RV BELGICA CRUISE 2022/11 – CRUISE REPORT

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Geology/Oceanography: 28/04/2022 - 11/05/2022

1. CRUISE DETAILS

1.	Cruise number		2022/11
2.	Date/time	Algeciras TD Algeciras TA	28/04/2022 at 08h00 11/05/2022 at 18h00
3.	Chief Scientist Participating institutes		General coordination – Dr. Lieven Naudts PI GRACE - Dr. Carmen Juan Valenzuela Co-PI SEAQUAKE - Dr. Sara Martínez Loriente IEO-Cádiz, ICM-CSIC, RBINS-OD Nature
4.	Area of interest		Ceuta Canyon, Alboran Sea (SW Mediterranean)

2. LIST OF PARTICIPANTS

INSTITUTE	NAME	28/04 – 11/05/2022
RBINS-OD NATURE	Lieven Naudts	X
	Nick Eloot	X
IEO	Carmen Juan	X
	Nieves López-González	X
ICM-CSIC	David Casas	X
	Ferran Estrada	X
	Sara Martínez Loriente	X
	Ariadna Canari Bordoy	X
Arquimea Research Centre	Maria Azpiroz	X
UGent	Alice Matossian	X
	Koen De Rycker	X
U. La Sapienza	Clara Beda	X
U. de Cádiz	Juan Alberto Jimenez Rincon	X
	Elizabeth Blazquez Gómez	X
	Patricia Soriano Tineo	X
	Angel Rafael Domínguez	X
VLIZ	Fred Fourie	X
	Kobus Langedock	X
Total number of participants:		18

3. SCIENTIFIC OBJECTIVES

Part 1 - GRACE Project (Geo-hazaRds Along the CEuta canyon)

Abstract

The GRACE project focuses on the Ceuta Canyon, a large-scale downslope feature overlooked as a mere boundary geological feature of the adjacent and much larger Ceuta Drift. However, a) its location is tectonically controlled and seems to be related to onshore active structures; b) its head (located close to the coast) and the eastern margin are affected by arcuate-shaped scars; and c) it is deeply influenced by vigorous bottom currents that cause erosion on its margins and the rapid growth of the Ceuta Drift. This context in which tectonism, bottom currents and sedimentary instabilities show a complex interplay raises concerns regarding the high exposure of coastal populations to geohazards. In addition, new projects to place electrical and telecommunications connections in between Spain and Morocco are endangered. This proposal aims to study the geological risks in the Ceuta Canyon and its annex areas with a multidisciplinary lens, focusing on the sedimentary processes, chrono-stratigraphy, and oceanography. To properly tackle this task, ultra-high resolution imaging of the seafloor must be carried out. For that, the incorporation of an AUV will allow geohazard mapping with unprecedented precision, providing higher resolution datasets than those achieved from surface vessels with traditional techniques.

Objectives

The working hypothesis is that the Ceuta canyon and surrounding domains represent a potential threat for proximal to coastal areas due to the striking occurrence of landslides, vigorous bottom currents, land-sea tectonic-related seismicity, and fluid dynamics. To test this hypothesis, this proposal pursues two main objectives: **a) to better understand the Ceuta Canyon, including its origins, influence of tectonic features, and chronostratigraphy of the deposits, and b) the study of potential hazardous geological and oceanographic processes occurring in the Ceuta Canyon and adjacent areas**. To answer the scientific questions related to these two objectives will be the main priority of the project, but a few additional questions have also been raised.

Objective A: origins, development and chronology of the Ceuta Canyon

a) Is the origin and current location of the Ceuta Canyon related to the Onsar fault? *

b) How was the Plio-Quaternary evolution of the Ceuta Canyon and its tributaries? How was the interplay between the Ceuta Canyon and Drift in the past?

c) Have the downslope processes influenced the Ceuta Canyon incision and the meandering of the thalweg in the past?

d) Are there any cyclic patterns dismantling the canyon head and eastern sidewall? Are these cyclic patterns related to glacioeustatic sea-level changes? *

Objective B: hazardous geological and oceanographic processes

e) Is the Onsar fault a relevant risk factor? *

f) Are slide scars on the canyon rims active today? Do they present a great risk to nearby populations? Which are the diagnostic criteria?

g) How is the Atlantic Jet affecting the morphology? Are internal waves detected in the study area? Are they a relevant triggering factor?

h) Which of the possible mechanisms (slope oversteepening, seismicity, internal waves...) prevails triggering the downslope processes?

Additional questions

j) Do the bioconstructions located besides the canyon head contain relevant information to reconstruct the past evolution of the Ceuta Canyon? Are they forming singular vulnerable ecosystems? Are sediment instabilities endangering the bioconstructions?

k) Do new interpretations fit within previously published sedimentary and oceanographic models? Which are the implications of these results? Can they be extrapolated to other margins with coexisting alongslope and downslope features?

* Unfortunately, the lack of sailing permits into Moroccan waters greatly affected the possibility of obtaining data of the canyon head to fully answer these questions, which will be nonetheless tackled with the currently available information.

Part 2 - SEAQUAKE Project (Unveiling the coseismic rupture of an active submarine fault in the Alboran SEA. The 2016 Al-Idrissi earthQUAKE)

Abstract

The objective to be achieved was to corroborate the eastern offshore continuation of a fault identified along the north coast of Morocco. Benchekroun et al. (2013) defined this structure as a normal fault with a surface rupture length of 20 km and seismogenic potential to generate an earthquake of M 6.6. This fault probably corresponds to an inherited structure from the Jurassic transfer zone that was reactivated during the Neogene convergence.

The specific objectives of this proposal were:

1. Corroborate the extension of the fault to the east within the sailing permit area. If the structure extends to the east (Figure 1c), the surface rupture length would reach 37.4 km, increasing its seismogenic potential and being capable of generating a M7.0 earthquake. Considering the proximity and orientation of the fault, our finding would notably increase the tsunamigenic hazard on the nearby coasts of Morocco and Spain, which are densely populated areas with important port infrastructures.

2. Geochronological and deformation history study. It was planned to collect piston cores in designated locations along TOPAS profiles (cm vertical resolution). The identification of the seismostratigraphic units on the cores and their dating will allow determining the Upper Pleistocene and Holocene seismostratigraphy and deformation history of the target fault. This will provide information about vertical fault offset and vertical fault slip-rate. This information is essential to consider the fault as a fault source in probabilistic seismic hazard assessment.

4. OPERATIONAL COURSE

All times are given in GMT. All coordinates in WGS84.

00 day 27/04/2022

13h30-20h30 Embarkation of instruments and personnel
14h00 Test and balancing of AUV incl. RHIB.

01st day 28/04/2022

06h00 Departure from the Port of Algeciras towards the mooring station
07h00 Safety training provided by the Captain at the Meeting Room.
08h00 The MMOs start their first shift
08h00 – 12h30 Preparation of the ADCP mooring line on deck.
TECHNICAL ISSUES: Part of the material corresponded to a different mooring line. The assemblage of the ADCP on the buoy was slightly modified to achieve a solid grip and a better orientation of the ceramic plates by placing two packing rings in between the clamp and the connection at the buoy's frame.
13h30 ADCP mooring maneuver (35.834743ºN / 5.124762ºW).
The buoy's frame was tied up with a rope and a liberator hook. The weight was placed in the wáter, and once the entire mooring line was in good position, the buoy was freed from the rope and the entire mooring line descended to the seafloor. Clean maneuver.
14h00 Full test with AUV (release, descent, acquisition)
16h00 Training for the day-to-day use of the various acousting sounders installed onboard the RV Bélgica (EK80, TOPAS, multibeam echosounders).
16h30 Recovery of the AUV. Test successful.
17h20 Calibration of the rosette
18h00 CTD-01 profile (35.8068333ºN / 5.17766667ºW). The Morocco authorities repeatedly request the RV Belgica not to enter into their waters.
19h00 Tuning of all the acoustic sounders (EK80, TOPAS, multibeam).
TECHNICAL ISSUES: The multibeam and TOPAS echosounders can't work simultaneously due to interferences. Given that a mid-resolution multibeam grid is available, priority in acquisition is given to TOPAS, so the multibeam is shut down. In addition, due to the insistence of the Moroccan authorities, the Sparker lines are modified even before their start to avoid navigation on the continental shelf, which are waters in conflict between Spain and Morocco.

19h00 Tuning of all Sparker systems. Navigation in circles around the starting point.

TECHNICAL ISSUES: The sparker can't fire, so the power supply is changed. Not knowing the duration of the repair, multibeam lines are planned in the meantime along the upper part of the Ceuta canyon, as a backup plan. A second Sparker test is performed on route to the first multibeam line. The test is successful, so the start of multibeam lines is aborted and the vessel returns to the start of the first Sparker line.

19h26 Start Of Line (SOL) GRACE01 (TOPAS) and A01 (Sparker), about 200 m west of the line. The vessel slowly fixes its course until reaching the line.

02nd day 29/04/2022

00h00 End Of Line (EOL) GRACE01 (TOPAS), slightly out of line for transit to the next line.

