrate (start of the dive).

Figure 5.32: video frame from the ROV dive OASIS-9 showing grown colonies of *A. hirsuta* on the steep volcanic wall.

Dive OASIS – 10

Area, date, time: Cabliers, 08 April, 08:05 – 09:32

Depth range: 808 m – 751 m **Length**: 1.30 km **Time at the bottom**: 1:27 hours

Main objectives of the dive: explore deep vertical walls of a volcanic ridge in Cabliers Bank (Fig. 5.33)

Main findings of the dive: volcanic bank steep volcanic walls, colonized by patchy aggregations of gorgonian *A. hirsuta,* black coral *Leiopathes sp.*, sponge *Sympagella delauzei* (Figs. 5.34, 5.35). Preliminary observation likely show that benthic communities are more common on a flank of the bank which is more exposed to inputs of organic matter (marine snow). The dive was interrupted as the umbilical cable got stack on a rock crevice. The cable was finally released from the rock and repaired on board.

Samples: none

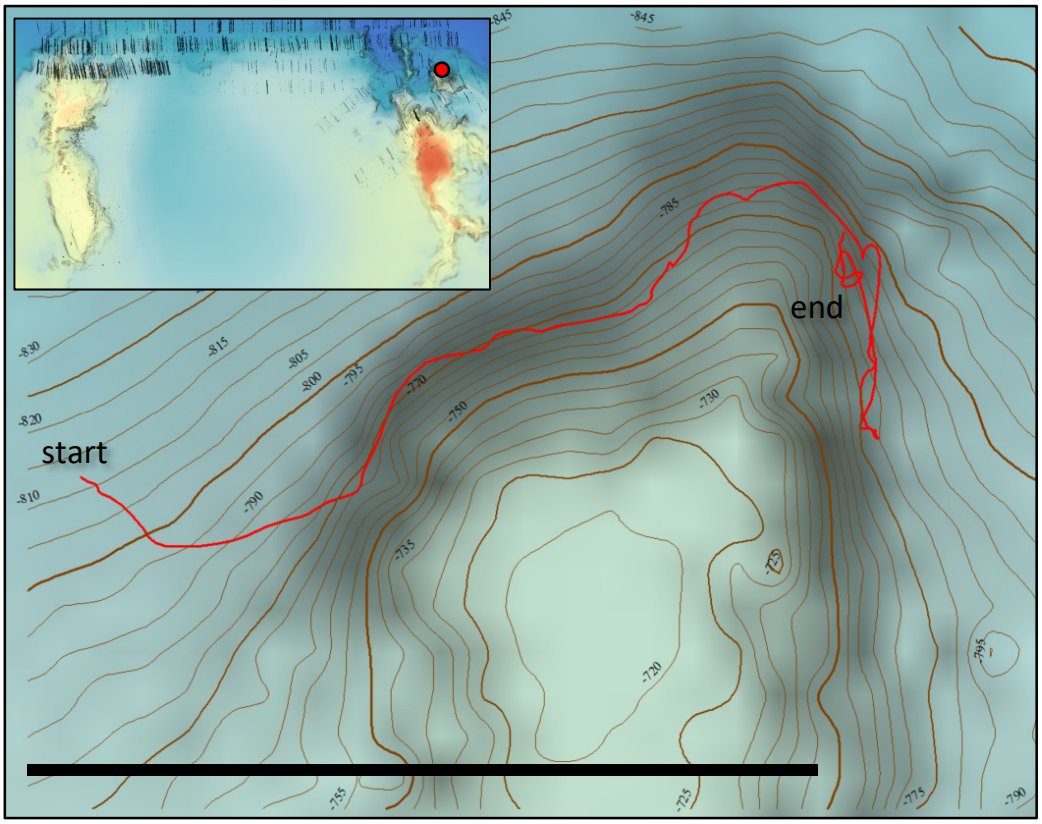

Figure 5.33: ROV track of dive OASIS – 10. Scale bar is 200 m long.

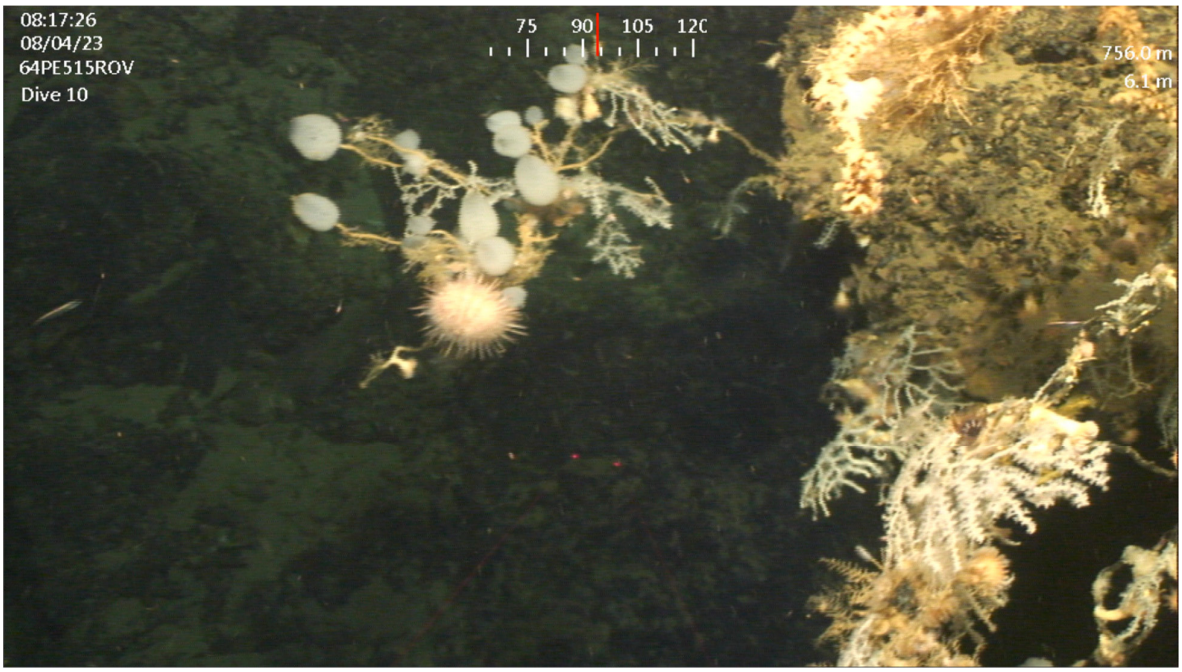

Figure 5.34: video frame from the ROV dive OASIS-10 showing grown colonies of *M. lepida* and the sponge *Sympagella delauzei* on the steep volcanic wall.

Figure 5.35: video frame from the ROV dive OASIS-10 showing grown colonies of the black coral *Leiopathes sp.* on the steep volcanic wall.

Dive OASIS – 11

Area, date, time: Cabliers, 09 April, 07:38 – 10:29

Depth range: 403 m – 365 m **Length**: 2.2 km **Time at the bottom**: 02:50 hours

Main objectives of the dive: location of gravity core samples, visit the top of a mound (Fig 5.36).

Main findings of the dive: CWC mounds field with fine sediment substrate mixed with dead CWC frameworks, with glass sponge *A. setubalense*, gorgonian *A. hirsuta*, and on top of the mound assemblages dominated by living *L. pertusa* and *M. oculata* colonies. The location of the long-term deployment of the OASIS lander has been selected from this dive (Figs. 5.37, 5.38).

Samples: none

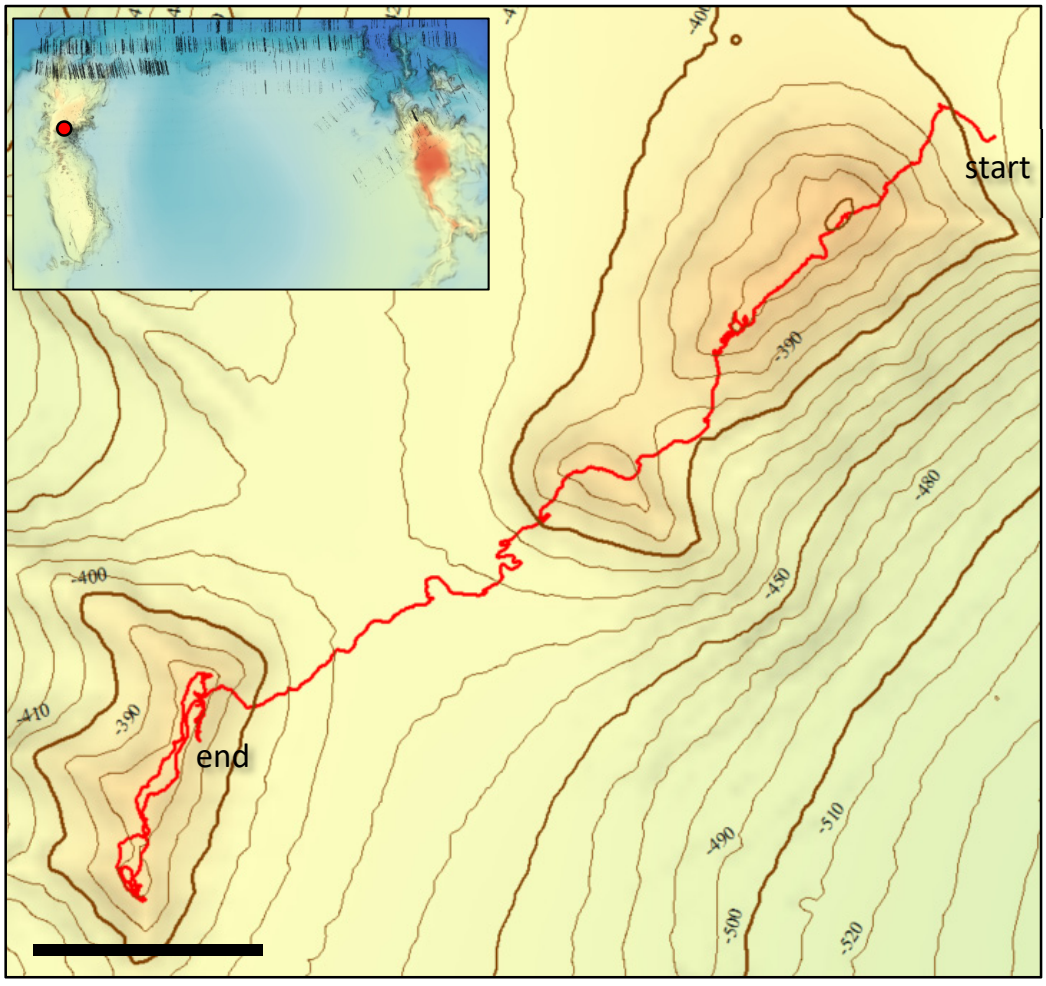

Figure 5.36: ROV track of dive OASIS – 11. Scale bar is 200 m long.

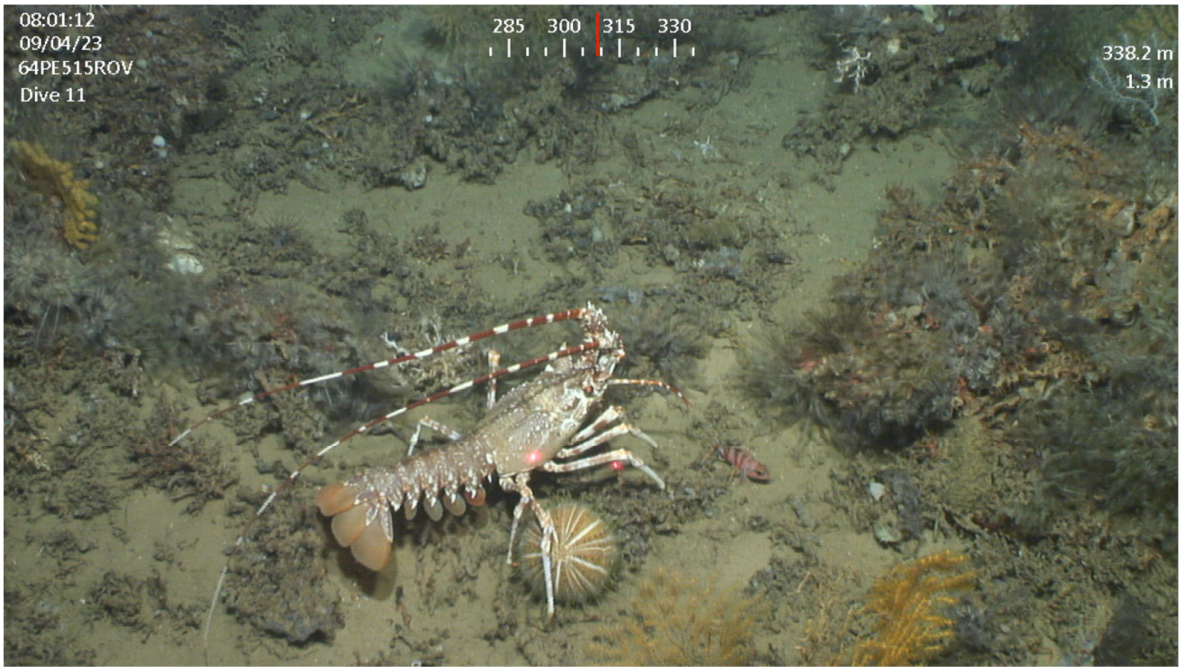

Figure 5.37: video frame from the ROV dive OASIS-11 showing *P. mauritanicus* on dead CWC frameworks

Figure 5.38: video frame from the ROV dive OASIS-11 showing a thriving colony of CWC *L. pertusa* and *M. oculata*, with a glass sponge *A. setubalense* within them.

Dive OASIS – 12

Area, date, time: Catifas, 09 April, 12:11 – 14:29

Depth range: 473 m – 340 m **Length**: 2.67 km **Time at the bottom**: 02:18 hours

Main objectives of the dive: SfM reconstruction along the crest of a CWC mound (Fig. 5.40).

Main findings of the dive: dead CWC frameworks with gorgonian *A. hirsuta*, one single colony of the gorgonian *Anthotela grandiflora*, black coral *P. larix* along the flank-top of the mound. Living *L. pertusa* and *M. oculata* colonies on top/crest of the mound (Figs. 5.41, 5.42). *Mola mola* at 13:32:56

Samples: none

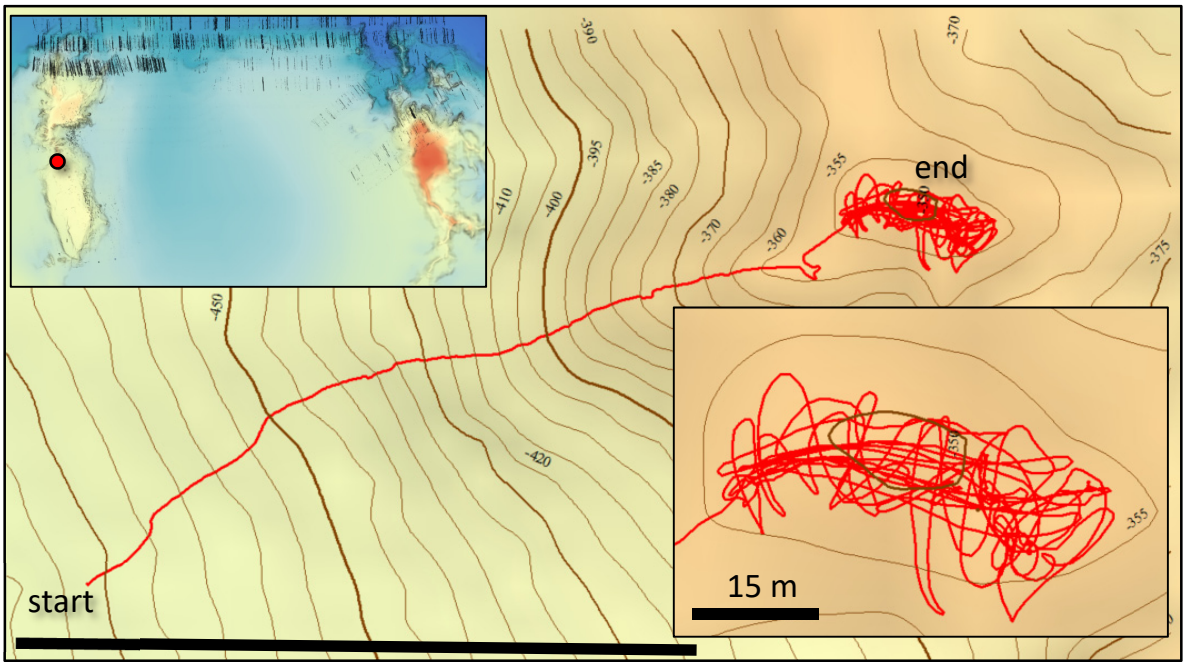

Figure 5.40: ROV track of dive OASIS – 12. Scale bar is 200 m long. The inset shows details of ROV navigation on top of the CWC mound aimed to SfM modeling.