00h02 SOL GRACE02 (TOPAS).

00h04 EOL A01/SOL A02 (Sparker).

02h29 EOL GRACE02 (TOPAS).

02h32 SOL GRACE03 (TOPAS).

02h37 EOL A02 /SOL A03 (Sparker).

02h56 TECHNICAL ISSUES: The EK80 loses the seafloor "at 400 m deep" and the TOPAS shows the we are currently at 85 m depth, but seems to be recording the water column. We force the depth into the EK80 and the problem is solved.

02h59 EOL A03 (Sparker) / SOL A04 (Sparker). EOL GRACE03 / SOL GRACE04 (TOPAS).

03h55 EOL GRACE04 TOPAS. The vessel made the turn on the inside of the angle made by the two lines and some features that were being imaged on the platform were lost.

03h58 SOL GRACE05 TOPAS. The beginning of the line was not recorded due to the turn of the vessel.

04h05 EOL A04/SOL A05 SPARKER. The change of the line was done a little bit late.

04h20 TECHNICAL ISSUES: GRACE05 (TOPAS). Problems with the depth, the system indicates only 4 m deep (which is not possible at the axis of the canyon), and then suddenly jumped to 1000 m. The depth of the system was manually forced to 300 m (which was the depth indicated by the EK80). Once stable, the settings of the depth were set back to automatic and went once again to 1000 m deep. The team had to return to manual settings.

04h57 When surveying a flat, not-so-relevant area, the TOPAS team tried once again to go back to automatic settings. At the beginning it went to 500 m, but slowly went to the actual depth of the seafloor, at 160 m deep.

05h04 EOL A05 / SOL A06 (Sparker).

05h06 EOL GRACE05 / SOL GRACE06 (TOPAS).

05h13 EOL A06/SOL A07 (Sparker) (There was another problem with the turn of the vessel and the new line 7 should still be line 6)

05h24 EOL A07/SOL A07b (Sparker).

05h26 EOL GRACE06 / SOL GRACE07 (TOPAS).

05h34 The team is still experiencing problems with the automatic detection of the seafloor on the TOPAS. These problems are explained to David, the technician of the vessel, who is about to start his shift. The technician switches to manual.

05h36 The technician switched the system back to automatic because in manual everything seems to work fine. The seafloor jumps suddenly to 800 m. After agreeing that there are problems with the automatic detection of the seafloor, he switched back to manual. Depth stays blocked at 150 m due to an internal error. The technician switched once again to automatic and back to manual and the system is able to detect the seafloor once again.

05h42 EK80 is stable at a good depth and one last attempt to switch to automatic is done. The depth of the TOPAS jumps to 1250 m, so the team returns to manual settings.

05h45 The technician suspects that there is a second synchrony problem between the sounders (on top of the interference that prevents to use TOPAS and Multibeam at the same time). The TOPAS pulse affects the EK80, that registers way too much noise and can't find the seafloor. Since the EK80 feeds the location of the seafloor to the TOPAS, she can't find the seafloor in automatic settings.

05h47 The technician lowers the energy of the TOPAS pulse to 39.8% to see if the EK80 can find the seafloor with less noise. It does not work, so the TOPAS goes back to 100% energy settings.

06h11 EOL A07b/SOL A08 (Sparker).

06h14 EOL GRACE07 / SOL GRACE08 (TOPAS).

07h10 EOL A8 (Sparker).

07h30 EOL GRACE08 / SOL transit to AUV1 -TRANSAUV1- (TOPAS).

08h30	EOL TRANSAUV01 (TOPAS).
09h30	CTD-02 to obtain a sound velocity profile (35.9048333ºN / 5.15383333ºW).
12h30	AUV on the water. (35º 55.381'N 5º 9.1462'W).
13h00	AUV back to surface (emergency stop due to a technical problem). It is sent back down without requiring to go on deck. The AUV resumes her work.
13h30	AUV back to surface. Emergency stop.
15h30	AUV is on deck to carry out a change of batteries.
16h22	AUV back to water
17h00	The AUV navigates correctly above the seafloor. Start of maneuvers to record a CTD in the meantime (CTD-03 - 35.9096667ºN / 5.15666667ºW).
17h55	CTD-03 back onboard
19h09	Dolphins near the prow (35º 54.571'N / 5º 9.398'W)
19h29	AUV back onboard (35º 54.538'N / 5º 9.375'W)
20h09	SOL Transit to GRACE 08B (TRAGRACE8B TOPAS).
20h56	EOL TRAGRACE8B / SOL GRACE 8B (TOPAS).
20h57	SOL A08B (Sparker).
22h39	EOL GRACE 8B (TOPAS).
22h40	EOL A08B / SOL A09 (Sparker).
22h55	TECHNICALL ISSUES: Connection problem with the Sparker system.
22h41	SOL GRACE 09 (TOPAS).
23h00	EOL GRACE 09 (TOPAS) and EOL A09 / SOL A010 (Sparker).
23h02	SOL GRACE 10 (TOPAS).

03rd day 30/04/2022

01h04	EOL GRACE 10 (TOPAS).
01h05	EOL A10 / SOL A011 (Sparker).
01h06	SOL GRACE 11 (TOPAS).
02h45	EOL GRACE11 / SOL GRACE12 (TOPAS) and EOL A11 / SOL A12 (Sparker).
02h52	EOL A12 / SOL A13 (Sparker).
02h53	EOL GRACE 12 / SOL GRACE 13 (TOPAS).
04h59	EOL GRACE 13 / SOL GRACE14 (TOPAS) and EOL A13 / SOL A14 (Sparker).
06h14	EOL GRACE14 (TOPAS) due to the presence of dolphins close to the vessel.
06h15	EOL A14 (Sparker) due to the presence of dolphins close to the vessel. Change of course towards AUV DIVE02
06h26	SOL TRANS AUV2 (TOPAS). Preparation of AUV during transit.
07h30	Arrival to AUV2 mother position.
07h42	SOL TRANS AUV2 (TOPAS).
08h15	AUV on water.
09h46	CTD-04 (35.897ºN / 5.1555ºW) Later we learned that doing a CTD during the AUV dive affected the navigation of the AUV, and we stopped using the time during AUV dives for CTDs.
12h56	AUV back on deck. Battery swap.
13.42	AUV diving once again
17.11	Start AUV recovery maneuver (very quick, at 17.14 the AUV is on deck). The analysis of the data reveals coral-like structures.
17h28	Start of the maneuver to recover Gravity Core 01 (35º53.3342' N / 5º10.5667' W). Since it is the very first time that the sediment core recovery system is used onboard the vessel, it is decided to only use the 1 m trigger core as the main core (thus, using the trigger as a small-sized gravity core) so all the personnel on deck can start to get used to using the system.
17h48	Gravity core GRACE GC-01 at the bottom of the seafloor (Depth: 646 m)
18h00	End of maneuver to recover the gravity core GRACE GC-01. (Penetration: 110 cm; Sections: 1/1). Full success.
18h00	Start of maneuver to record CTD-05 (35.8888333 ºN / 5.17616667 ºW)
18h49	CTD-05 back on deck.
19h00	SOL transit to GRACE15 (TOPAS).
20h36	EOL transit to GRACE15. SOL GRACE 15 (TOPAS) and SOL A15 (Sparker).
23h17	EOL GRACE 15 (TOPAS).
23h18	SOL GRACE 16 (TOPAS) and EOL A15 / SOL A16 (Sparker).

23h28 EOL GRACE 16 (TOPAS).
23h29 EOL A16 / SOL A17 (Sparker).
23h30 SOL GRACE 17 (TOPAS).

04th day 01/05/2022

01h19 EOL A17 / SOL A18 (Sparker).
01h20 EOL GRACE 17 (TOPAS).
01h23 SOL GRACE 18 (TOPAS).
01h45 EOL GRACE18 (TOPAS).
02h03 EOL A18 / SOL A19 (Sparker).
02h04 SOL GRACE19 (TOPAS).
03h28 EOL GRACE19 / SOL GRACE20 (TOPAS) and EOL A19 / SOL A20 (Sparker).
05h07 EOL GRACE20 / SOL GRACE21 (TOPAS).
05h08 EOL A20 / SOL A21 (Sparker).
05h59 EOL A21 / SOL A22 (Sparker) and EOL GRACE21 / SOL GRACE22 (TOPAS)
TECHNICAL ISSUES: The seafloor is lost on the TOPAS profiles.
06h15 Early EOL A22 (Sparker) due to the presence of dolphins in the vicinity.
06h50 The Sparker line A22 is resumed once the dolphins are gone. SOL A22B (Sparker).
07h12 EOL A22B (Sparker). Change of recording parameters in Sparker (shooting interval 2 s).
07h13 EOL GRACE22 (TOPAS).
07h15 SOL A23 (Sparker) and SOL GRACE23 (TOPAS).
08h06 EOL GRACE23 and SOL transit to AUV3 (TOPAS). The AUV is prepared during the transit.
08h10 EOL A23 (Sparker).
09h07 EOL TRANSIT AUV3 (TOPAS).
09h27 Start of AUV deployment maneuver for AUV dive 3 (mother positionh 35º58.10002' N / 5º 10.8997' W)
09h40 Start of AUV dive3
15h35 AUV back onboard for battery swap
16h33 AUV back on the water
17.30 AUV back bordo. End of AUV DIVE3
19h03 Start of CTD-06 (35.987606ºN / 5.258445ºW)
19h50 CTD-06 back onboard.
20h45 The TOPAS is not working. Krongsberg is contacted, the team awaits for answers. Given that we can’t use the TOPAS, the multibeam echosounder is switched on.
20h47 SOL A24 (Sparker).
22h30 SOL LMB25 MULTIBEAM (the recording starts when Sparker line A24 is about halfway).
23h12 EOL A24 / SOL A25 Sparker (change of acquisition parameters: shooting rate 1.5 s, recording length 1.4 s).

05th day 02/05/2022

00h05 EOL A25 / SOL A26 (Sparker). The weather is bad and the vessel drifts far away from the planned line.
00h09 EOL LMB25 / SOL LMB26 (Multibeam).
03h07 EOL A26 / SOL A27 (Sparker), and EOL LMB26 (Multibeam).
TECHNICAL ISSUES: Problem with Multibeam acquisition.
03h10 The multibeam system is restored and it seems to work fine. SOL LMB27 (Multibeam).
03h50 TECHNICAL ISSUES: Acquisition problems with Sparker.
04h19 TECHNICAL ISSUES: The source of the problem with the Sparker system seems to be the power supply unit (CSP700). It seems to work fine, but it stops after a while. Test with different acquisition parameters.
04h53 Still with problems. The sparker centipede and the power supply (CSP600) are changed.
05h02 SOL A27_002 (Sparker).
05h45 EOL LMB27 (Multibeam).
05h51 SOL LMB28 (Multibeam).
05h52 EOL A27_002 / SOL A28 (Sparker).
06h30 EOL A28 SPARKER. The planned Sparker line is not finished yet, but Sparker is cut short due to the worsening weather. The day will be dedicated to the acquisition of high-resolution multibeam lines along the canyon axis (the multibeam lines that were planned on the first night as a backup plan).
06h38 EOL LMB28 and SOL TRANSCTD7 (Multibeam).

07h10 EOL TRANSCTD7 (Multibeam). The multibeam record is stopped by mid-transit towards the CTD position 07. TECHNICAL ISSUES: The TOPAS is being fixed, and a few tests will be carried out during the rest of the transit.
8h02 CTD-07 is lowered to the water (35.964541ºN / 5.214523ºW)
8h53 CTD-07 back onboard.
09h13 SOL TRANS LMB01 (Multibeam).
10h06 EOL TRANS LMB01 (Multibeam).
10h26 SOL LMB01 (Multibeam).
10h42 EOL LMB01 (Multibeam).
10h49 SOL LMB02 (Multibeam).
11h13 EOL LMB02 (Multibeam).
11h19 SOL LMB03 (Multibeam).
12h37 EOL LMB03 (Multibeam).
12h46 SOL LMB04 (Multibeam).
14h29 EOL LMB04 (Multibeam).
14h35 SOL LMB05 (Multibeam).
14h50 During the afternoon various tests are carried out to check the power supplies of the Sparker system, as well as all the connection cables.
15h43 EOL LMB05 (Multibeam).
15h48 SOL LMB06 (Multibeam). The vessel drifts away from the planned course.
15h56 The vessel is back to its course.
16h39 EOL LMB06 / SOL LMB07 (Multibeam).
17h08 EOL LMB07 (Multibeam).
17h13 SOL LMB08 (Multibeam).
18h38 EOL LMB08 / SOL LMB09 (Multibeam).
19h27 The vessel stops at the CTD-08 planned position (35.8601667ºN / 5.1895ºW).
19h31 EOL LMB09 (Multibeam).
19h32 Start of CTD-08 (35.8601667ºN / 5.1895ºW).
20h18 End of maneuver to record CTD-08.
20h42 SOL LMB09-B (Multibeam).
21h37 EOL LMB09-B / SOL LMB10 (Multibeam).
23h03 EOL LMB10 (Multibeam).
23h09 SOL LMB11 (Multibeam).

06th day 03/05/2022

00h23 EOL LMB11 (Multibeam).
00h23 START OF SEAQUAKE OPERATIONS FOR DAY 03/05/2022. Transit to SQ-MB-01(EM-304)
01h37 SOL SQ-MB-01 (EM-304)
02h15 EOL SQ-MB-01 (EM-304)
02h22 SOL SQ-MB-02 (EM-304)
02h56 EOL SQ-MB-02 (EM-304)
03h04 SOL SQ-MB-03 (EM-304)
03h39 EOL SQ-MB-03 (EM-304)
03h46 SOL SQ-MB-04 (EM-304)
04h16 EOL SQ-MB-04 (EM-304)
04h24 SOL SQ-MB-05 (EM-304)
04h51 EOL SQ-MB-05 (EM-304)
04h56 SOL SQ-MB-06 (EM-304)
05h27 EOL SQ-MB-06 (EM-304)
05h40 SOL SQ-MB-07 (EM-304)
06h21 EOL SQ-MB-07 (EM-304)
06h23 SOL SQ-MB-08 (EM-304)
06h51 EOL SQ-MB-08 (EM-304)
06h57 SOL SQ-MB-09 (EM-304)
07h35 EOL SQ-MB-09 (EM-304)
07h38 SOL SQ-MB-10 (EM-304)
08h10 EOL SQ-MB-10 (EM-304)

08h14 SOL SQ-MB-11 (EM-304)
08h25 SOL SQ-MBS-11 (EM-2040)
08h53 EOL SQ-MB-11 (EM-304)
08h54 EOL SOL SQ-MBS-11 (EM-2040).
08h57 SOL SQ-MB-12 (EM-304)
09h00 SOL SQ-MBS-12 (EM-2040).
09h18 EOL SQ-MBS-12 (EM-2040)
09h26 EOL SQ-MB-13 (EM-304)
09h28 SOL SQ-MB-13 (EM-304)
09h42 SOL SQ-MBS-13 (EM-2040).
10h12 EOL SQ-MB-13 (EM-304)
10h13 EOL SQ-MBS-13 (EM-2040).
10h18 SOL SQ-MB-14 (EM-304) / SOL SQ-MBS-14 (EM-2040).
10h48 EOL SQ-MBS-14 (EM-2040).
10h51 EOL SQ-MB-14 (EM-304)
11h58 SQ-CTD-09a 35° 57,46' N / 5°12,23' W.
TECHNICAL ISSUES: The operation is aborted due to the extremely strong current, which threatens to break the cable. The vessel moves to a more sheltered location.
14h15 SQ-CTD-09b (35° 56' 02.9338" N / 5° 10' 21.7353" W).
TECHNICAL ISSUES: The operation is once again aborted due to the extremely strong current. The hull-mounted ADCP data is checked to better understand the current conditions and the signal of a very strong internal wave is clearly visible on screen.
14h40 END OF SEAQUAKE OPERATIONS FOR DAY 03/05/2022.
14h40 New recorded TOPAS tests while sailing towards the next AUV dive.
20h25 SOL GRACE 24 (TOPAS).
22h29 EOL GRACE 24 (TOPAS).
22h30 SOL GRACE 25 (TOPAS).
23h20 EOL GRACE 25 (TOPAS).
23h22 SOL GRACE 26 (TOPAS).
16h02 AUV on water at the same position of AUV dive 02, but with the Grasshopper camera, to try to discern if the coral mounds detected in previous dives are alive or just relict features.
18h32 AUV back onboard.
Core GRACE GC-02 (35º53.276'; -5º9.522') First attempt unsuccessful.
19h22 Start of the second attempt to recover Core GRACE GC-02 (35º53.276'; -5º9.522').
19h28 The Gravity core is at the seafloor (Depth: 492 m).
19h40 End of maneuver for GRACE GC-02. Not much sediment is recovered, two plastic bags are filled with the top (about 10-15 cm of recovery) and bottom (core catcher) sediment.
20h34 SOL A28B (Sparker) (the line that was left unfinished is resumed).
22h30 EOL A28B / SOL A29 (Sparker).
23h20 EOL A29 / SOL A30 (Sparker).

07th day 04/05/2022

01h07 EOL A30 / SOL A31 (Sparker).
01h11 EOL GRACE26 / SOL GRACE27 (TOPAS).
02h58 EOL A31 / SOL A32 (Sparker).
03h03 EOL GRACE27 / SOL GRACE28 (TOPAS).
03h04 EOL A32 / SOL A32B (Sparker).
04h03 EOL A32B / SOL A33 (Sparker).
04h04 EOL GRACE28 / SOL GRACE29 (TOPAS).
05h15 EOL A33 / SOL A34 (Sparker).
TECHNICAL ISSUES: There are once again problems with the power supply of the Sparker system after starting the new line.
05h19 EOL GRACE29 / SOL GRACE30 (TOPAS).
05h25 Change of the power supply of the Sparker, to CSP600. SOL A34b
05h40 The Sparker seems to work properly once again. EOL A34b / SOL A35 (Sparker).
05h41 EOL GRACE30 / SOL GRACE31 (TOPAS).
07h27 EOL A35 (Sparker) and EOL GRACE31 (TOPAS).