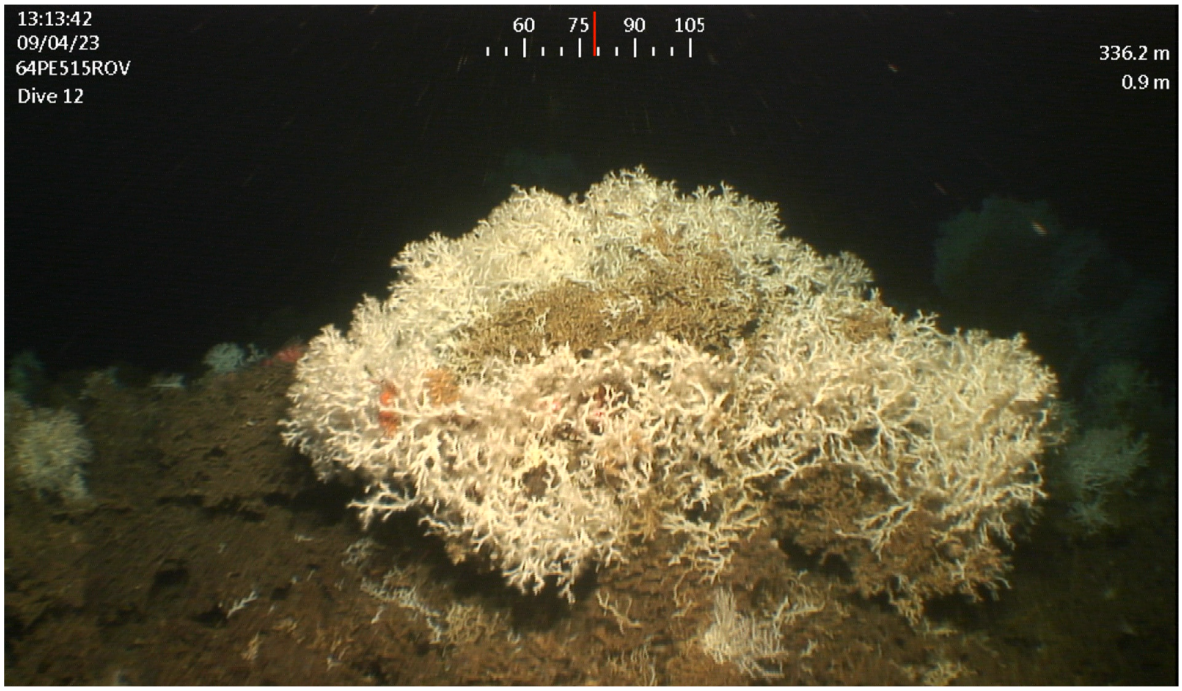

Figure 5.41: video frame from the ROV dive OASIS-12 showing a thriving colony of CWC *L. pertusa* on the regions where the SfM dive have been performed.

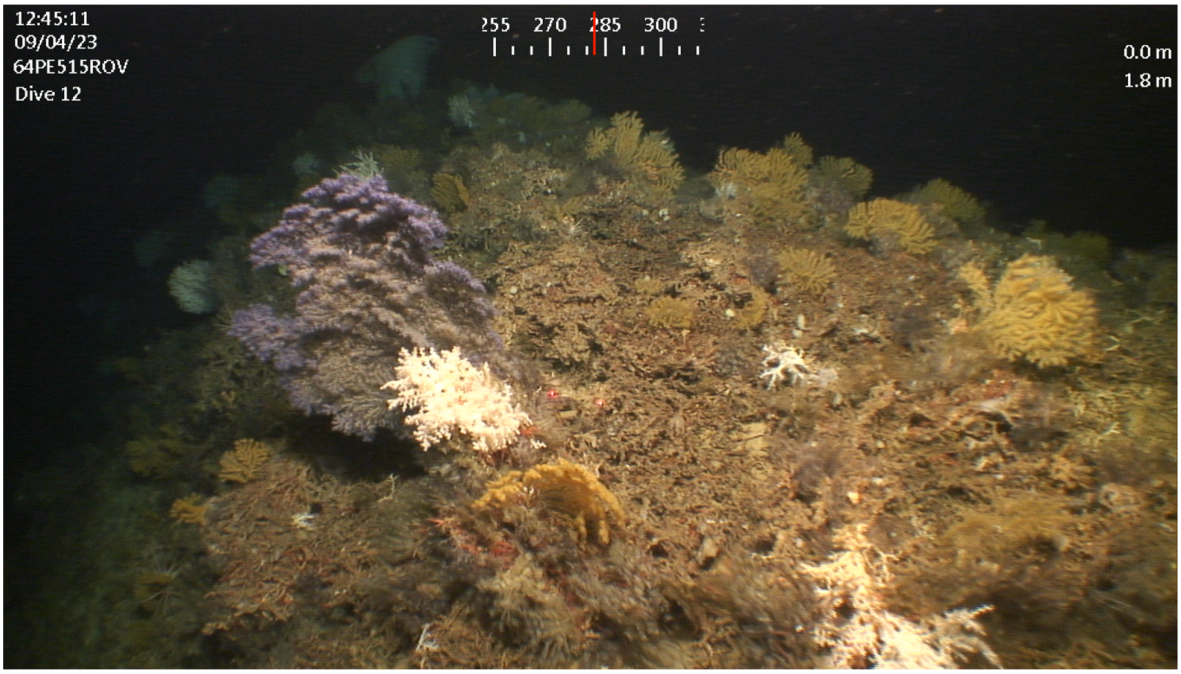

Figure 5.42: video frame from the ROV dive OASIS-12 showing dead CWC framework along the mound flank, serving as substrate for gorgonians *A. hirsuta*, *Anthotela grandiflora* (single violet colony) and small living colonies of scleractinians (likely *M. oculata*).

Dive OASIS – 13

Area, date, time: Catifas, 10 April, 14:35 – 15:03

Depth range: 417 m – 333 m **Length**: 2.2 km **Time at the bottom**: 00:27 hours

Main objectives of the dive: check of lander status (Fig. 5.43)

Main findings of the dive: The lander sat on a steep terrain. Need for recovery and new deployment on a wider area. Substrate on the flank is made of dead CWC frameworks plus the sponge *A. setubalense*. The top of the mound is fully covered by living colonies of *L. pertusa* and *M. oculata* (Figs. 5.44, 5.45).

Samples: none

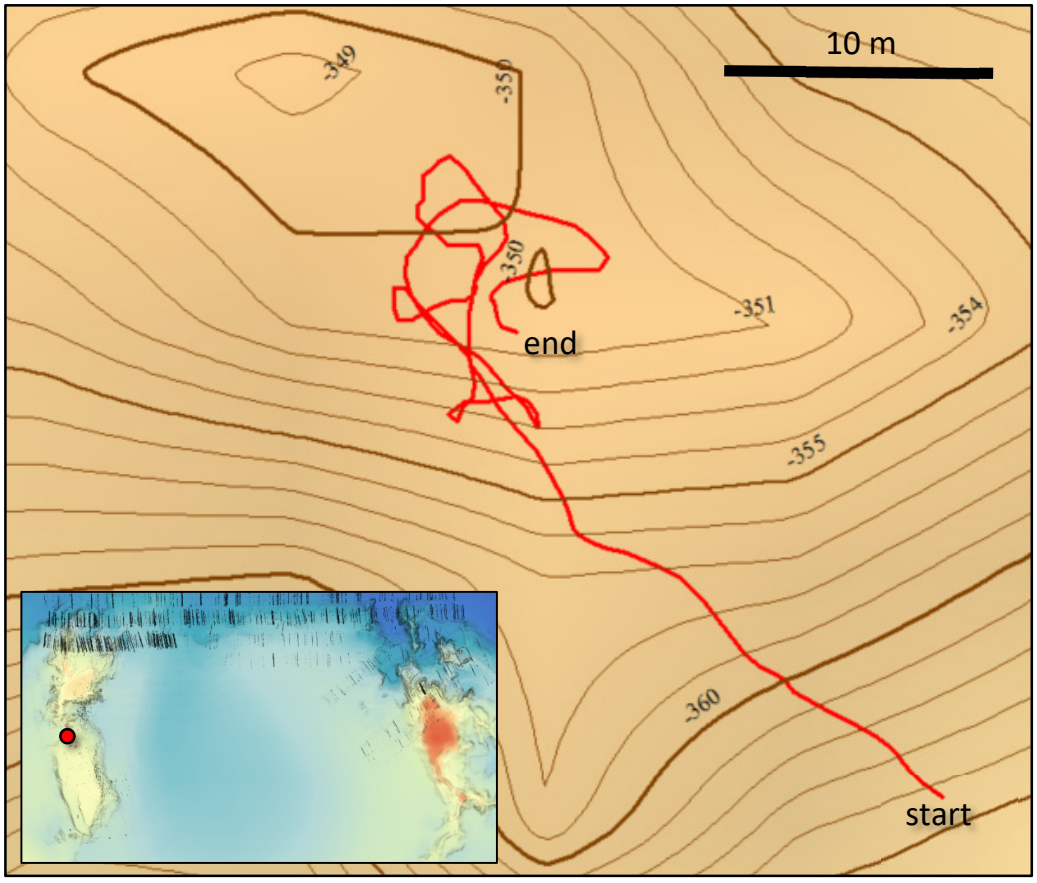

Figure 5.43: ROV track of dive OASIS – 13.

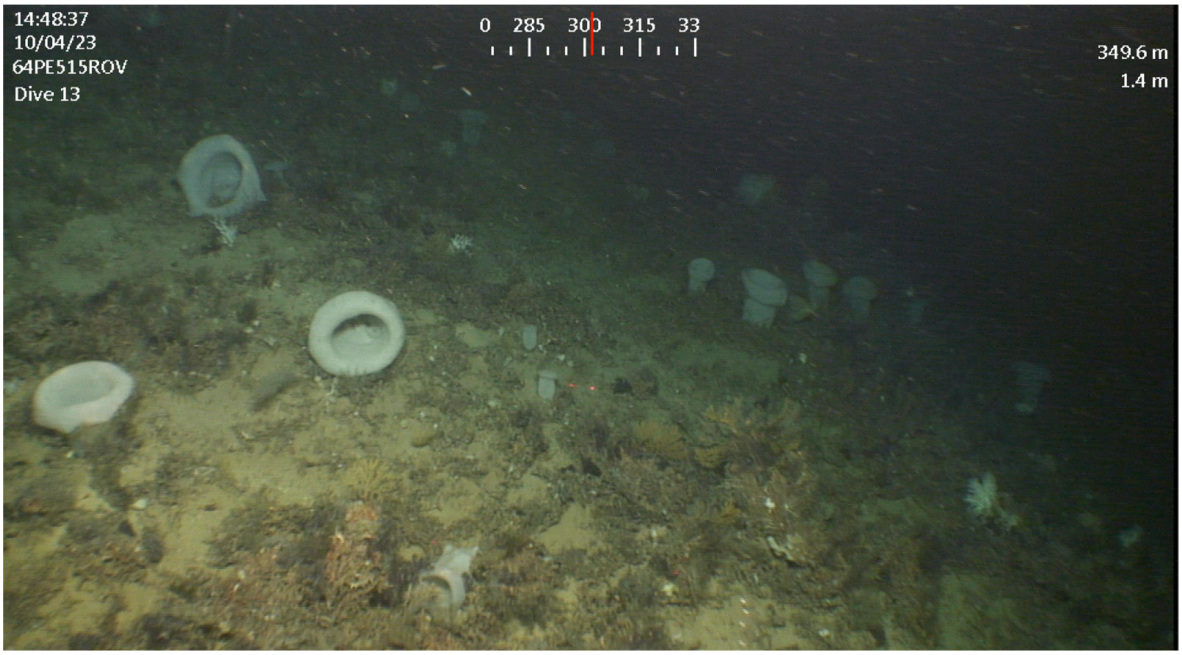

Figure 5.44: video frame from the ROV dive OASIS-13 showing glass sponges on dead CWC frameworks, close to the lander deployment.

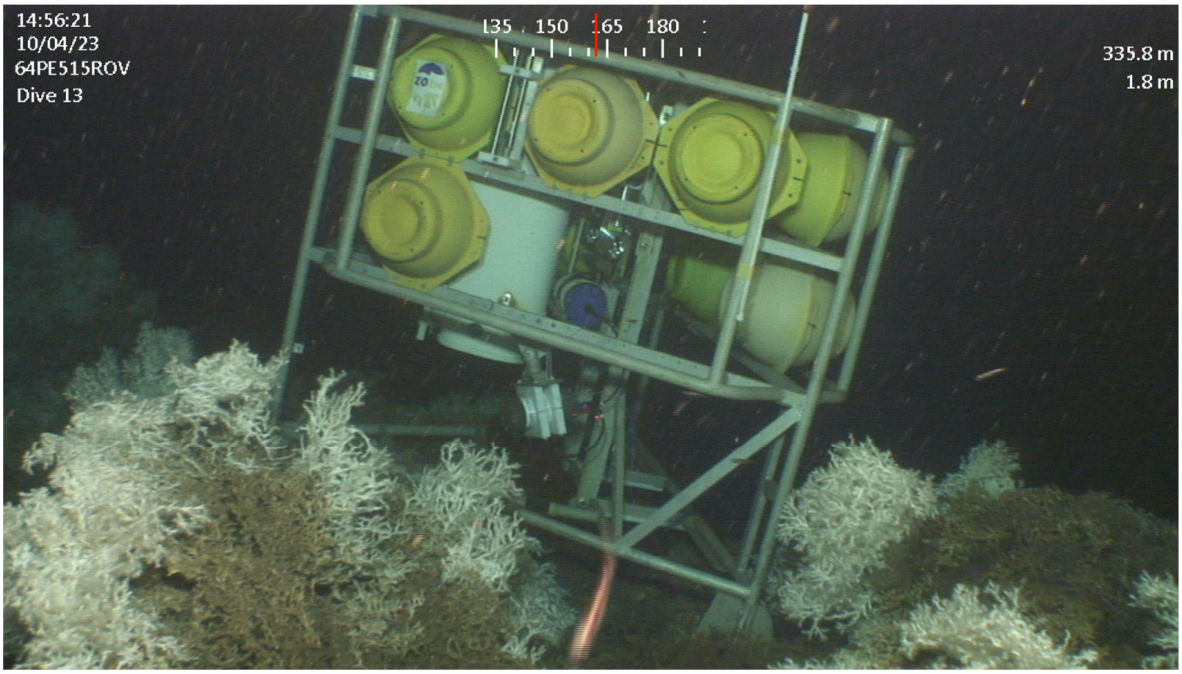

Figure 5.45: video frame from the ROV dive OASIS-13 showing the ALBEX benthic lander on the Catifas deployment site for long-term. The lander was on the edge of a vertical terrain and has been removed.

Dive OASIS – 14

Area, date, time: Catifas, 10 April, 19:00 – 19:18

Depth range: 348 m – 336 m **Length**: 0.2 km **Time at the bottom**: 00:18 hours

Main objectives of the dive: check of (re-deployed) lander status (Fig. 5.46).

Main findings of the dive: The lander sat on a flat and stable terrain, and will remain acquiring data for 12 months until recovery (April 2024, PROTEUS Cruise). Substrate is made of fine sediments with the sponge *A. setubalense* and large living colonies of *L. pertusa* and *M. oculata* (Figs. 5.47, 5.48).

Samples: none

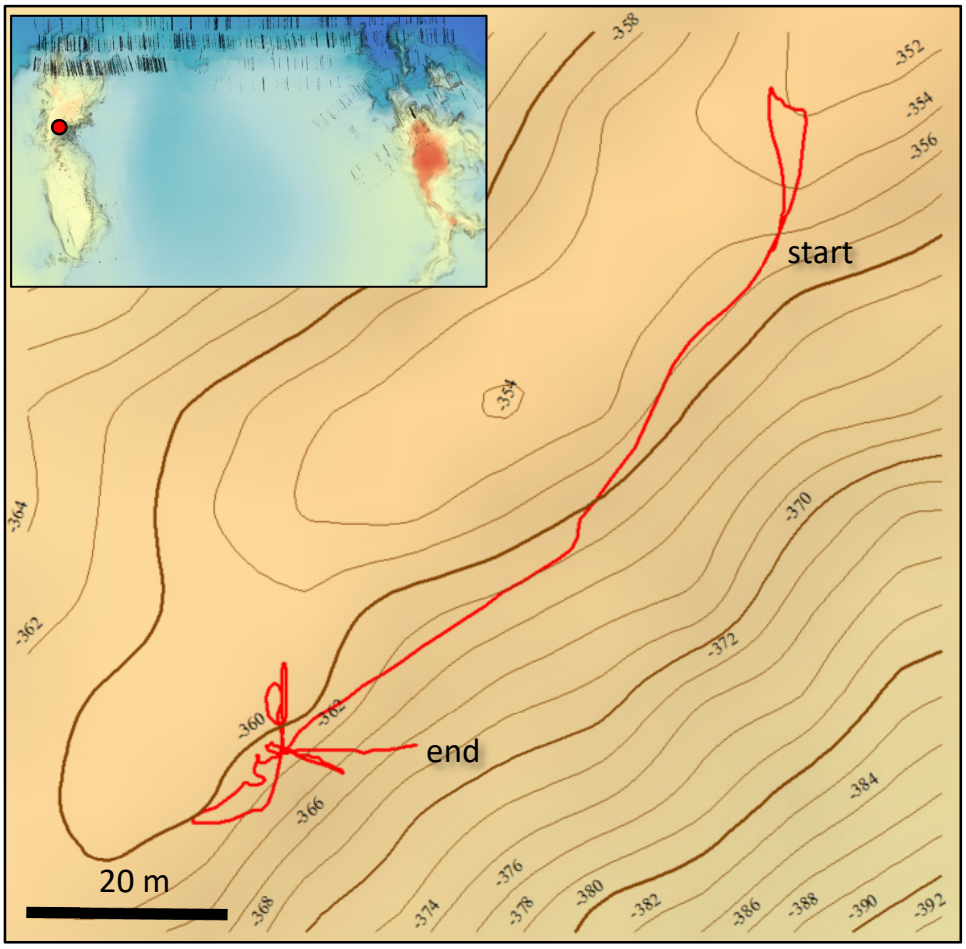

Figure 5.46: ROV track of dive OASIS – 14.