07h29 SOL TRANS to AUV04 (TOPAS).
08h26 EOL TRANS to AUV04 (TOPAS).
10h00 AUV on water.
14h04 AUV back onboard.
14h27 SOL transtit to PC01 LMB (Multibeam).
14h47 EOL TRANS PC01LMB (Multibeam).
14h57 Start of maneuver for GRACE PC-01 (35º56.897'N; 5º8.0455'W)
15h33 The piston core system touches bottom (Depth 508 m).
16h49 End of maneuver for GRACE PC-01 (196 cm recovery, 2 sections + trigger core)
18h25 START OF SEAQUAKE OPERATIONS FOR DAY 04/05/2022, using both the shallow and deep multibeam echosounders. SOL Transit to SQ-MB-15 (EM-304)
19h39 EOL Transit to SQ-MB-15 (EM-304)
19h49 SOL Transit to S Q-MB-15B (EM-304)
20h00 EOL Transit to SQ-MB-15B (EM-304)
20h08 SOL Transit to SQ-MB-15C (EM-304)
20h15 SOL Transit to SQ-MBS-15 (EM-2040). (EM-304)
20h31 EOL Transit to SQ-MBS-15 / SOL SQ-MBS-15 (EM-2040).
20h54 EOL SQ-MBS-15 (EM-304) / SOL SQ-MBS-17 (EM-2040).
21h25 EOL SQ-MBS-17 (EM-304) / SOL SQ-MBS-19 (EM-2040).
21h49 EOL TRANSITOASQ-LMB-15C (EM-304) / SOL SQ-MB-19
22h05 EOL SQ-MBS-19 (EM-304) / SOL SQ-MBS-21 (EM-2040).
22h07 EOL SQ-MB-19 (EM-304) / SOL SQ-MB-21 (EM-304)
22h57 EOL SQ-MBS-21(EM-304) / SOL SQ-MBS-23 (EM-2040).
23h01 EOL SQ-MB-21 (EM-304) / SOL SQ-MB-23 (EM-304)
23h55 EOL SQ-MBS-23 (EM-304) / SOL SQ-MBS-25 (EM-2040).
23h56 EOL SQ-MB-23 (EM-304) / SOL SQ-MB-25 (EM-304)

08th day 05/05/2022

00h56 EOL SQ-MBS-25 (EM-304) / SOL SQ-MBS-27 (EM-2040)
00h58 EOL SQ-MB-25 (EM-304) / SOL SQ-MB-27 (EM-304).
01h47 EOL SQ-MBS-27 (EM-304) / SOL SQ-MBS-29 (EM-2040)
01h48 EOL SQ-MB-27 (EM-304) / SOL SQ-MB-29 (EM-304).
02h43 EOL SQ-MB-29 (EM-304) / SOL SQ-MB-30 (EM-304).
02h48 EOL SQ-MBS-29 (EM-304) / SOL SQ-MBS-30 (EM-2040)
03h10 EOL SQ-MBS-30 (EM-304) / SOL SQ-MBS-31 (EM-2040)
03h12 EOL SQ-MB-30 (EM-304) / SOL SQ-MB-31 (EM-304).
03h21 EOL SQ-MBS-31 (EM-2040)
03h22 EOL SQ-MB-31 (EM-304) / SOL SQ-MB-32 (EM-304).
03h28 EOL SQ-MB-32 (EM-304) / SOL SQ-MB-33 (EM-304).
04h30 End of SEAQUAKE OPERATIONS
04h30 SOL transit to AUV8 (recording with MULTIBEAM).
05h55 EOL TRA-LMB-AUV8 (Multibeam). Arrival to AUV8 mother position.
06h50 Start of AUV8 dive on a rocky outcrop at the upper sector of the canyon.
09h18 AUV back onboard.
11h03 Start of maneuver to recover the piston core GRACE PC-02 (35º52.8696'N/ 5º9.074'W)
11h30 GRACE PC-02 touches bottom (Depth: 463 m)
12h11 GRACE PC-02 is on deck (251 cm penetration; 3 sections + trigger).
14h17 Start of maneuver for core GRACE PC-03 (replica of PC-02, for geotechnical analysis) (35º52.8698'N; 5º9.07431'W)
14h45 Bottom (Depth: 464 m).
15h20 End of maneuver for core GRACE PC-03 (261 cm of penetration; 3 sectionc + trigger).
16h45 Same position as AUV8, second dive with the Grasshopper camera (after battery swap) to check on a different benthic community.
17h00 AUV is still at the surface. There is bad communication link with the vessel.
17h12 AUV back on deck to fix comms.

17h35 AUV back on the water for a quick and short dive (it must be recovered while there is still some light, before 21h30 local time, 19h30 GMT).
19h25 AUV back on deck.
20h04 START OF SEAQUAKE OPERATIONS, using TOPAS. SOL Transit to SQ-TOPAS1 TOPAS.
20h32 EOL Transit to SQ-TOPAS1 TOPAS.
20h40 SOL SQ-Topas-1
21h11 EOL SQ-Topas-1 / SOL SQ-Topas-2
21h28 EOL SQ-Topas-2 / SOL SQ-Topas-3
21h53 EOL SQ-Topas-3 / SOL SQ-Topas-4
22h00 EOL SQ-Topas-4 / SOL SQ-Topas-5
22h15 EOL SQ-Topas-5
22h16 SOL SQ-Topas-6
22h34 SQ-Topas-6
22h40 EOL SQ-Topas-6 / SOL SQ-Topas-7
22h53 EOL SQ-Topas-7 / SOL SQ-Topas-8
23h03 EOL SQ-Topas-8 / SOL SQ-Topas-9
23h17 EOL SQ-Topas-9.
INCIDENCE: Problems due to the abundance of tiny boats not properly signalled and without radio. The bridge cuts the line and asks for a design change.
23h29 SOL SQ-Topas-10
23h50 EOL SQ-Topas-10 / SOL SQ-Topas-11

09th day 06/05/2022

00h03 EOL SQ-Topas-11 / SOL SQ-Topas-12
00h33 EOL SQ-Topas-12 / SOL SQ-Topas-13
00h58 EOL SQ-Topas-13 y SOL Transit to a new area.
01h31 EOL Transit to new area.
01h33 SOL SQ-MB-34 (EM-304). STOP TOPAS due to interferences with multibeam.
02h54 EOL SQ-MB-34 (EM-304).
03h04 SOL SQ-MB-35 (EM-304).
03h58 EOL SQ-MB-35 (EM-304).
04h08 SOL SQ-MB-36 (EM-304).
05h23 SOL SQ-MB-37 (EM-304).
06h12 EOL SQ-MB-37 (EM-304) / SOL Transit to SQ-AUV1
07h09 EOL Transit to SQ-AUV1
07h58 AUV on water SQ-AUV-1
11h35 AUV recovered SQ-AUV-1
12h46 AUV on water SQ-AUV-2
15h27 AUV on deck.
15h58 SOL SQ-TP-14 TOPAS.
INCIDENCE: Problem with TOPAS. The technician re-starts the equipment.
16h09 EOL SQ-TP-14 TOPAS.
16h12 SOL SQ-TP-14B TOPAS.
16h19 EOL SQ-TP-14B / SOL SQ-TP-15 TOPAS.
16h28 EOL SQ-TP-15 / SOL SQ-TP-16 TOPAS.
16h32 EOL SQ-TP-16 / SOL SQ-TP-17 TOPAS.
16h47 EOL SQ-TP-17 / SOL SQ-TP-18 TOPAS.
17h12 EOL SQ-TP-18 / SOL SQ-TP-19 TOPAS.
17h35 EOL SQ-TP-19 / SOL SQ-TP-20 TOPAS.
18h10 EOL SQ-TP-20 / SOL SQ-TP-21 TOPAS.
18h46 EOL SQ-TP-21 / SOL SQ-TP-22 TOPAS.
19h34 EOL SQ-TP-22 / SOL SQ-TP-23 TOPAS.
20h07 EOL SQ-TP-23 / SOL SQ-TP-24 TOPAS.
20h23 EOL SQ-TP-24 TOPAS. End of SEAQUAKE OPERATIONS.
20h23 SOL transit GRACE32 (TOPAS).
TECHNICAL ISSUES: Depth detection is once again not working at all… TOPAS does not update it and EK80 provides almost random values.

20h46 SOL transit A36 (Sparker).
22h28 EOL transit A36 / SOL A36 (Sparker).
22h30 EOL transit GRACE32 / SOL GRACE32 (TOPAS).