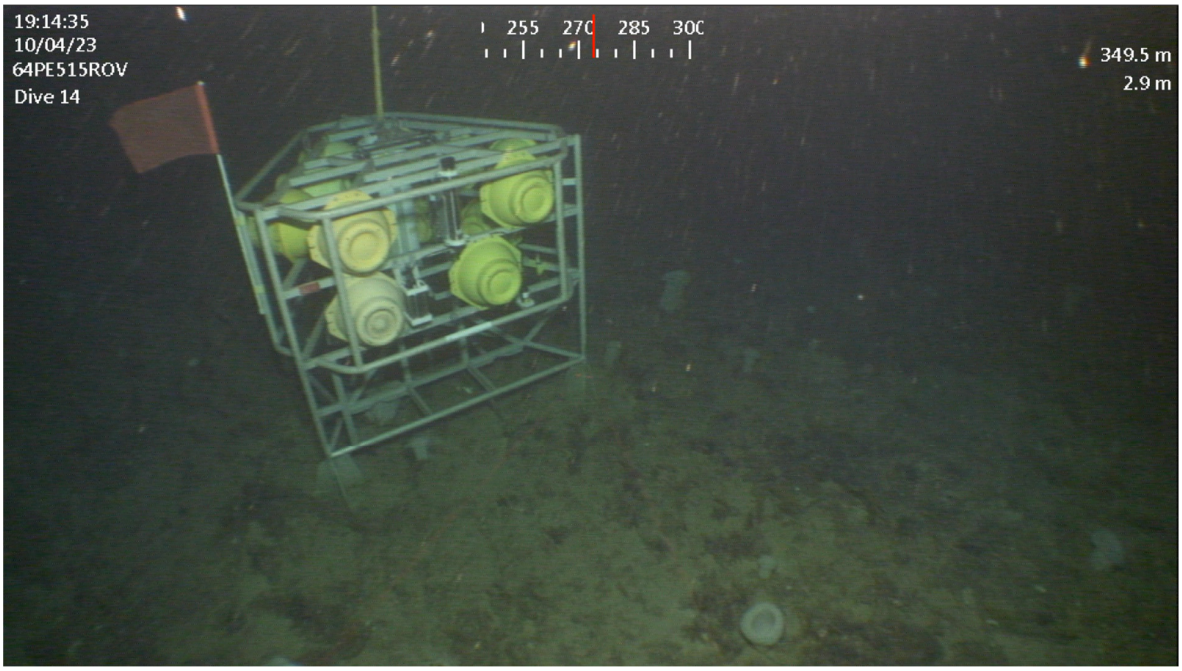

Figure 5.47: video frame from the ROV dive OASIS-14 showing the ALBEX benthic lander on the Catifas long-term deployment site.

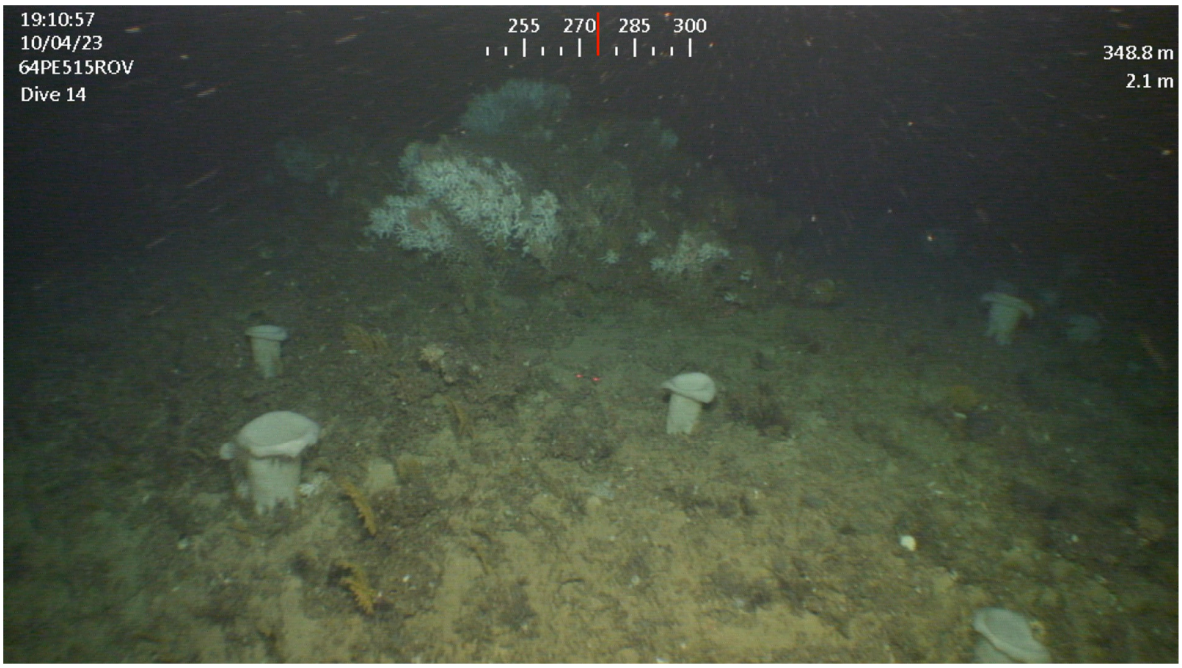

Figure 5.48: video frame from the ROV dive OASIS-14 showing *L. pertusa* colonies and glass sponges *A. setubalense* close to the site of the ALBEX benthic lander for long-term monitoring.

Dive OASIS – 15

Area, date, time: Catifas, 11 April, 13:15 – 13:34

Depth range: 508 m – 454 m **Length**: 0.26 km **Time at the bottom**: 00:18 hours

Main objectives of the dive: visit a vertical wall (likely a fault scarp) (Fig. 5.49).

Main findings of the dive: the vertical wall, likely consisting of volcanic rocks, is up to 10 m high and is colonized by several clusters of *A. setubalense*, which seem to show a different shape (longer and thinner than what observed in previous dives) (Fig. 5.50), most probably due to adaptive strategies allowing to live on vertical walls? Soon before encountering the wall a linear depression with fine sediments, few meters wide and around 1 m deep, runs parallel to the wall. Before and on top of the wall video footage shows a substrate with dead CWC frameworks and gorgonians (Fig. 5.51).

Samples: none

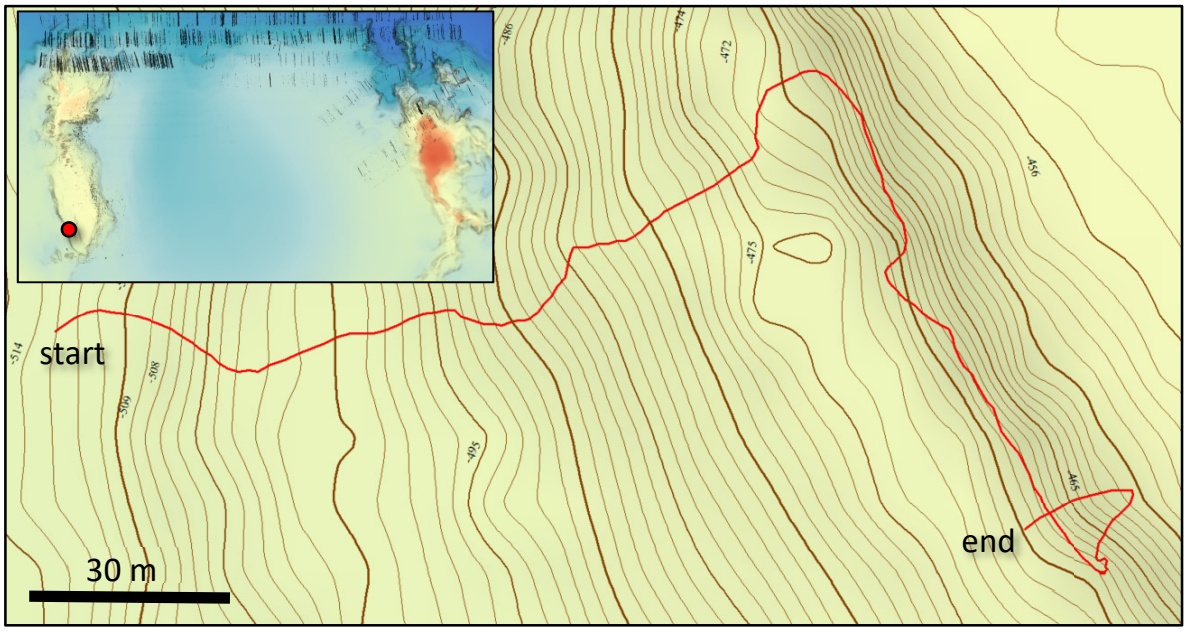

Figure 5.49: ROV track of dive OASIS – 15. Scale bar is 200 m long.

Figure 5.50: video frame from the ROV dive OASIS-15 showing glass sponges *A. setubalense* hanging on the steep vertical wall.

Figure 5.51: video frame from the ROV dive OASIS-15 showing glass sponges *A. setubalense*, unidentified sponges and gorgonians *A. hirsuta* on dead CWC frameworks, observed in front and on top of the vertical wall.

5.3 CTD-Rosette + L-ADCP

OASIS CTD casts were performed along and across the Cabliers and Catifas mound provinces (Figs. 5.52 to 5.54 and Table 5.2). Casts were collected along 4 transversals and longitudinal transects crossing Cabliers and Catifas, during which water samples were collected. A further CTD transect crossing Cabliers was repeated 4 times during 12 consecutive hours along the same direction (SW to NE) to appreciate the situ hydrographic and hydrodynamic variability during an entire semidiurnal cycle. A longer regional transect was performed along the Catifas Bank. Finally, 2 CTD yo-yos were also performed on both Cabliers and Catifas regions (see Figures 5.53, 5.54). The CTD deployed during the OASIS Cruise was the Seabird SBE 911, mounted with a SBE 32 carousel (24 bottle, 12 L) (Figure 5.52). The SBE9 can measure conductivity, temperature, dissolved oxygen, fluorescence, turbidity and pressure (i.e. water depth) at a sampling frequency of 24 scans per second (24Hz) and at a maximum water depth of 7000 m. The CTD frame is alimented through a coaxial cable. CTD data were converted into CNV formats with the Seabird software (SBE Data Processing, v.7), in order to obtain the vertical CTD profiles, averaged in space (1db bin) and time (1 second bin). Once converted into .CVN files, the data were visualized and post-processed using the software Ocean Data View 4 (ODV) (Figs. 5.55 to 5.60). Preliminary results of data processing show increased values of turbidity along the base of CWC mounds. Sampling of water masses along specific depths of the water column was carried out in some of the cast (see below paragraph 5.3.1, underscored station numbers in Figs. 5.53 and 5.54). Acquisition of CTD casts were made in parallel with the acquisition of current intensity and direction along the water column through a L-ADCP data (see next section 5.4.1).

5.3.1 Water Sampling

In some of CTD casts, water samples were collectd by rosette bottles ad speficic depths. Once the CTD-Rosette was onboard, water was collected from the bottles and filtered in specific ramps. Glass microfiber filters were used to filter water sample and will be analyzed to quantify (Table 5.3) Nutrients, Suspended Particulate Organic Matter (SPOM), Chlorophyll, and microplastic content (EF+ Co-PI UNSEEN Project). Stations where water samples have been collected are the underscored numbers in figures 5.53 and 5.54).

Figure 5.52: Photo of the CTD-rosette used during OASIS. L-ADCP is the yellow echosounder installed on the lower part of the frame. Red box is the battery pack supplying the L-ADCP.

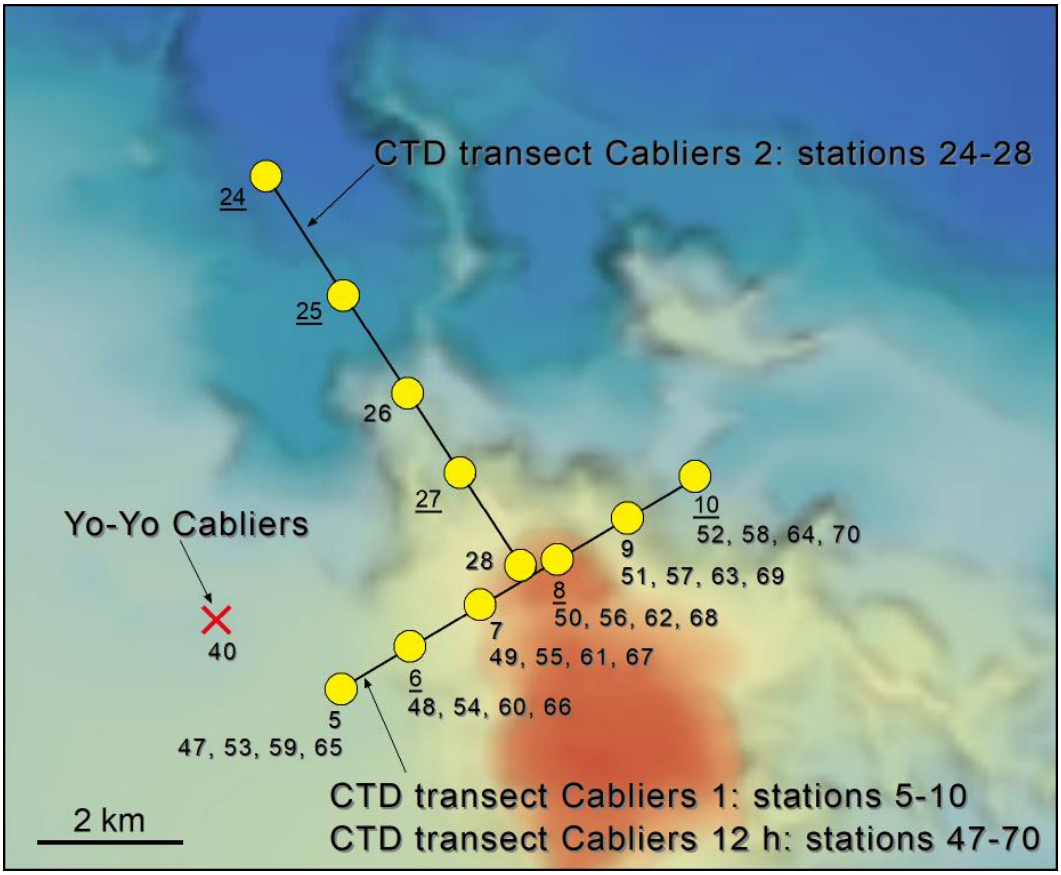

Figure 5.53: CTD-rosette + L-ADCP transects and 12 hours yo-yo casts on Cabliers region. Numbers refer to stations, underlined numbers indicate the stations with sampled water.