10th day 07/05/2022

00h56 EOL GRACE32 (TOPAS).
01h00 SOL GRACE33 (TOPAS) and EOL A36 / SOL A37 (Sparker).
02h27 EOL A37 / SOL A38 (Sparker).
02h28 EOL GRACE33 / SOL GRACE34 (TOPAS).
02h57 EOL GRACE34 / SOL GRACE35 (TOPAS) and EOL A38 / SOL A39 (Sparker).
03h37 EOL A39 / SOL A40 (Sparker).
03h49 TECHNICAL ISSUES: A new interference appears on the TOPAS data. The team calls to David, the technician.
04h03 TECHNICAL ISSUES: After a few tests, the technician reboots the TOPAS a couple of times and the interference (serious enough to mask all the data) remains. EOL GRACE35 TOPAS, and end of all TOPAS recording.
05h15 TECHNICAL ISSUES: Problems with the Sparker once again.
05h19 EOL A40 (Sparker). The technician switches once again the power supply (CSP600), but the system keeps failing.
05h33 SOL A40_002 (Sparker).
05h35 EOL A40_002/ SOL A40_003. Short test lines. Suddenly there is a warning coming from the bridge that we must transit to AUV position.
05h39 EOL A40_003 (Sparker) with the system already on deck.
05h40 TRANSIT TO SEAQUAKE AUV POSITION.
07h16 AUV on water SQ-AUV-3 Dive 1
12h01 AUV on water
14h56 AUV back on board (Emergency exit).
INCIDENCES: Problems with the propeller. There is no replacement onboard. END of all operations involving AUV acquisition
15h23 SOL Transit to CTD to calibrate the Multibeam.
15h54 EOL Transit to CTD to calibrate the Multibeam.
15h54 Arrival to the CTD station (35.9093333ºN / 5.1825ºW).
16h26 SQ-CTD-10 on water.
17h23 SQ-CTD-10 on deck.
17h29 SOL Transit to SQ-MB-39 Multibeam.
17h35 Change of velocity profile during transit to SQ-MB-39.
17h46 EOL Transit to SQ-MB-39 / SOL SQ-MB-39 (EM-304)
18h39 EOL SQ-MB-39 / SOL SQ-MB-40 (EM-304).
19h14 EOL SQ-MB-40 / SOL SQ-MB-41 (EM-304).
19h45 EOL SQ-MB-41 / SOL Transit to SPK-41 (EM-304). END OF SEAQUAKE OPERATIONS (07/05/2022).
19h45 Start transit to Sparker line A41
21h03 EOL transit to A41 / SOL SPK-41 (Multibeam).
21h04 SOL A41 (Sparker).
21h51 EOL SPK-41 / SOL SPK-42 (Multibeam).
21h52 EOL A41 / SOL A42 (Sparker).
22h29 EOL A42 / SOL A43 (Sparker).
22h30 EOL SPK-42 / SOL SPK-43 (Multibeam).
23h32 EOL SPK-43 / SOL SPK-44 (Multibeam).
23h33 EOL A43 / SOL A44 (Sparker).

11th day 08/05/2022

00h52 EOL A44 / SOL A45 (Sparker).
00h57 EOL SPK-44 / SOL SPK-45 (Multibeam).
02h22 EOL SPK-45 / SOL SPK-46 (Multibeam). Problems with the adjustement of the sound velocity profile on the Multibeam echosounder.
02h27 EOL A45 / SOL A46 (Sparker).
02h37 EOL SPK-46 / SOL SPK-47 MULTIBEAM and EOL A46 / SOL A47 (Sparker).

03h45 EOL SPK-47 / SOL SPK-48 MULTIBEAM and EOL A47 / SOL A48 (Sparker).
03h59 EOL SPK-48 / SOL SPK-49 (Multibeam).
04h01 EOL A48 / SOL A49 (Sparker).
05h01 EOL SPK-49 + turn (Multibeam).
05h04 SOL SPK-50 (Multibeam).
05h05 EOL A49 / SOL A50 SPARKER
07h35 EOL A50 (Sparker).
05h37 EOL SPK-50 and transit to GC03 still recording with the (Multibeam).
07h00 EOL TRAN-GC03 (Multibeam).
07h14 Gravity corer GRACE – GC03 in water (35º 58.32'N / 5º 9.6484'W)
07h55 Corer on the sea surface, all the sediment (aprox. 3 m) is lost during the recovery maneuver due to a failure of the core catcher. Second attempt with 2 core catchers.
08h00 Gravity corer GRACE GC-03 back on water (35º 58.32' N / 5º 9.6497' W)
08h35 The gravity corer touches bottom. Depth: 553
08h47 Recovery of core GRACE GC-03 (35º 58.3205' N / -5º 9.6500' W) (241 cm of penetration; 3 sections).
09h21 Core GRACE GC-04. Replica of core GC-03 (35º 58.3203' N; -5º 9.6515' W). Core to the water.
09h31 Core GRACE GC-04 hits bottom; Depth: 553 m.
09h42 Core GRACE GC-04 back on deck. Recovery: 226 cm; 2 sections.
TECHNICAL ISSUES: After the loss of another gravity core once it was back up, it is decided to use piston corer once again, despite the relatively low penetration (equivalent to that of the gravity core) and much slower maneuvers. Switching the system back to piston corer configuration takes a few hours.
13h40 Start of Core GRACE PC-04 (35º52.4288'; -5º12.3522').
14h09 Core GRACE PC-04 hits bottom. Depth: 450 m.
14h48 Core GRACE PC-04 back on deck. TECHNICAL ISSUESh BENT SHAFT (a.k.a. “banana”). 99 cm of recovery, 1 section + trigger.
16h01 Core GRACE PC-05 starts descending (35º 56.0703'N; 5º 10.3616'W).
16h30 Core GRACE PC-05 hits bottom. Depth: 761 m.
17h07 Core GRACE PC-05 is back on deck. Recovery: 251 cm (2 sections).
17h29 CTD-11 starts its descent (35º 56.4614' N / 5º 10.0892' W).
18h14 CTD-11 back onboard.
19h10 SOL SPK-51 MULTIBEAM
19h38 SOL A51 (Sparker).
TECHNICAL ISSUES: The acquisition software of the Sparker starts showing a mistake, adding more delay that it was actually required and making “jumps” on the record. Fortunately, it’s something that can easily be fixed after some processing.
20h41 EOL A51 / SOL A52 (Sparker).
22h16 EOL A52 / SOL A53 (Sparker).
22h17 EOL SPK-51 / SOL SPK-52 (Multibeam).
23h21 EOL A53 / SOL A54 (Sparker).
23h22 EOL SPK-52 / SOL SPK-53 (Multibeam).
23h35 EOL A54 / SOL A55 (Sparker).
23h36 EOL SPK-53 / SOL SPK-54 MULTIBEAM

12th day 09/05/2022

00h31 EOL SPK-54 / SOL SPK-55 (Multibeam).
00h32 EOL A55 / SOL A56 (Sparker).
01h02 EOL SPK-55 / SOL SPK-56 (Multibeam) and EOL A56 / SOL A57 (Sparker).
01h59 EOL A57 / SOL A58 (Sparker).
02h00 EOL SPK-56 / SOL SPK-57 (Multibeam).
02h51 EOL SPK-57 / SOL SPK-58 (Multibeam) and EOL A58 / SOL A59 (Sparker).
03h02 EOL SPK-58 / SOL SPK-59 (Multibeam) and EOL A59 / SOL A60 (Sparker).
04h05 EOL SPK-59 / SOL SPK-60 (Multibeam) and EOL A60 / SOL A61 (Sparker).
04h44 EOL SPK-60 / SOL SPK-61 (Multibeam).
04h45 EOL A61 / SOL A62 (Sparker).
04h59 EOL A62 (Sparker) because the Sparker stops working. Koen, the technician switches the power supply to CSP600.
05h07 SOL 62_002 (Sparker).

05h37 EOL 62_002 (Sparker). Sparker out of the water. Transit to recovery point of ADCP (recording with Multibeam TRANS-ADCP). The ADCP is recovered due to the concerns of the technician due to the weather forecast suggesting wind will be coming.
06h01 EOL TRANS-ADCP (Multibeam).
06h46 ADCP back onboard in a very quick and clean maneuver.
08h30 Core GRACE PC-06 (35º51.5445'; -5º11.4122') starts its descent.
09h07 Core GRACE PC-06 hits bottom (Depth: 587 m)
09h42 Core GRACE PC-06 is back on deck (Recovery: 410 cm; 4 sections).
11h24 Start of Core GRACE PC-07 (35º54.22'; -5º12.09')
11h46 Core GRACE PC-07 hits bottom. Depth: 533 m.
12h30 Core GRACE PC-07 is on deck. TECHNICAL ISSUESh BENT SHAFT (a.k.a. “banana”). 47 cm of recovery, 1 section.
14h00 Start of Core GRACE PC-08 (35º56.8974'; -5º8.0447').
14h28 Core GRACE PC-08 hits bottom (Depth: 497 m)
15h15 Core GRACE PC-08 is on deck. (235 cm of recovery, 2 sections).
16h41 Start of descent for core GRACE PC-09 (replica of PC08) (35º 56.9026' N / 5º 8.0539'W)
17h03 Core GRACE PC-09. Bottom. Depth: 497 m;
17h36 Core GRACE PC-09 is back on deck. (Recovery: 242 cm; 2 sections)
19h00 CTD-12 (35.9438333N / 5.18966667W)
21h02 SOL A62B (Sparker).
21h10 EOL A62B / SOL A63 (Sparker).
21h12 SOL SPK-63 (Multibeam).
21h30 EOL A63 / SOL A64 (Sparker).
21h32 EOL SPK-63 SOL SPK-64 (Multibeam).
22h44 EOL A64 / SOL A65 (Sparker).
22h45 EOL SPK-64 SOL SPK-65 (Multibeam).
22h56 EOL SPK-65 SOL SPK-66 (Multibeam) and EOL A65 / SOL A66 (Sparker).
23h57 EOL A66 / SOL A67 (Sparker).
23h58 EOL SPK-66 SOL SPK-67 (Multibeam).