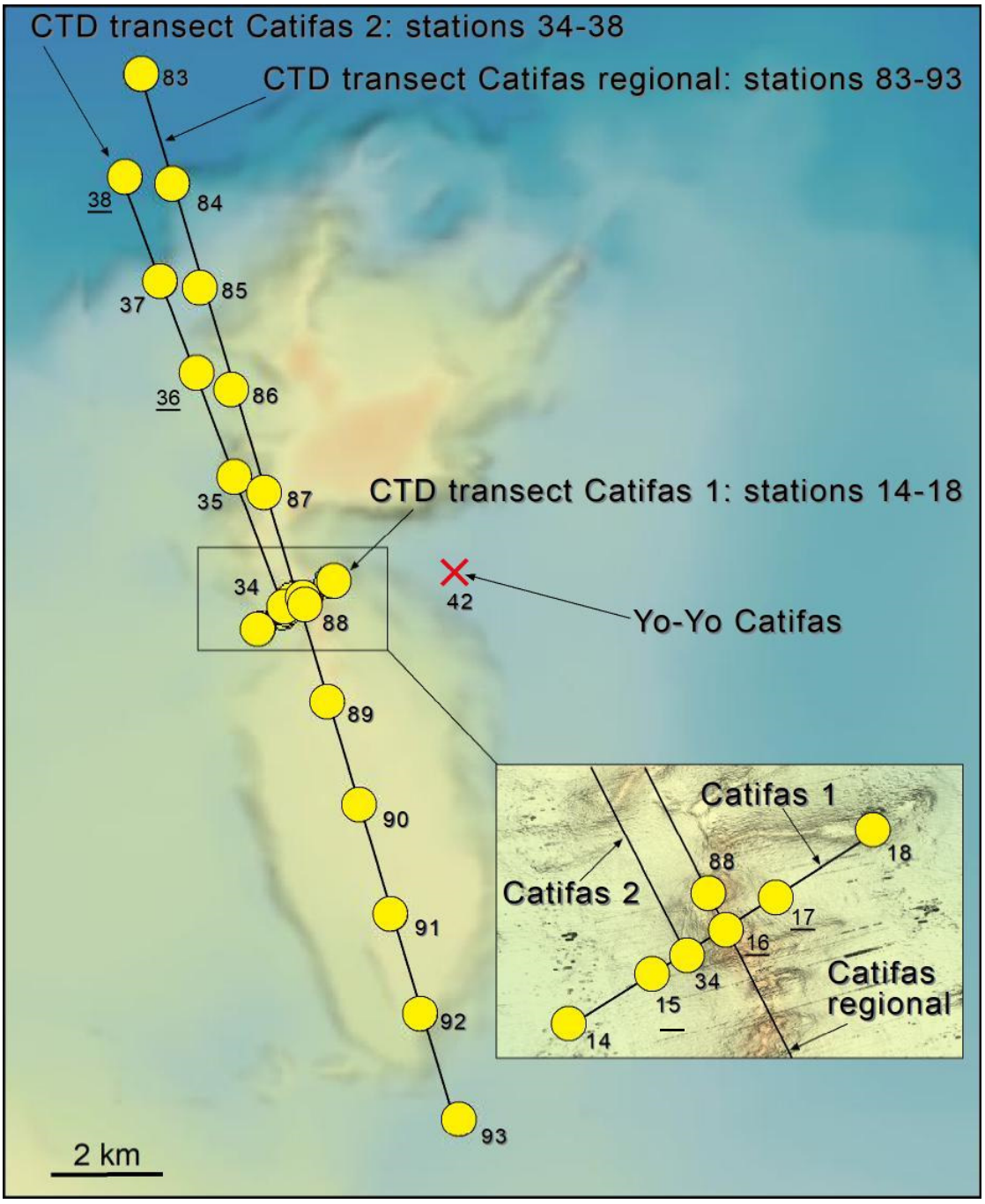

Figure 5.54: CTD-rosette + L-ADCP transects and 12 hours yo-yo casts on Catifas region. Numbers refer to stations, underlined numbers indicate the stations with sampled water.

CTD casts	Station	Lat	Long
SVP Calib	1	35.919° N	2.272° W
CTD transect Cabliers - 1	5	35.830° N	2.285° W
	6 (W)	35.835° N	2.276° W
	7	35.840° N	2.267° W
	8 (W)	35.846° N	2.257° W
	9	35.852° N	2.248° W
	10 (W)	35.857° N	2.239° W
CTD transect Catifas - 1	14	35.828° N	2.581° W
	15 (W)	35.831° N	2.578° W
	16 (W)	35.832° N	2.575° W
	17 (W)	35.833° N	2.573° W
	18	35.836° N	2.57° W
CTD transect Cabliers - 2	24 (W)	35.896° N	2.295° W
	25 (W)	35.881° N	2.285° W
	26	35.868° N	2.276° W
	27 (W)	35.857° N	2.269° W
	28	35.845° N	2.261° W
CTD transect Catifas - 2	34	35.831° N	2.577° W
	35	35.854° N	2.585° W
	36 (W)	35.871° N	2.592° W
	37	35.886° N	2.597° W
	38 (W)	35.904° N	2.604° W
yo-yo Cab	40	35.837° N	2.301° W
yo-yo Cat	42	35.836° N	2.55° W

CTD casts	Station	Lat	Long
CTD transect Cabliers 12 hours	47	35.829° N	2.285° W
	48	35.835° N	2.276° W
	49	35.841° N	2.267° W
	50	35.846° N	2.257° W
	51	35.852° N	2.248° W
	52	35.857° N	2.239° W
	53	35.829° N	2.285° W
	54	35.835° N	2.276° W
	55	35.841° N	2.267° W
	56	35.846° N	2.257° W
	57	35.852° N	2.248° W
	58	35.857° N	2.239° W
	59	35.829° N	2.285° W
	69	35.835° N	2.276° W
	61	35.841° N	2.267° W
	62	35.846° N	2.257° W
	63	35.852° N	2.248° W
	64	35.857° N	2.239° W
	65	35.829° N	2.285° W
	66	35.835° N	2.276° W
	67	35.841° N	2.267° W
	68	35.846° N	2.257° W
	69	35.852° N	2.248° W
	70	35.857° N	2.239° W
Calib. MB	78	35.882° N	2.435° W
CTD transect Catifas regional	83	35.921° N	2.601° W
	84	35.903° N	2.596° W
	85	35.885° N	2.591° W
	86	35.868° N	2.586° W
	87	35.851° N	2.581° W
	88	35.833° N	2.576° W
	89	35.816° N	2.570° W
	90	35.798° N	2.565° W
	91	35.78° N	2.559° W
	92	35.763° N	2.554° W
	93	35.746° N	2.548° W
Calib. MB	103	35.825° N	2.533° W

Table 5.2: List of stations and coordinated of OASIS CTD casts. (W) stands for water sampling.

Filters	Station	Depth (m)	Volume per filter (L)	Analyses
CTD transect Cabliers - 1				
17G121, 17G122	6	489	10	Nutr., SPOM, Chl., micropl.
17G125, 17G126	6	207	10	Nutr., SPOM, Chl., micropl.
17G123, 17G124	6	39	5	Nutr., SPOM, Chl., micropl.
17G128, 17G130	8	262	10	Nutr., SPOM, Chl., micropl.
17G127, 17G129	8	38	5	Nutr., SPOM, Chl., micropl.
17G133, 17G134	10	763	10	Nutr., SPOM, Chl., micropl.
17G131, 17G132	10	263	10	Nutr., SPOM, Chl., micropl.
17G135, 17G180	10	38	5	Nutr., SPOM, Chl., micropl.
CTD transect Catifas - 1				
17G176, 17G177	15	474	10	Nutr., SPOM, Chl., micropl.
17G178, 17G179	15	40	5	Nutr., SPOM, Chl., micropl.
17G174, 17G175	15	249	10	Nutr., SPOM, Chl., micropl.
17G172, 17G173	16	369	10	Nutr., SPOM, Chl., micropl.
17G170, 17G171	16	258	10	Nutr., SPOM, Chl., micropl.
17G168, 17G169	16	41	5	Nutr., SPOM, Chl., micropl.
17G166, 17G167	17	37	5	SPOM, Chl., micropl.
17F197, 17F196	17	285	10	SPOM, Chl., micropl.
17F198, 17F199	17	432	10	SPOM, Chl., micropl.
CTD transect Cabliers - 2				
17F200, 17C037	24	247	10	SPOM, Chl., micropl.
17C036, 17C038	24	32	5	SPOM, Chl., micropl.
17C039, 969	25	422	10	SPOM, Chl.
970, 971	25	270	10	SPOM, Chl.
972, 973	25	35	5	SPOM, Chl.
974, FB83	27	1031	10	SPOM, Chl., micropl.
FB84, FB85	27	279	10	SPOM, Chl., micropl.
FB86, FB87	27	40	5	SPOM, Chl., micropl.
CTD transect Catifas - 2				
FB90, 17F157	36	614	10	Nutr., SPOM, Chl.
FB88, FB89	36	280	10	Nutr., SPOM, Chl.
17F158, 17F159	36	39	5	Nutr., SPOM, Chl.
17F160, 17F161	38	1081	10	Nutr., SPOM, Chl., micropl.
17F162, 17F163	38	279	10	Nutr., SPOM, Chl., micropl.
17F164, 17F165	38	38	5	Nutr., SPOM, Chl., micropl.

Table 5.3: List of stations of OASIS water sampling and details on filters and foreseen analyses. Nutr. stands for Nutrients, SPOM stands fro Suspended Particulate Organic Matter, Chl. stands fro Chlorophyll, Micropl. stands for Microplastics. Microplastics content will be analyzed in the frame of EF+ CO-PI Project “UNSEEN”.

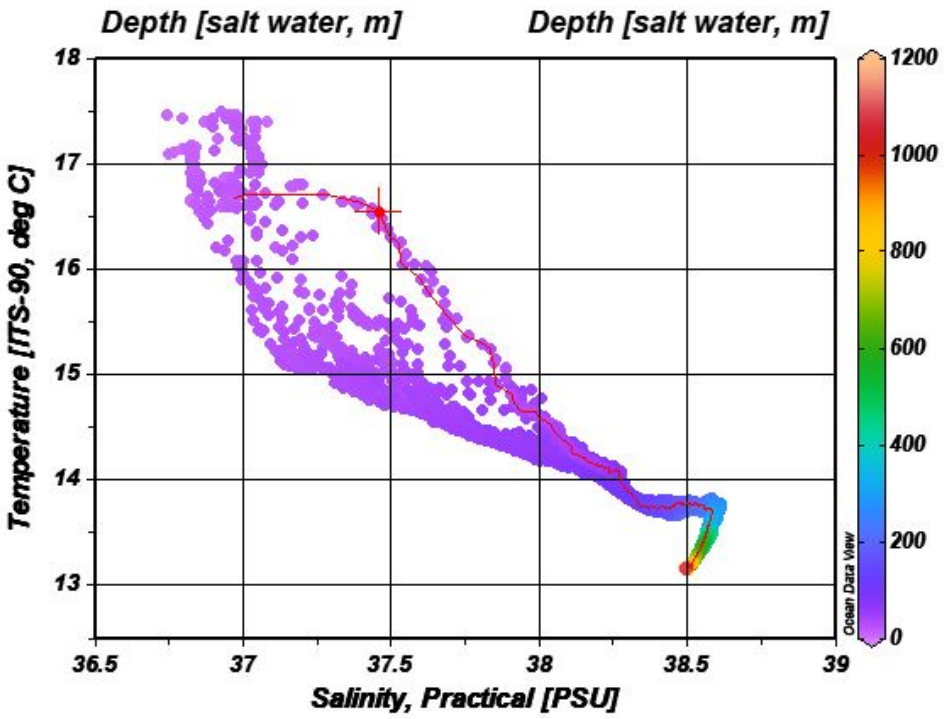

Figure 5.55: T-S diagram from the Cabliers-1 CTD transect. The Atlantic Water, Levantine Intermetiade Water (LIW) and the West Mediterranean Deep Water (WMDW) are evident in the diagram.

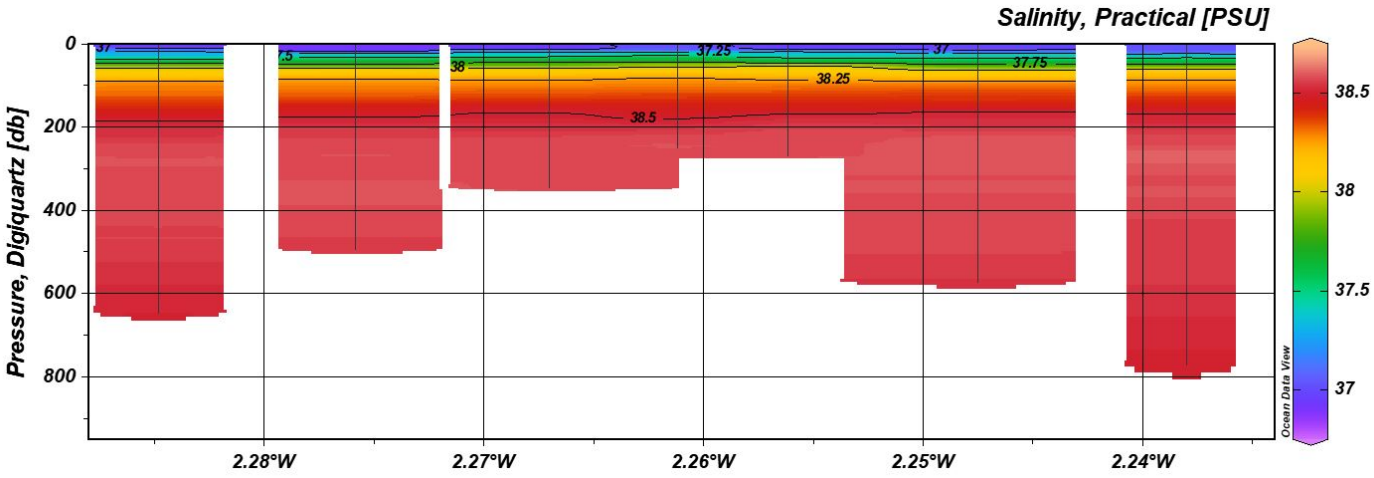

Figure 5.56 : Salinity section from the Cabliers-1 CTD transect. Note the AW-LIW interface at a depth of around 200 m.

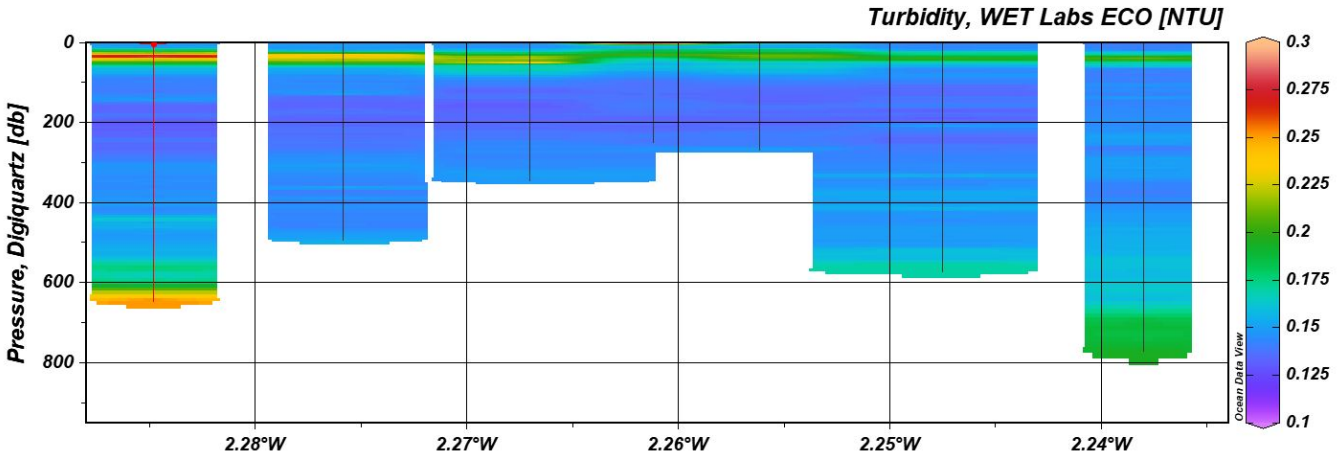

Figure 5.57: Turbidity section from the Cabliers-1 CTD transect. Note the increase of turbidity values at the seafloor, probably due to increased sediment resuspension generated by bottom currents enhanced by interaction with seafloor morphology. Also note the superficial nepheloid layer deflected by the morphology of Cabliers Bank (section distance around 2.26° W).

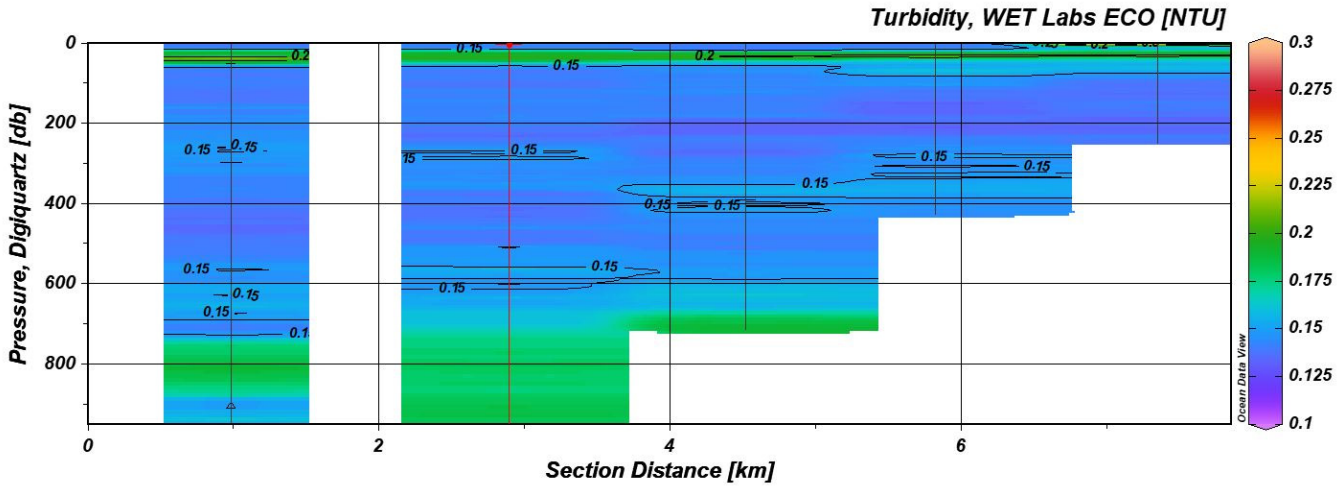

Figure 5.58 : Turbidity section from the Cabliers-2 CTD transect. Note the increase of turbidity values at the seafloor, probably due to increased sediment resuspension generated by bottom currents enhanced by interaction with seafloor morphology.

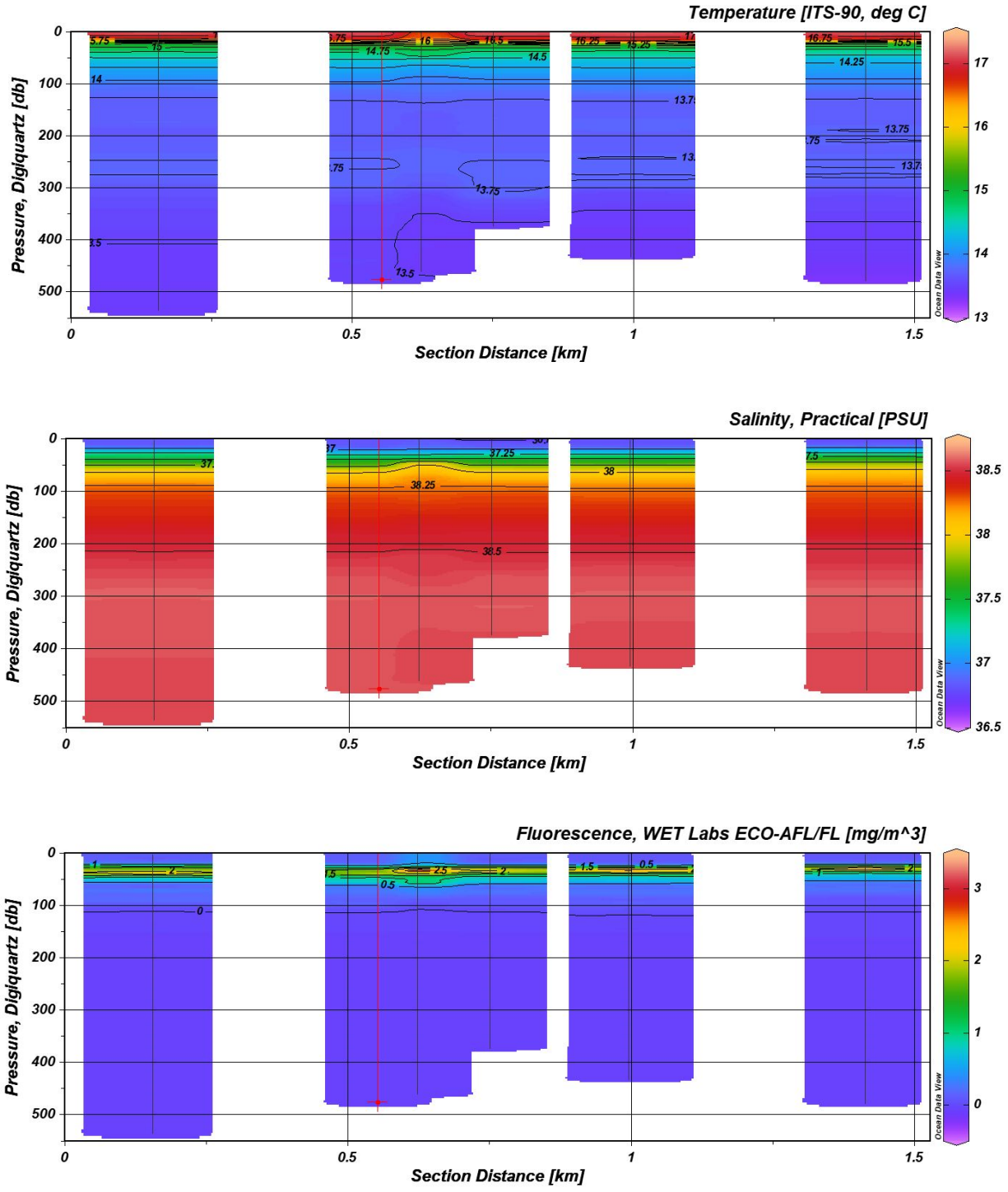

Figure 5.59: Temperature, Salinity and Fluorescence sections from the Catifas-1 CTD transect. Note the increase of all plotted values in correspondance with Catifas coral mound, which most likely affects local hydrodynamics.

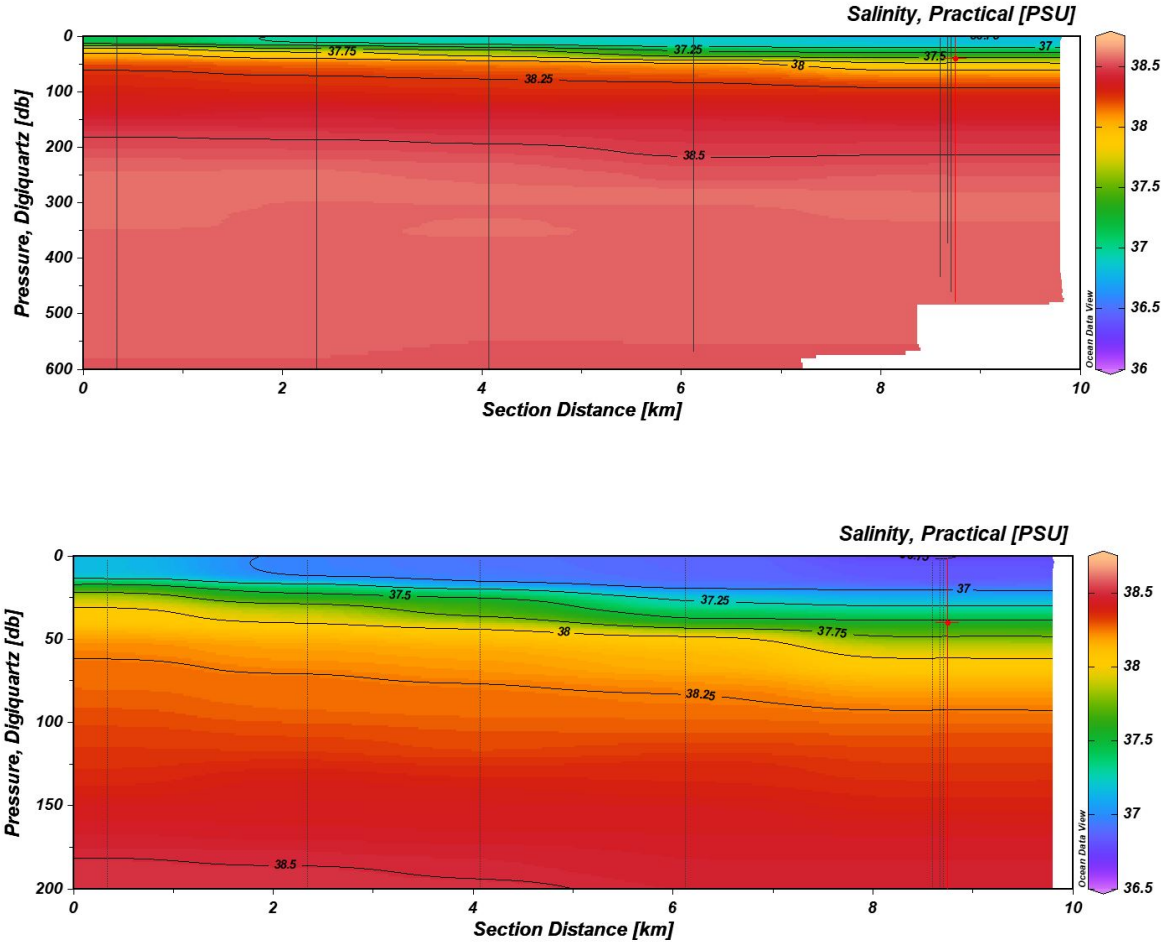

Figure 5.60: Salinity section (a) and zoom of the first 200 meters of wd (b) from the Catifas-2 CTD transect. Note the inclined isopycnals suggesting an increased tickness of AW towards the south.

5.4 Characterization of water masses currents

5.4.1 Lowered Acoustic Doppler Current Profiler (L-ADCP) mounted on CTD-Rosette

During the OASIS Cruise the L-ADCP (Fig. 5.52) was installed in the lower part of the CTD-Rosette frame. The L-ADCP measured the current characteristics on the below portion of the water column during the lowering and the recovering of the CTD frame. During the CTD transtects, every L-ADCP measurement was isolated for every cast (and named with the same station number of the CTD cast) (Tab. 5.4). Closure and launching of acquisition were necessarily made with the CTD on the deck, and were programmed between casts, during the transits between measurement points. During the 2 CTD yo-yos, we acquired a constant L-ADCP file for the entire duration of the measurement (12 h), as the CTD-Rosette was not recovered on board between casts (Fig. 5.61). Hull mounted ADCP was programmed to acquire data in contemporary with the L-ADCP (Section 5.4.2).

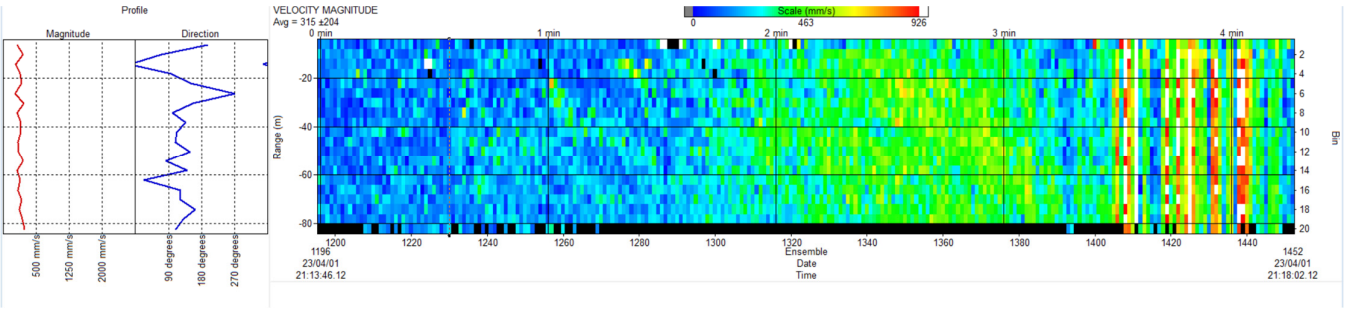

Figure 5.61: Example of L-ADCP profile acquired during OASIS CTD casts showing current velocity across the water column

CTD casts	Station	ML-ADCP files
CTD transect Cabliers - 1	5	07, 08, 09
	6	10, 11, 12
	7	13, 14
	8	15, 16
	9	17, 18, 19
	10	20, 21, 22, 23
CTD transect Catifas - 1	14	24, 25, 26
	15	27, 28, 29
	16	30, 31, 32
	17	33, 34
	18	35, 36
CTD transect Cabliers - 2	24	37, 38, 39
	25	40, 41, 42
	26	43, 44
	27	45, 46
	28	47
CTD transect Catifas - 2	34	48, 49, 50
	35	51, 52, 53
	36	54, 55, 56
	37	57, 58, 59
	38	60, 61
yo-yo Cab	40	62, 63, 64
yo-yo Cat	42	65, 66, 67, 68

CTD casts	Station	ML-ADCP files
CTD transect Cabliers 12 hours	47	69, 70, 71
	48	72, 73
	49	74, 75, 76
	50	77, 78, 79
	51	80, 81, 82
	52	83, 84, 85
	53	86, 87, 88
	54	89, 90, 91
	55	92, 93
	56	94, 95, 96
	57	97, 98
	58	99, 101, 102
	59	103, 104
	69	105, 106, 107
	61	108, 109
	62	110, 111
	63	112, 113
	64	114
	65	115, 116, 117
	66	118, 119, 120, 121
	67	122, 123
	68	124, 125, 126
	69	127, 128, 129
	70	130, 131
Calib. MB	78	132, 133
CTD transect Catifas regional	83	134, 135, 136
	84	137, 138, 139
	85	140, 141, 142
	86	143, 144
	87	145, 146, 147
	88	148, 149, 150
	89	151
	90	152, 153, 154
	91	155
	92	156, 157, 158
	93	159, 160

Table 5.4: L-ADCP files acquired during CTD casts, separated by stations and CTD transects

5.4.2 Hull-mounted Acoustic Doppler Current Profiler (ADCP)

Hull-mounted ADCP profiles were acquired during specifically designed CTD transects or yo-yo casts (Tab. 5.5). The ADCP onboard the RV "Pelagia" is a Teledyne RDI, Ocean Surveyor 75 kHz (broad ad narrow band). The ADCP is aimed to measure intensity and direction of currents and echostrength throughout the entire water column using the doppler methodology. Preliminary results showed coherence of acquired data, with relevant changes of current intensity and direction in space (depth) and time (Figs. 5.62, 5.63).

The ADCP configuration during the OASIS Cruise was:

Frequency: 75 kHz

Swath angle: 30º - Cell unit length: 4 m (narrow band)

Bottom track: Yes, Max bottom track range: 400 m (max operative depth).

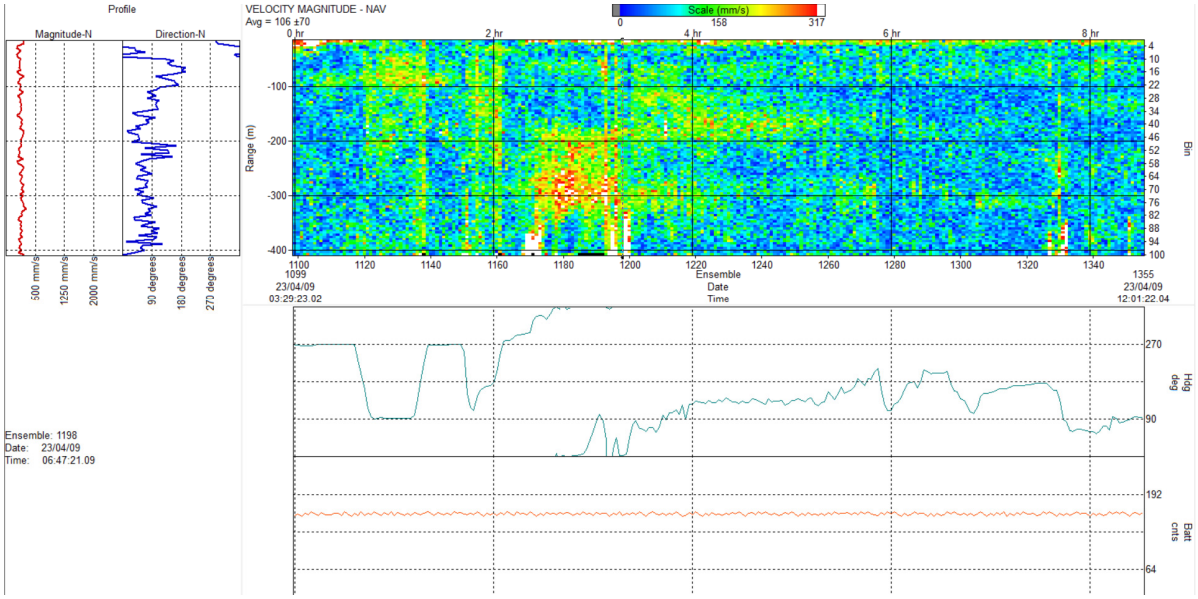

Figure 5.62: Example of ADCP profile acquired during OASIS showing the velocity of water masses within the first 400 m