13th day 10/05/2022

03h21 EOL LMB-67 SOL LMB-68 (Multibeam).
03h23 EOL A67 / SOL A68 (Sparker).
03h27 EOL LMB-68 SOL LMB-69 (Multibeam).
03h29 EOL A68 / SOL A69 (Sparker).
06h30 EOL A69 / SOL A70 (Sparker). A loop will be made to cover a hole in the multibeam data due to the huge inwards gyre of the vessel.
07h04 EOL LMB-69 SOL LMB-70 (Multibeam).
07h06 EOL A70 / SOL A70B (Sparker).
08h16 EOL LMB-70 (Multibeam).
09h23 EOL A70B (Sparker).
09h30 Sparker back onboard. END OF ALL SPARKER OPERATIONS.
11h15 Start of Core GRACE PC-10 (35º59.0349'; -5º10.865')
11h39 Core GRACE PC-10 hits bottom. Depth: 570.7 m.
12h01 Core GRACE PC-10 back on deck. Recovery: 224 cm; 2 sections)
13h01 Start transit to SEAQUAKE CTD location. The main activity will be Multibeam.
14h03 at SQ-CTD-13 area (35° 54.7052'N / -5° 11.2711'W)
14h23 SQ-CTD-13 on water
14h43 SQ-CTD-13 seafloor
15h10 SQ-CTD-13 on deck
15h29 SOL Transit to SQ-MB (EM-304)
16h08 EOL Transit to SQ-MB / SOL SQ-MB-42 (EM-304)
17h01 EOL SQ-MB-42 (EM-304)
17h05 SOL SQ-MB-43 (EM-304)
17h44 EOL SQ-MB-43 / SOL SQ-MB-44 (EM-304)
18h45 EOL SQ-MB-44 / SOL SQ-MB-45 (EM-304)
19h27 EOL SQ-MB-45 / SOL SQ-MB-46 (EM-304)

20h26 EOL SQ-MB-46 / SOL SQ-MB-47 (EM-304)
21h08 EOL SQ-MB-47 / SOL SQ-MB-48 (EM-304)
22h02 EOL SQ-MB-48 / SOL SQ-MB-49 (EM-304)
23h59 EOL SQ-MB-49 / SOL SQ-MB-50 (EM-304)

14th day 11/05/2022

01h46 EOL SQ-MB-50 / SOL SQ-MB-51 (EM-304)
04h23 EOL SQ-MB-51 (EM-304)
04h31 SOL SQ-MB-52 (EM-304)
06h56 EOL SQ-MB-52 MB at SQ-CTD-14 station (35.8693333 ºN / 5.11933333 ºW)
07h03 SQ-CTD-14 on water
08h24 SOL SQ-MB-53 (EM-304)
10h55 SOL TRANSIT to SQ-MB-54 (EM-304)
11h42 EOL TRANSIT to SQ-MB-54 / SOL SQ-MB-54 (EM-304)
12h46 EOL SQ-MB-54 / SOL SQ-MB-55 (EM-304)
12h55 EOL SQ-MB-55 (EM-304)
13h30 END OF SEAQUAKE OPERATIONS.
13h30 Quick Multibeam E-W lines for the GRACE team to have better data on a few features imaged at the northern end of the study area, almost on our way to the port.
16h00 End of all scientific operations. Start transit to the Port of Algeciras.
17h00 Vessel at the Port station
18h30 Vessel back on Algeciras dock.
19h00 The first members of the scientific team leave the vessel.

15th day 12/05/2022

08h00 Lab disassembly and cleaning. Transport of all external material to deck (scientific team).
09h00 Load of truck to ICM-CSIC (Barcelona) by both the scientific and deck teams.
11h30 Load of truck to University of Cádiz (Puerto Real) by the deck team.
17h30 The truck to Puerto Real is finally allowed to leave the port. The last member of the scientific team (GRACE chief scientist) leaves the vessel.

- End of campaign 2022/11 -

5. TRACK PLOT

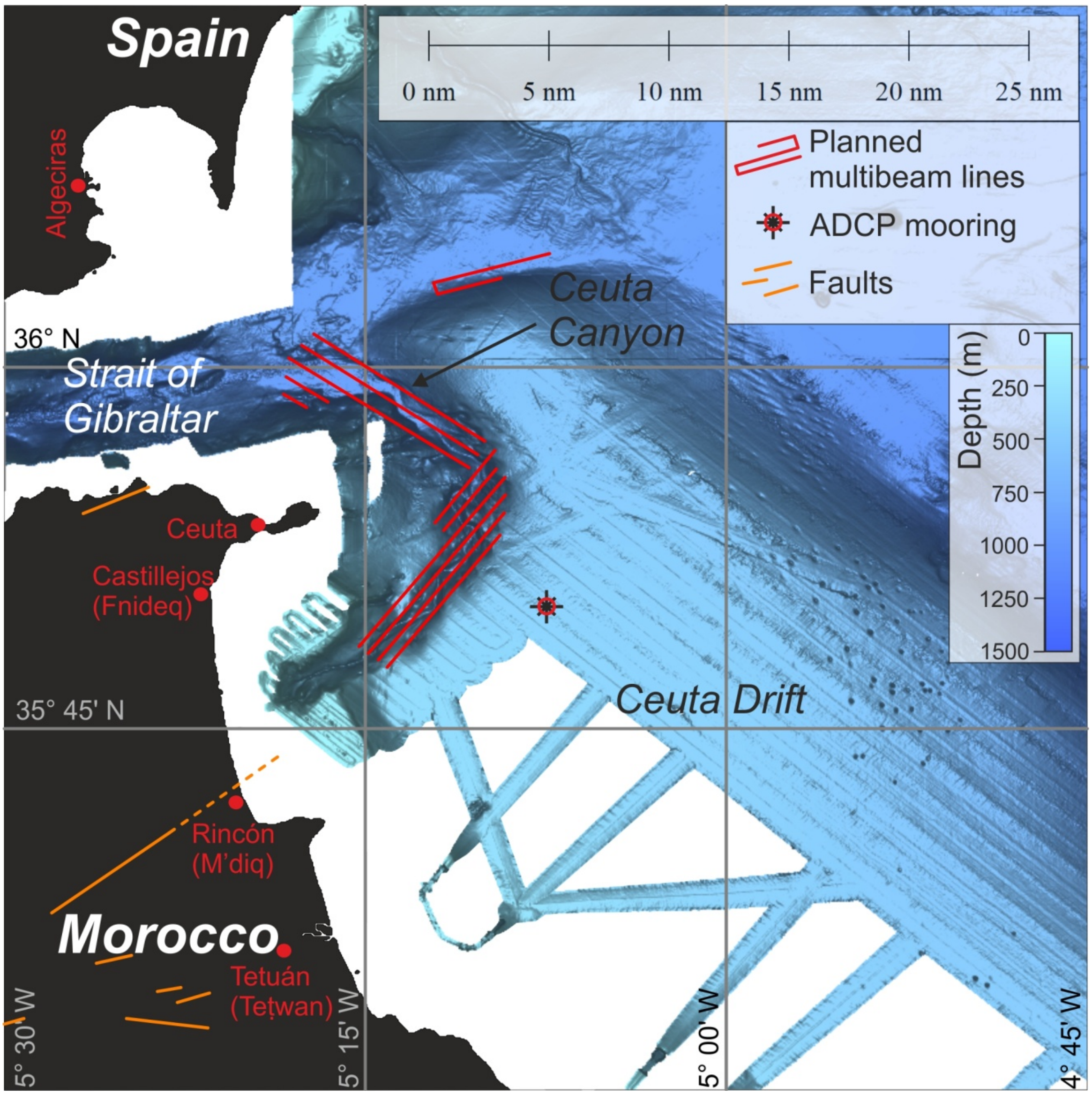
5.1 GRACE PROJECT

5.1.1 Multibeam (Kongsberg EM304)

The multibeam echosounder data was recorded both following planned lines with the aim of imaging in high resolution specific structures or areas (i.e., the entire canyon axis) (Fig. 01a), and as opportunistic data after the TOPAS sub-bottom profiler could no longer operate, during navigation and while acquiring Sparker lines. In the first case, the overlap between different lines was over 100%, with an aperture angle of up to 65º, and navigation velocities between 4 and 5 knots to obtain good resolution data. In the second case, the velocity could vary depending of the activity (4-5 knots if the data was recovered during Sparker acquisition, and up to 6,5 knots if the data was recorded during navigation between different stations.