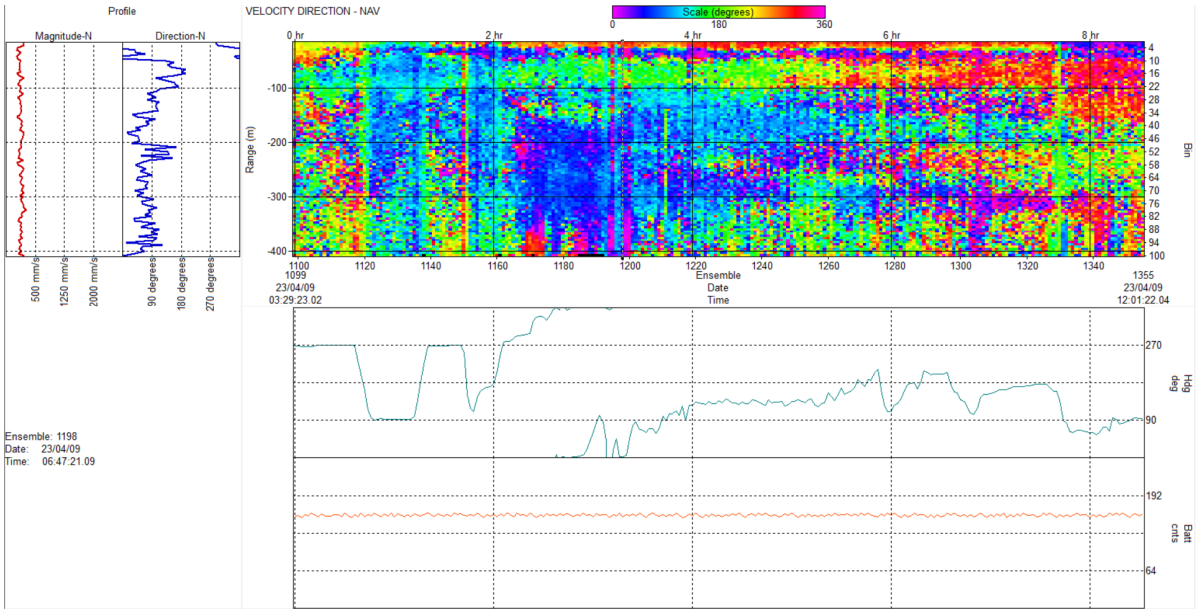

Figure 5.63: Example of ADCP profile acquired during OASIS showing the direction of water masses within the first 400 m

Station	File	from	to
40 - yo-yo Cabliers	64PE515-st40_002_000000	5 April 13:22:22.08	6 April 01:10:57.07
42 - yo-yo Caifas	64PE515-st42_001_000000	6 April 09:20:17.06	6 April 21:45:48.01
St 47 to St 93 (continuous acquisition)	64PE515-st47_001_000000	7 April 22:26:43.09	10 April 00:01:16.05
	64PE515-st47_001_000002	8 April 06:00:09.04	10 April 00:01:16.05
	64PE515-st47_001_000003	8 April 13:33:35.00	10 April 00:01:16.05
	64PE515-st47_001_000004	8 April 21:07:00.05	10 April 00:01:16.05
	64PE515-st47_001_000005	9 April 04:40:26.04	10 April 00:01:16.05
	64PE515-st47_001_000006	9 April 12:13:51.09	10 April 00:01:16.05
	64PE515-st47_001_000007	9 April 19:47:17.04	10 April 00:01:16.05

Table 5.5: ADCP files acquired during OASIS and corresponding stations.

5.5 Water column and seafloor observatories

5.5.1 Oceanographic moorings

Two oceanographic moorings belonging to ICM-CSIC have been deployed at Cabliers and Catifas regions the 04th of April 2023 (Table 5.6, Figure 5.64). Deployment of moorings has been carried out from the stern and at free fall over the selected locations. Start of acquisition time of all oceanographic sensors has been set for the 01 of April 2024. Sampling frequencies on the moored instruments have been set to allow an endurance of the battery packs up to 12 months. Moorings are expected to be recovered in April 2024, during a cruise onboard the R/V *Sarmiento de Gamboa*, in the frame of PROTEUS Project, recently funded to ICM by the Spanish Ministry of Science and Innovation.

Cabliers mooring:

The first mooring (Figure 5.65) has been deployed on the Cabliers region at a depth of 234 m. This mooring consists of (from shallower to deeper instruments):

- Upward looking RDI 300 kHz ADCP at 124 meters above bottom (mab)
- Downward looking RDI 300 kHz ADCP at 120 mab
- Conical sediment trap (1 m^2 collecting area, 24 bottles, 1 sample every 15 days) at 17 mab
- Currentmeter+CTD+turbidimeter at 12 mab
- Oximeter at 6 mab
- Triplet (fluorometer+2 turbidimeters) at 5 mab

Catifas mooring:

The second mooring (Figure 5.66) has been deployed on the Catifas region at a depth of 373 m. This mooring consists of (from shallower to deeper instruments):

- Upward looking Sontek 250 kHz ADCP at 124 mab
- Downward looking RDI 300 kHz ADCP at 120 mab
- Conical sediment trap (1 m^2 collecting area, 24 bottles, 1 sample every 15 days) at 17 mab
- Currentmeter+CTD+turbidimeter at 12 mab
- Oximeter at 6 mab
- Triplet (fluorometer+2 turbidimeters) at 5 mab

Mooring Cabliers					
Station	**Date**	**hour**	**Lat**	**Long**	**Depth**
31	04/04/2023	11:58	35.8330° N	2.2572° W	234 m

Mooring Catifas					
Station	**Date**	**hour**	**Lat**	**Long**	**Depth**
32	04/04/2023	14:30	35.8617° N	2.5660° W	372 m

Table 5.6: Stations, time of deployment and position of OASIS oceanographic moorings.

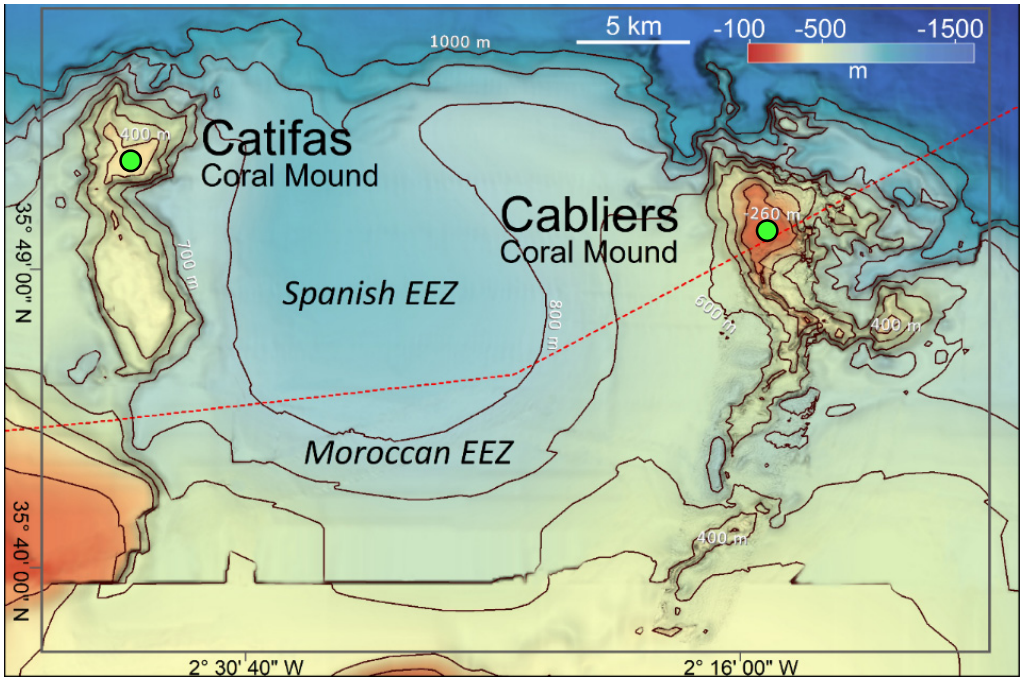

Figure 5.64: Map of the study area and location of OASIS moorings.

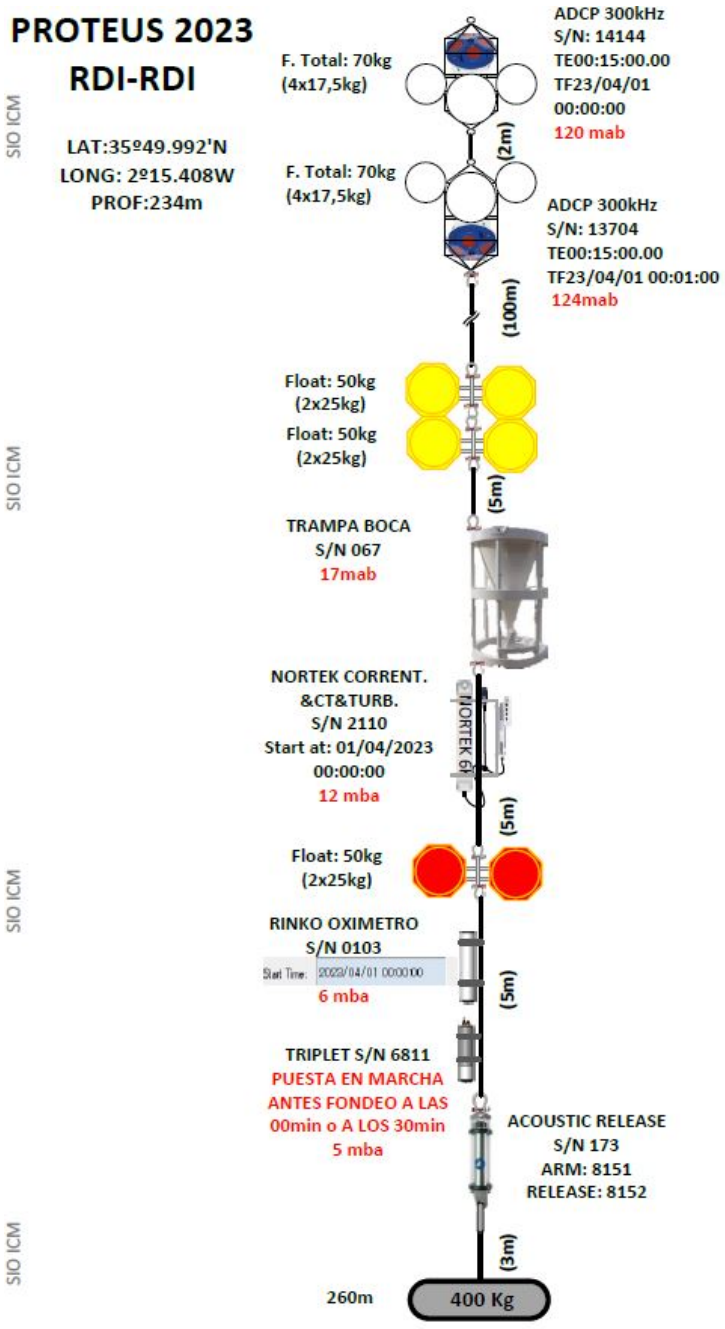

Figure 5.65: Schematic structure of the OASIS Cabliers mooring.

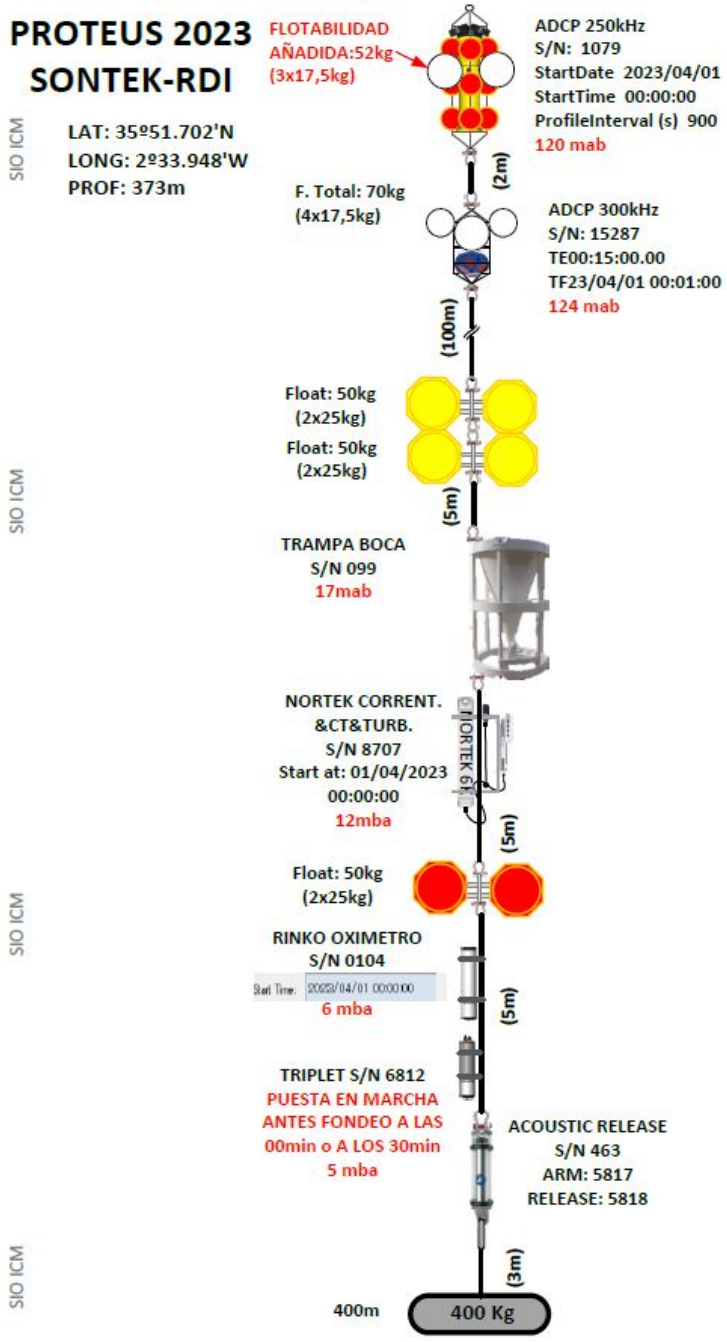

Figure 5.66: Schematic structure of the OASIS Catifas mooring.

5.5.2 Benthic landers

2 ALBEX benthic landers (Figs. 5.67, 5.68 A) belonging to NIOZ were deployed during the OASIS Cruise on Cabliers and Catifas regions, for a total of two short-term deployments (4 and 7 days, respectively) both in Cabliers and Catifas and one long-term deployment (one year) in Catifas mounds (Tab. 5.7).

Figure 5.67: The two ALBEX benthic landers used in OASIS soon before their deployments.

Lander Cabliers						
Stations	**Model**	**Deployment**	**Recovery**	**Lat**	**Long**	**Depth**
23 - 46	ALBEX 4	03/04/2023	07/04/2023	35.8443° N	2.2543° W	258 m
Lander Catifas short term						
Stations	**Model**	**Deployment**	**Recovery**	**Lat**	**Long**	**Depth**
21 - 80	ALBEX 2	03/04/2023	09/04/2023	35.8320° N	2.5748° W	353 m
Lander Catifas long term						
Station	**Model**	**Deployment**	**Recovery**	**Lat**	**Long**	**Depth**
101	ALBEX 2	10/04/2023	10/04/2024	35.8307° N	2.5733° W	358 m
Lander Catifas longt term FAILED						
Station	**Model**	**Deployment**	**Recovery**	**Lat**	**Long**	**Depth**
98 - 100	ALBEX 2	10/04/2023	10/04/2023	35.8313° N	2.5745° W	349 m

Table 5.7: Stations, time of deployment/recovery and positions of OASIS landers.

Landers were deployed from the starboard side, using a crane attached to a deployment frame with a USBL transponder (Fig. 5.68 B) mounted on the terminal part of the cable, in order to monitor the position of landers and locate them on the most convenient target points with the maximum allowed precision. Moreover, a camera connected with fibre-optic cables, allowed to visualize the seafloor habitats and morphology in real time once the lander was close to the bottom. Finally, once over the selected points, landers were deployed making a free fall at around 3 meters from the seafloor. This manoeuvre has allowed to deploy the observatories at specific strategic locations selected from videos previously acquired during OASIS ROV dives. Cabliers lander has been deployed for a short-term period only (station 23), Catifas lander has been first deployed for a short-term period (station 21) and on a different site for a long-term period (station 101). Deployment for long-term has been attempted on a dense CWC field (station 98) but following ROV videos on the deployment site revealed the lander was sitting on a steep terrain and had to be recovered (station 100). Finally, the lander was deployed on a larger area, on top of a CWC mound with sparse large colonies of *D. pertusum* and sponge grounds (station 101).