The data was processed onboard using the software Caris HIPS & SIPS v.11. As a result, a first general bathymetric map was obtained (Fig. 01b). The new bathymetric data (5 m resolution) largely improved the previously available bathymetry (30 m resolution), allowing to image in high resolution structures that were only fuzzy before.

A)



B)

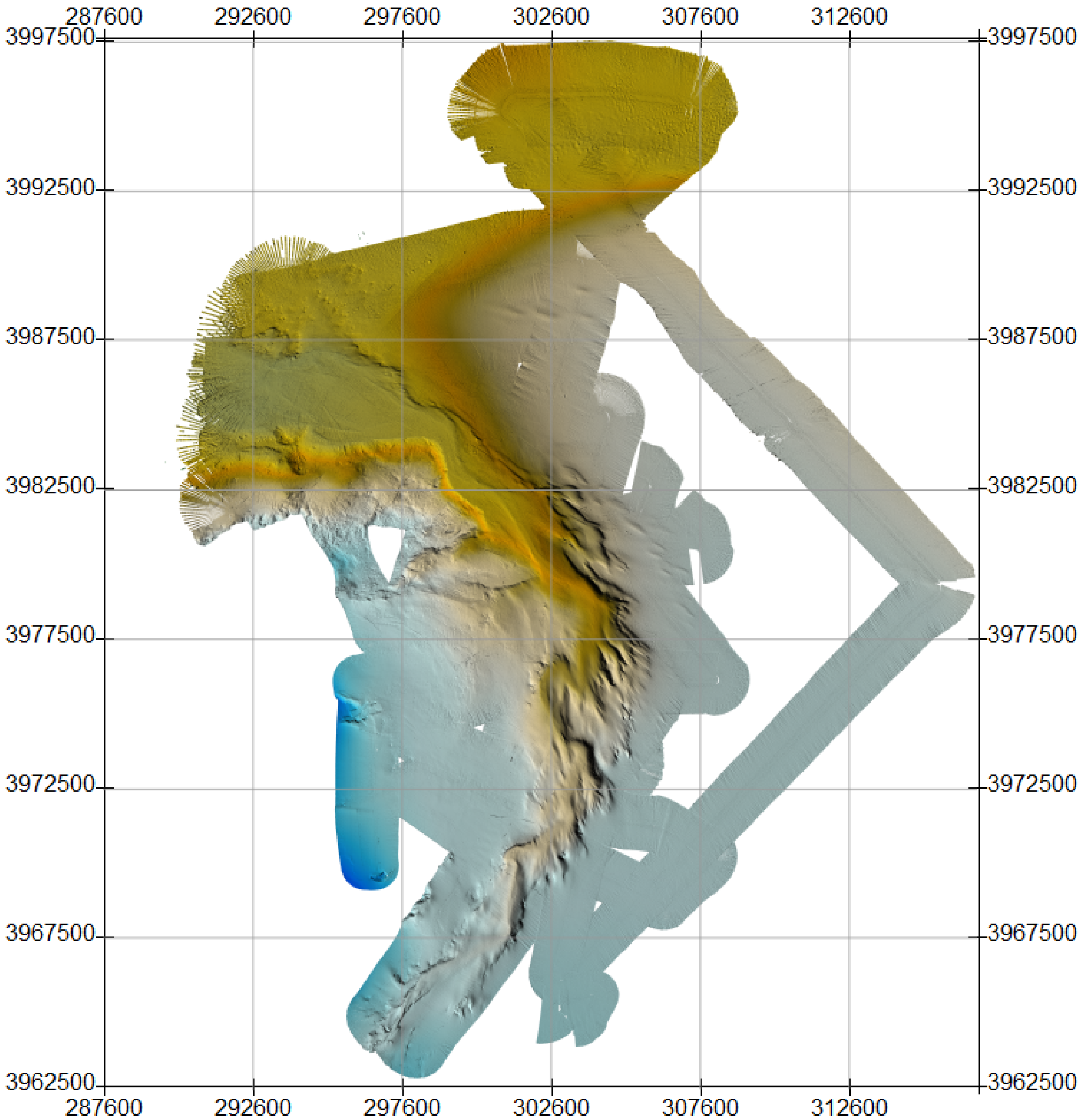


Figure 01: *A) Planned multibeam lines for the GRACE Project during the campaign 2022/11. Background bathymetry (30 m resolution) from the CONTOURIBER Project (Published in Somoza et al., 2012). B) New preliminary multibeam map with 5 m resolution obtained after a first processing of both the planned and the opportunistic multibeam lines, using CARIS HIPS & SIPS during the GRACE cruise.*

5.1.2 TOPAS PS18 system

The TOPAS system had synchronicity problems with the Kongsberg EM304 multibeam echosounder. For that reason, the TOPAS was given priority at the beginning of the cruise. The TOPAS system, however, broke down twice during the course of the cruise, and could not be fixed again due to the lack of additional spare parts onboard. The two periods in which the system could work properly allowed nonetheless obtaining a general high-resolution overview of the uppermost sedimentary cover (Fig. 02).

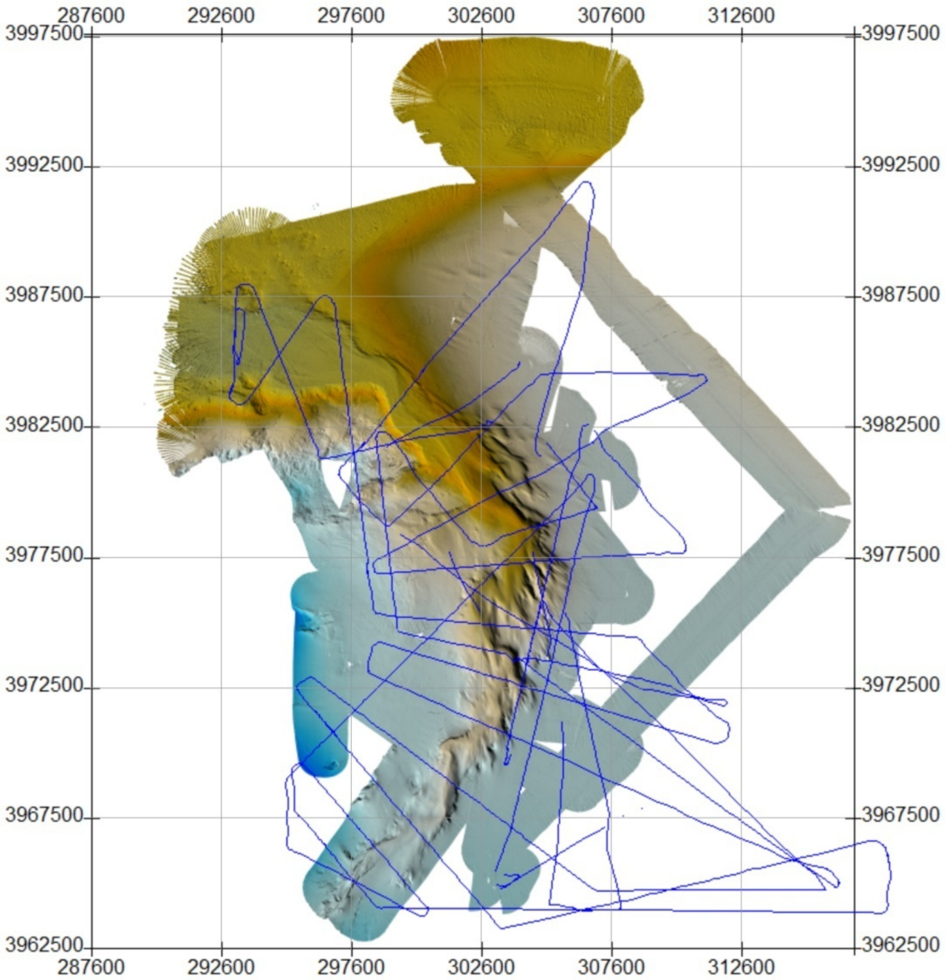


Figure 02: *Overview of the TOPAS high-resolution profiles recorded during the GRACE working time, campaign 2022/11*

5.1.3 Single-channel Sparker system

The Sparker seismic profiles were considered as key data to understand the characteristics and evolution of the Ceuta Canyon, and to map the different interacting sedimentary systems. The Sparker system was composed of a multi-tip SIG ELC820, and the source varied during the course of the cruise from Applied Acoustics CSP600 to CSP700. The entire system was adapted based on the available literature (Debusschere, 2016; Crocker & Fratantonio, 2016; Crocker et al., 2018) as well as the technical specifications of the equipment, by lowering the shooting energy in joules, the working depth of the system and with the maximum amount of Sparker tips, to avoid surpassing noise levels capable of disturbing marine fauna. The area was nonetheless scanned by the Marine Mammal Observers before the start of operations, to ensure that no cetaceans were in the vicinity, and the operations were paused if cetaceans were observed too close to the vessel or if their behaviour showed any signs of distress.