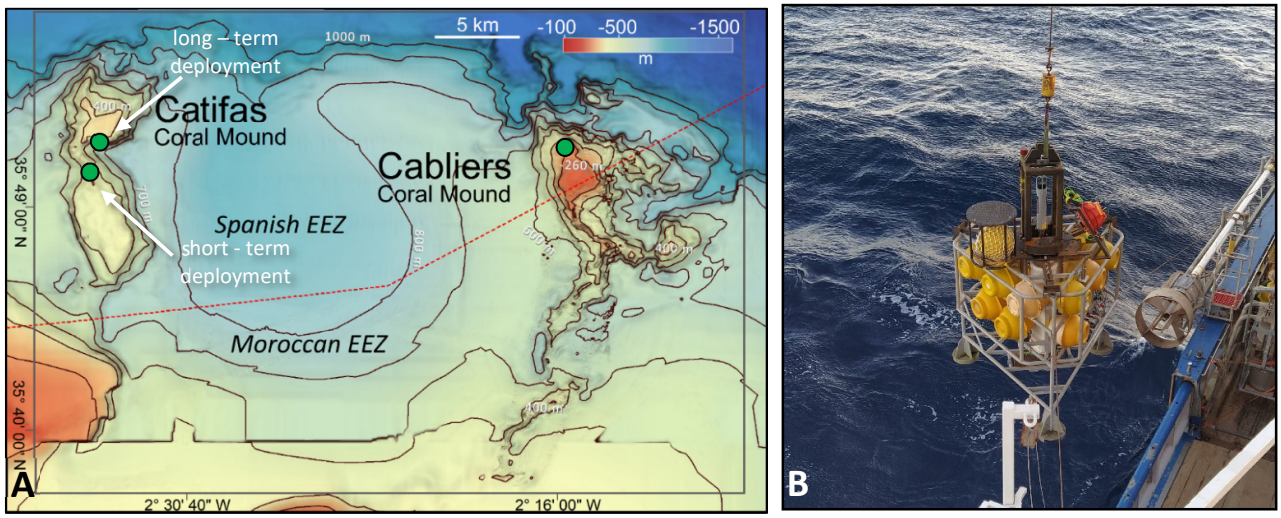

Figure 5.68. A: Map of the study area and location of OASIS landers.
Details are showed in figures 5.57 and 5.62. B: Photo of one of the OASIS ALBEX lander being deployed from RV Pelagia. Note the USBL on the above frame at cable termination.

Cabliers short-term deployment

1 benthic lander (ALBEX 4) has been deployed during 4 days amidst a glass sponge field (*Asconema setubalense*) in Cabliers (Fig. 5.69), at a depth of 258 m, from 03 april 2023 (19:29) to 07 april (14:09). The Lander was instrumented with a Wetlabs FLNTU to measure temperature, optical backscatter and fluorescence at 1 mab (sampling interval 5 min), a Rinko Advantech oxygen sensor at 1 mab (sampling interval 5 min), an upward looking 2 MHz Nortek ADCP at 2 mab (sampling interval 5 min), a Technicap PPS4/3 cilicndro-conical sediment trap (0.05 m^2 collecting area) with the aperture at 2 mab (sampling interval 3 days), a NIOZ designed HD video camera with infrared illumination pointed at bait. Preliminary results show a clear dominance of semidiurnal tidal hydrodynamics (Fig. 5.70). The baited camera was infrared, to reduce any bias related to the attraction of motile fauna by white light. Dead fishes were tied in front of the camera as preys to attract fauna (Fig. 5.71). Several indivudals of sharks, congers, groupers, lobster, crabs and fishes of large dimensions were observed during the four days of observation (Fig. 5.71). Large sizes of fishes and crustaceans suggest their mature stage and confirm the reduced impact of human activites on Cabliers and the well preserved ecological conditions of the reefs.

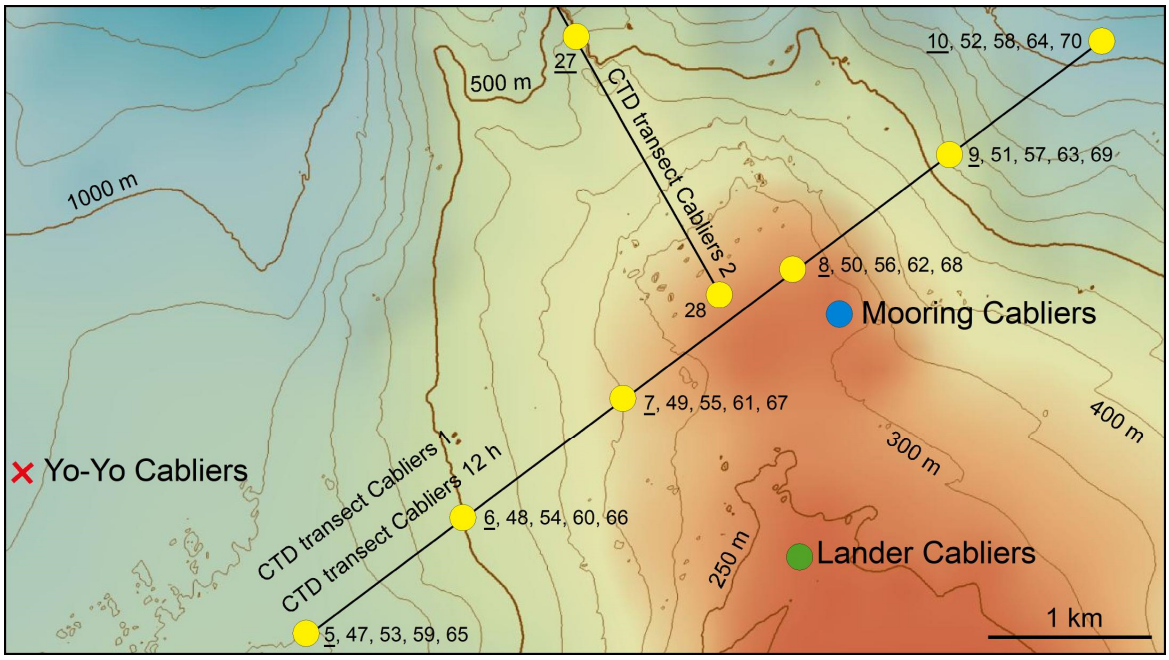

Figure 5.69: detailed map of Cabliers lander (short deployment) position, including the location of Cabliers mooring and the closest CTD casts (see section. Contour lines every 50 m.

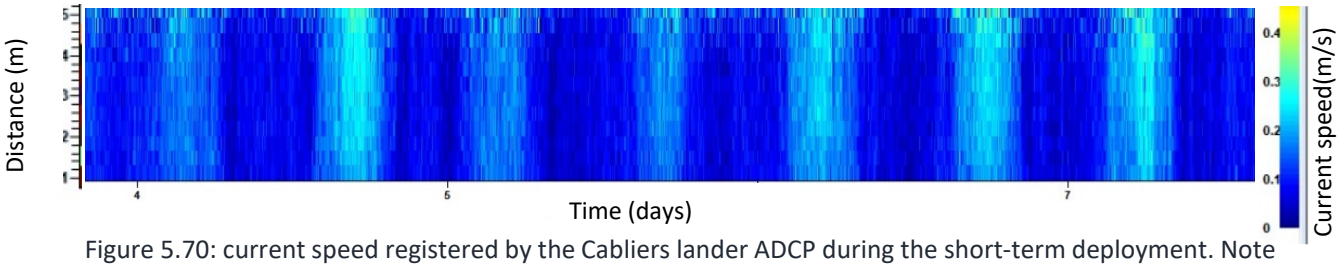

Figure 5.70: current speed registered by the Cabliers lander ADCP during the short-term deployment. Note the increase of speed up to 30 cm/s showing a semidiurnal tidal period.

Figure 5.71: photo of the baited camera installed on the ALBEX 4 lander and selected frames of the recording periods.

Catifas short-term deployment

A benthic lander (ALBEX 2) has been deployed during 6 days on a CWC mound with living colonies of *Desmophillum pertusum* in Catifas, at a depth of 353 m, from 03 april 2023 (13:49) to 09 april (06:38) (Fig. 5.74). The Lander was instrumented with a Wetlabs FLNTU to measure temperature, optical backscatter and fluorescence at 1 mab (sampling interval 5 min), a Rinko Advantech oxygen sensor at 1 mab (sampling interval 5 min), an upward looking 2 MHz Nortek ADCP at 2 mab (sampling interval 5 min), a cilindro-conical Technicap PPS4/3 sediment trap (0.05 m^2 collecting area) with the aperture at 2 mab (sampling interval 3 days), a McLane particle pump for in-situ SPOM sampling with the inlet at 40 cm mab (24 filter cups, 10L of seawater was filtered at 2 hours interval (Fig. 5.72), 1 stand-alone camera for macrofauna analysis (1 picture every 20 mins).

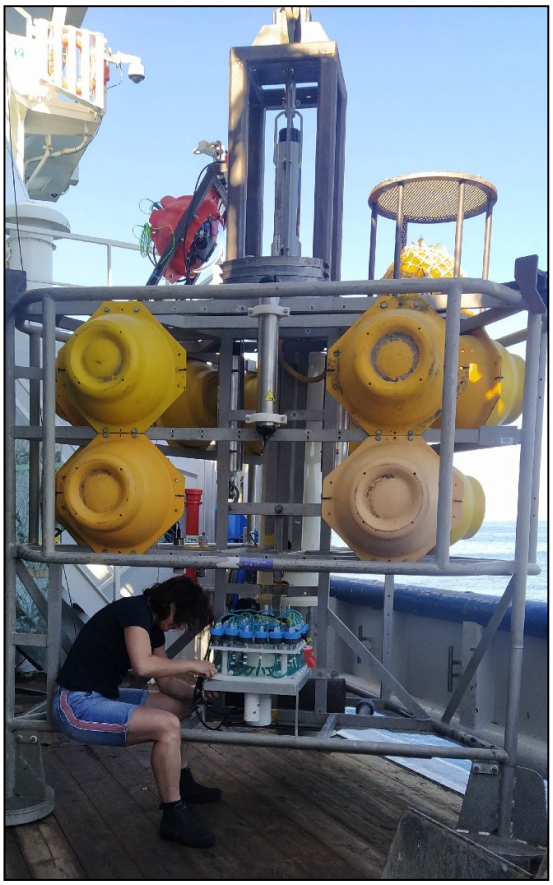

Figure 5.72: Dr. Furu Mienis installing the McLane pump on the ALBEX 2 lander.

Catifas long-term deployment

At the end of the cruise a benthic lander (ALBEX 4) has been deployed on top of a CWC mound with sparse living colonies of *D. pertusum* and sponge grounds (*Asconema setubalense*) in Catifas, at a depth of 358 m, from 10 april (18:02) for a long term deployment (Figs. 5.73, 5.74). The recovery of this lander is planned for April 2024, in the frame of a oceanographic expedition funded to ICM-CSIC by the Spanish Ministry of Science and Innovation (PROTEUS Project). The Lander was instrumented with a temperature sensor, a Wetlabs FLNTU to measure optical backscatter and fluorescence at 1 mab (sampling interval 15 minutes), a Rinko Advantech oxygen sensor at 1 mab (sampling interval 30 minutes), an upward looking 2 MHz Nortek ADCP at 2 mab (sampling interval 15 minutes), a cilindro-conical Technicap PPS4/3 sediment trap (0.05 m2 collecting area) with the aperture at 2 mab (12 bottles filled with buffered formalin solution, interval of 30 days), 1 stand-alone camera for macrofauna analysis (1 picture every 20 mins).

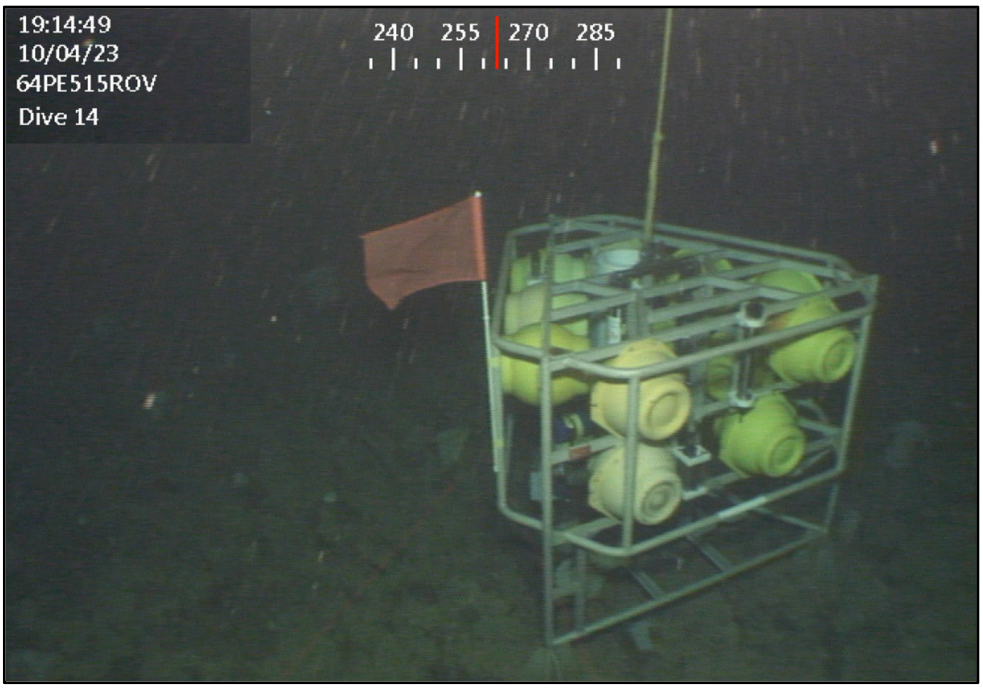

Figure 5.73: frame extracted from ROV video footage of OASIS Dive 14, showing the ALBEX lander on the long-term deployment site.

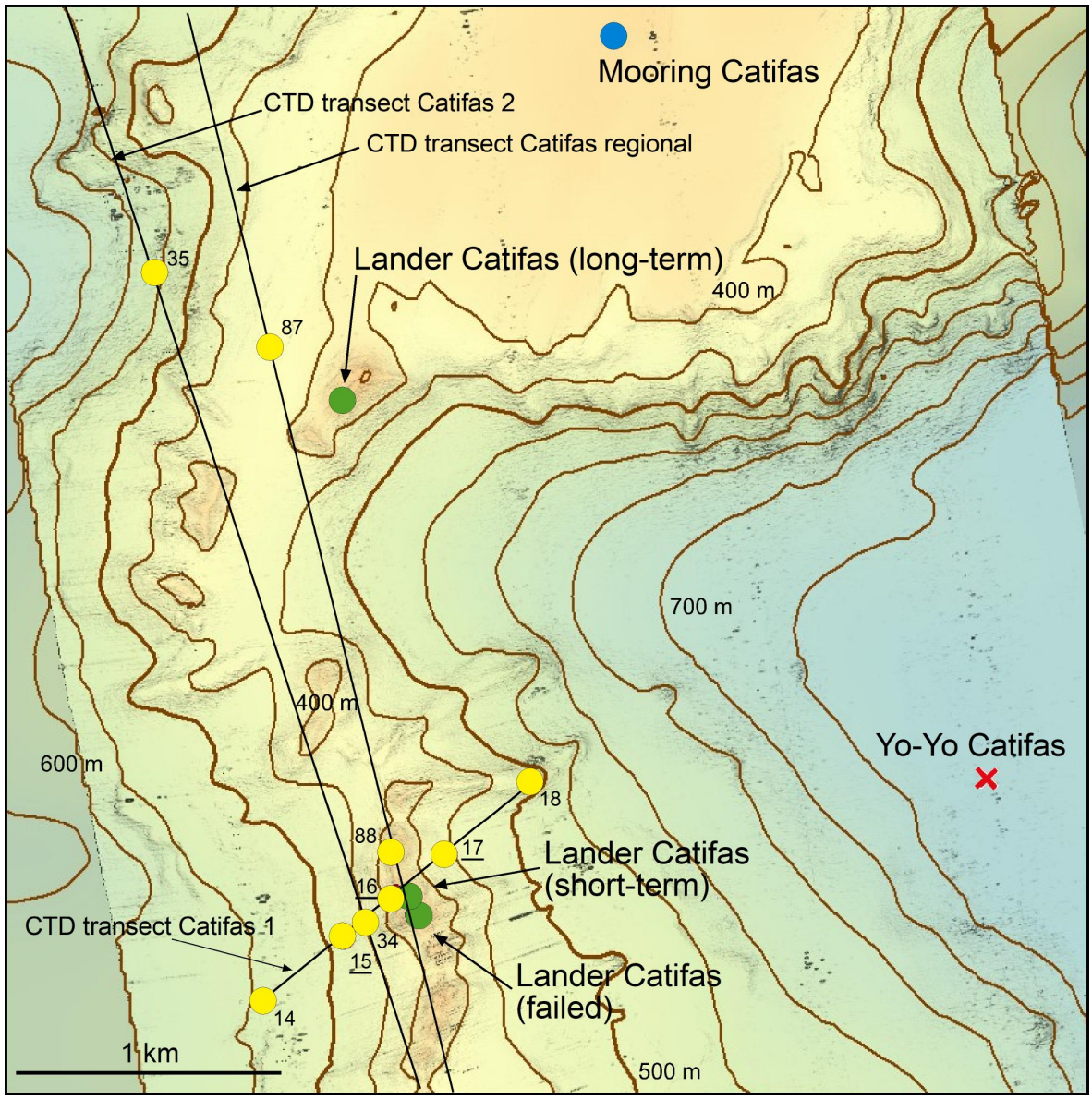

Figure 5.74: detailed map of Catifas landers positions, including the location of Catifas mooring and the closest CTD casts. Contour lines every 50 m.

5.6 Sediment sampling

5.6.1 Gravity cores

During OASIS Cruise, five gravity cores were collected for the first time on the newly discovered Catifas CWC mound province (Tab. 5.8). The main aims were to define the chronological and environmental constraints during which the sampled mounds developed in recent geologic time and to advance the understanding of how observed cyclic reefs evolve. For this reason, the five cores were collected on crests and troughs of small reefs observed on the top of a ridge-like CWC mound (Figs. 5.75, 5.76). The location of each sampling station was designed based on the MB bathymetry collected during OASIS.

The gravity corer on-board the RV Pelagia, consisted of 12 cm wide galvanized steel tube, 6 m long, containing a 11 cm wide PVC liner. The weight of the gravity corer head was around 1300 Kg.

Coring operations consisted of:

1. Lowering of the instrument at a velocity of 1 m/s.
2. Increasing the falling velocity (fee fall) at an altitude of around 40 meters over the seafloor, to ensure the probability to reach maximum core penetration.
3. The corer penetrated and sampled the CWC mounds.
4. The corer is recovered at a velocity of 10-20 m/min, gradually increasing towards 1 m/s when getting close to the sea surface.

Right after the recovery, gravity cores were measured, labelled and cut in 1-meter long Sections. Lowermost sediments contained in the core-catcher were introduced in labelled plastic bags. Finally, all the recovered sections and samples were stored in a refrigerated room at 4ºC in order to preserve the sediment moisture and other physicochemical properties of the sampled material.

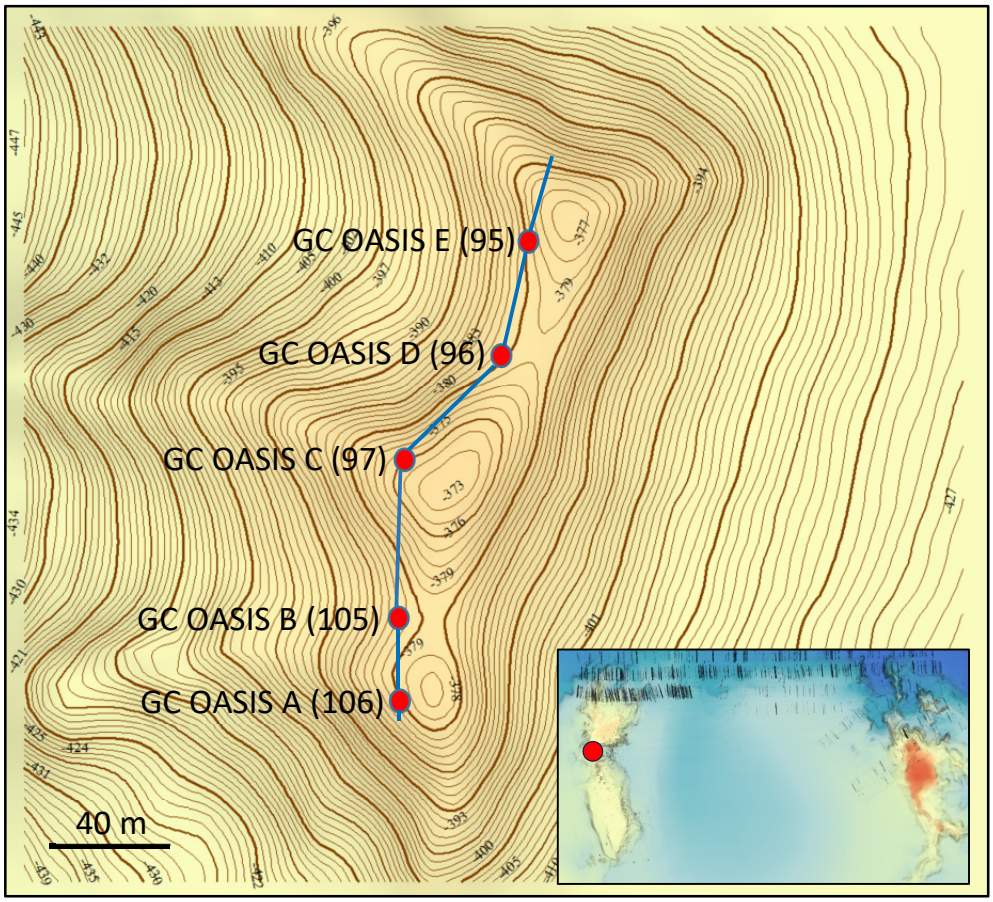

Figure 5.75: distribution of OASIS gravity cores on a CWC mound of Catifas province. (numbers within brackets refer to station numbers). Blue line refers to the bathymetric transect of figure 5.76.

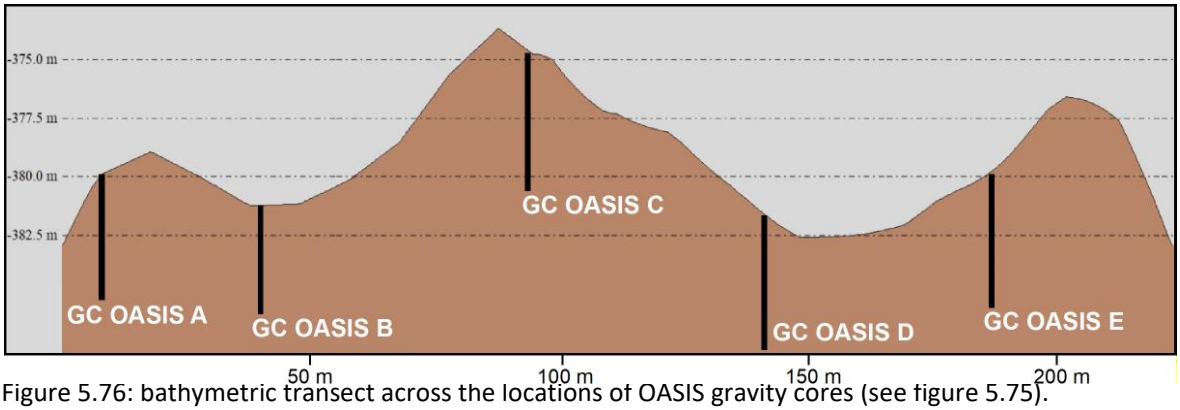

Figure 5.76: bathymetric transect across the locations of OASIS gravity cores (see figure 5.75).

GC OASIS A					
Station	**Date**	**Lat**	**Long**	**Depth**	**Recovered**
95	10/04/2023	35.8447° N	2.5835° W	376 m	5.26 m
GC OASIS B					
Station	**Deployment**	**Lat**	**Long**	**Depth**	**Recovery**
96	10/04/2023	35.8450° N	2.5835° W	378 m	4.89 m
GC OASIS C					
Station	**Deployment**	**Lat**	**Long**	**Depth**	**Recovery**
97	10/04/2023	35.8455° N	2.5835° W	371 m	5.37 m
GC OASIS D					
Station	**Deployment**	**Lat**	**Long**	**Depth**	**Recovery**
105	11/04/2023	35.8458° N	2.5832° W	378 m	5.36 m
GC OASIS E					
Station	**Deployment**	**Lat**	**Long**	**Depth**	**Recovery**
106	11/04/2023	35.8462° N	2.5830° W	376 m	5.24 m

Table 5.8: Coordinates and main characteristics of OASIS gravity cores.

5.6.2 Box Cores

4 box cores were collected during OASIS Cruise (Tab. 5.9, Fig. 5.77), aimed to characterize the on- and off-mound sedimentary characteristics of Cabliers and Catifas CWC provinces (Fig. 5.78) and to address the main aims of the CO-PI Eurofleets+ Project UNSEEN, focused to estimate the occurrence of microplastics both in the water column, within surficial sediments and on CWC reefs of the study area.

Four box cores were retrieved successfully out of 8 tries. Unsuccessful sampling (Station 72, 74, 76, 77) were most probably due to exceeded weight of the gear, which brought to the overflow of sediments from the box core. Once on board, first sampling operation has been the collection of the water above the sediments, which was filtered for microplastic analyses. Eventually, surficial sediments were sampled for organic matter analyses through small vials (3 replicates), for grain size analyses (250 gr) and for microplastic analyses (250 gr). Finally, 2 sub-cores were intruded in the box cores, and collected for analyses of grain size and of CWC and associated fauna (Fig. 5.77). 5 cm compaction has to be considered for the two sub-cores. For box cores 1 and 2 (stations 73 and 75), residual sediments surrounding the sub-cores were eventually sieved and stored. Only for Box Core 1 (station 73), surficial sediments were sampled for foraminifera analyses using three syringes.

Fig. 5.77: photo of OASIS box corer and of Dr. Martina Pierdomenico working on the subsampling of OASIS box core 1 (station 73).

BC OASIS 1					
Station	**Date**	**Lat**	**Long**	**Depth**	**Recovery**
73	10/04/2023	35.8452° N	2.2597° W	266 m	full
BC OASIS 2					
Station	**Date**	**Lat**	**Long**	**Depth**	**Recovery**
75	10/04/2023	35.8424° N	2.2950° W	687 m	full
BC OASIS 3					
Station	**Date**	**Lat**	**Long**	**Depth**	**Recovery**
107	11/04/2023	35.8230° N	2.5733° W	422 m	full
BC OASIS 4					
Station	**Date**	**Lat**	**Long**	**Depth**	**Recovery**
108	11/04/2023	35.8533° N	2.5300° W	752 m	full

Table 5.9: Coordinates and main characteristics of OASIS box cores.

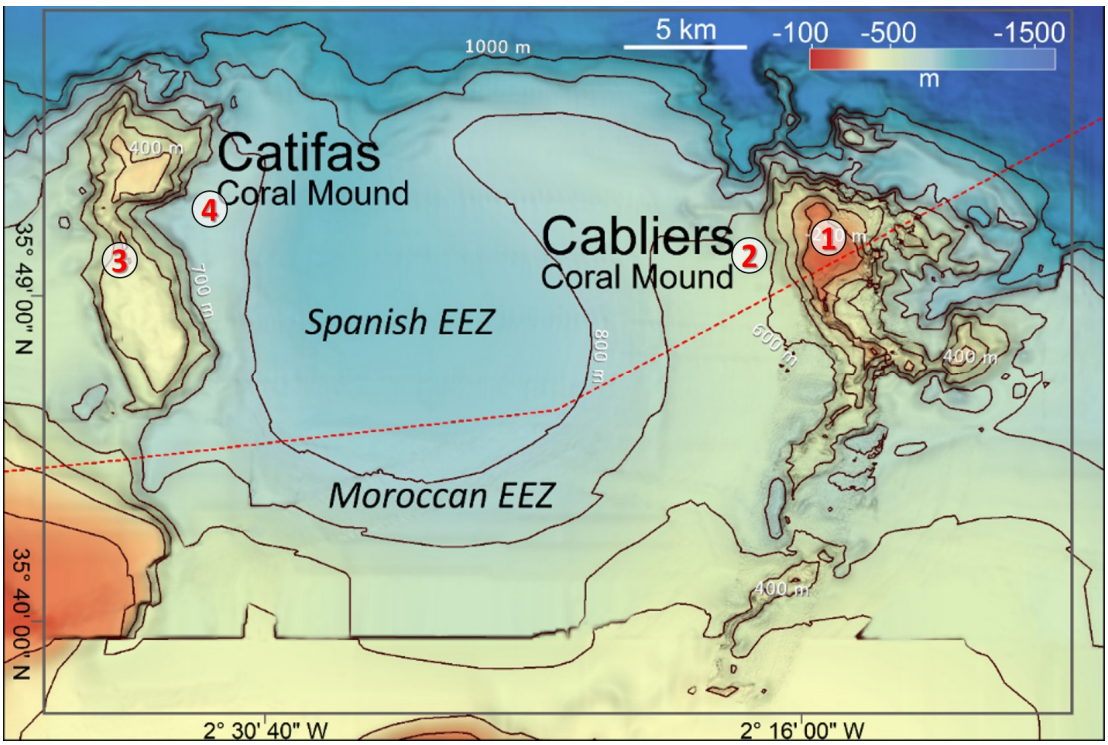

Figure 5.78: distribution of OASIS box cores.

6 Data and Sample Storage / Availability

OASIS meta-data will be available for inclusion in open-access interchange networks such as EMODnet (European Marine Observation and Data Network) (in the thematic portals of bathymetry, seabed habitats, biology, physics), PANGAEA, Digital CSIC and EMSO ERIC. The ship operator saved a copy of metadata acquired through the RV equipment. According to the Data Management Plan required by Eurofleets+, data will be delivered using SeaDataNet standards (https://www.seadatanet.org/).

7 Participants

No.	Name	Funded by EF+	Early career (Y/N)	Gender	Affiliation	On-board tasks
1	Claudio Lo Iacono	Y	N	M	CSIC	Principal Investigator
2	Furu Mienis	Y	N	F	NIOZ	Landers, CTD-Rosette
3	Pere Puig	Y	N	M	CSIC	Moorings, CTD-Rosette
4	MartinaPierdomenico	Y	N	F	CNR	CTD-Rosette, Box Cores
5	Guillem Corbera	Y	Y	M	UB	ROV dives, Gravity Cores
6	Ariadna Martinez	N	Y	F	CSIC	ROV dives, Gravity Cores
7	Aina del Alcazar	N	Y	F	UB	CTD-Rosette, Box Cores

CSIC	Spanish National Research Council, Marine Science Institute, Barcelona, Spain
NIOZ	Royal Netherlands Institute for Sea Research, Texel, the Netherlands
CNR	Italian National Research Council, Rome, Italy
UB	University of Barcelona, Spain

Figure 5.79: the scientific and technical team of OASIS Cruise.

8 Acknowledgements

We gratefully acknowledge the support of EU H2020 Eurofleets+ Project, especially Bernadette Ni Chonghaile and Niamh Flavin, from the Marine Institute of Ireland, which gave a crucial support and assistance to make this cruise happen, and to overcome the several issues that arose in the preparation of OASIS Cruise during the last four years. It was tough be we got there! We are deeply grateful to Jose Pozo and Maribel Lloret, from the Oceanographic Engineering Service of ICM-CSIC, for their professional assistance during the preparation of OASIS moorings. We deeply thank the captain, the officers and the entire crew of the RV Pelagia for their assistance and professional work during cruise operations, which made possible the 100% success of OASIS Cruise, but also for their sympathy and for the nice and happy moments we could share during those special days. A special thank goes to the dear friends of the HCMR ROV crew, for their professional attitude in ROV operations, their availability and flexibility, and of course for the nice moments we spent sailing together. We thank the UTM-CSIC for having provided the L-ADCP used during OASIS CTD

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9 References

[1] Corbera G. et al., 2019. Ecological characterization of a Mediterranean cold-water coral reef: Cabliers Coral Mound Province (Alboran Sea, western Mediterranean). Progress in Oceanography 175, 245-262

[2] Roberts et al., 2009. The Biology and Geology of Deep-Sea Coral Habitats. Cambridge Univ. Press, Cambridge, UK.

[3] D’Onghia G. et al., 2017. Anthropogenic impact in the Santa Maria di Leuca cold-water coral province (Mediterranean Sea): observations and conservation straits. Deep Sea Res II 145: 87-101

[4] Mytilineou C. et al., 2014. New cold-water coral occurrences in the Eastern Ionian Sea: Results from experimental long line fishing. Deep Sea Res II. 99:146-157

[5] Gori et al., 2013. Bathymetrical distribution and size structure of cold-water coral populations in the Cap de Creus and Lacaze-Duthiers canyons (northwestern Mediterranean). Biogeosciences 10(3):2049-2060.

[6] Puig and Gili, 2019. Submarine Canyons in the Mediterranean: A Shelter for Cold-Water Corals In: (Orejas and Jimenez eds) Mediterranean Cold-Water Corals: Past, Present and Future. Springer International Publishing AG - Springer Nature

[7] Corbera G. et al., 2021. Glacio-eustatic variations and sapropel events as main controls on the Middle Pleistocene-Holocene evolution of the Cabliers Coral Mound Province (W Mediterranean). Quaternary Science Reviews 253(1)

[8] Bo M. et al. 2018. Phylogenetic relationships of Mediterranean black corals (Cnidaria : Anthozoa : Hexacorallia) and implications for classification within the order Antipatharia Invertebrate Systematics 2018, 32, 1102–1110

[9] Ercilla et al., 2016. Significance of bottom currents in deep-sea morphodynamics: An example from the Alboran Sea. Marine Geology 378 (2016) 157–170