Up to 70 seismic profiles were recorded during the course of the cruise, crossing perpendicularly the Ceuta Canyon along its course and allowing a pseudo-3D view of its structure, erosive scars, palaeo-canyons, etc (Fig. 03).

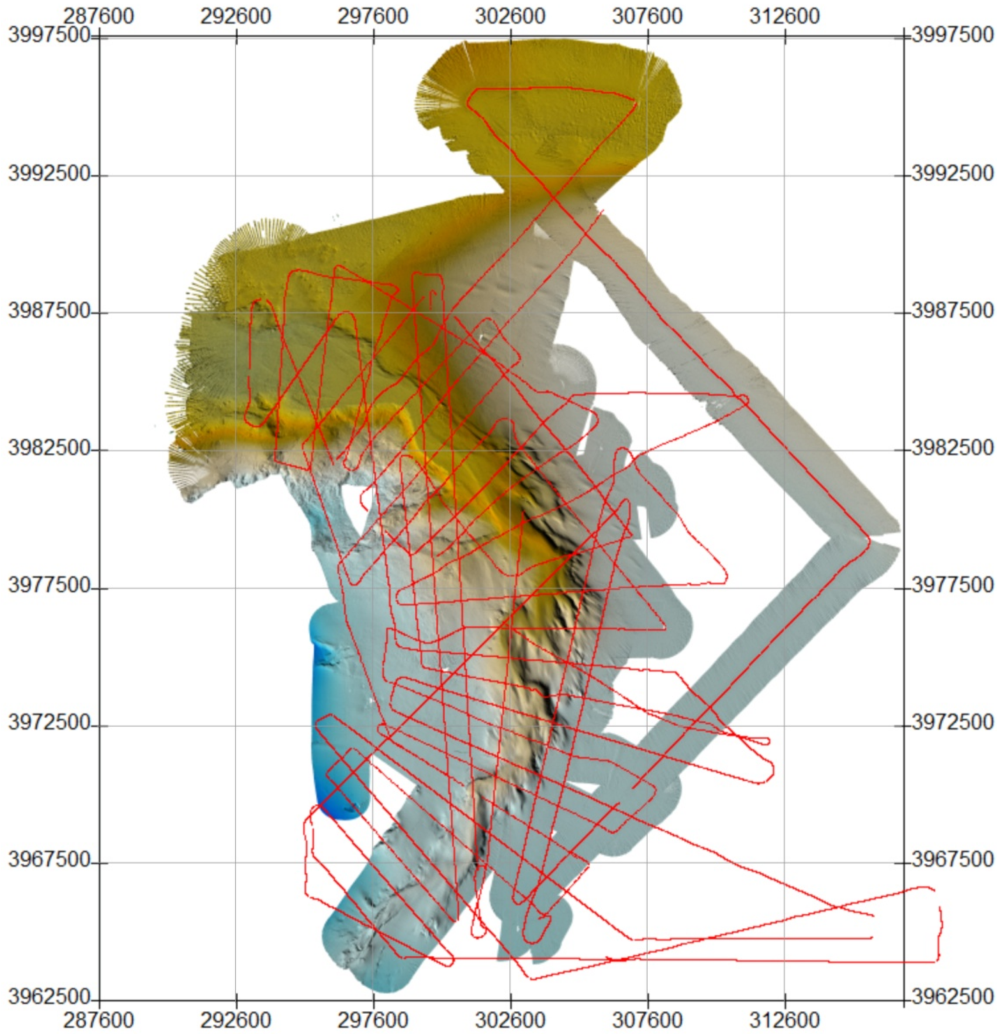


Figure 03: *Overview of the Sparker single-channel seismic profiles recorded during the cruise 2022/11*

5.1.4 Automated Underwater Vehicle (AUV Barabas – VLIZ)

During the course of the cruise, the AUV Barabas (VLIZ) carried out a total of 10 dives for the GRACE Project (Fig. 04):

-Two dives in target area 1 (AUV 1.1, in green; AUV 1.2, in magenta).

-Two dives in the last part of target area 1, the entire target area 2, and a notch of target area 7 (AUV 2.1, in orange; and AUV 2.2, in yellow).

-Two dives in target area 3 and part of target area 4 (AUV 3.1, in apricot; and AUV 3.2, in sky blue).

-One dive with the GAVIA grasshopper camera in target area 2 (AUV 4, in black/lilac).

-One more dive to complete target area 4 (AUV 5).

-Two dives in the vicinity of target area 8, whose location was modified due to the high slopes (AUV 6.1, with the SSS, in red; AUV 6.2, with the GAVIA grasshopper camera, in navy blue).

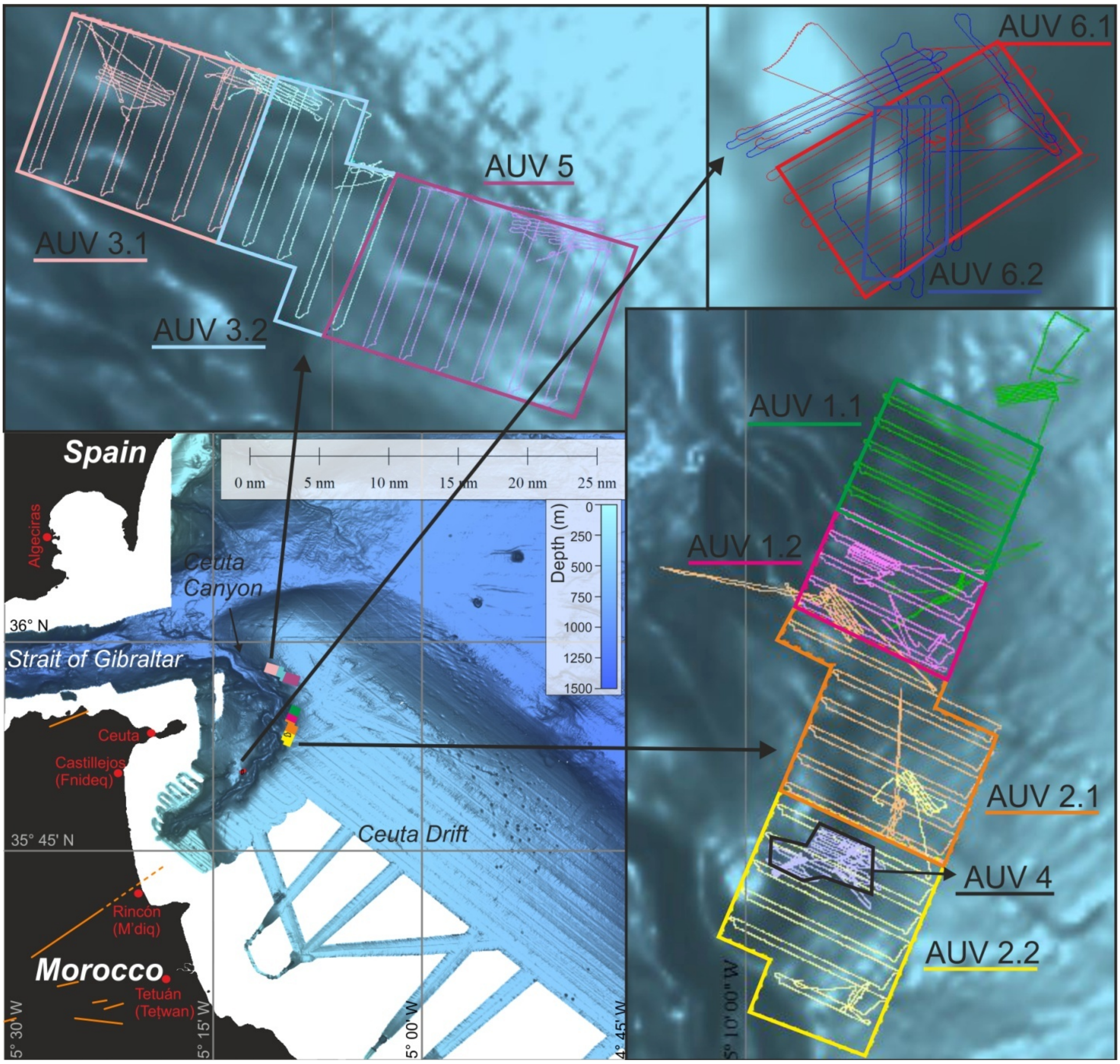


Figure 04: *Location and tracks of the 10 AUV dives carried out for the GRACE Project during the course of the cruise 2022/11. Of all the dives, 8 were carried out using the side scan sonar with long range, and 2 using the GAVIA Grassgopper camera (AUV 4 and AUV 6.2). Background bathymetry from the CONTOURIBER Project (Published in Somoza et al., 2012).*

5.2 SEAQUAKE PROJECT

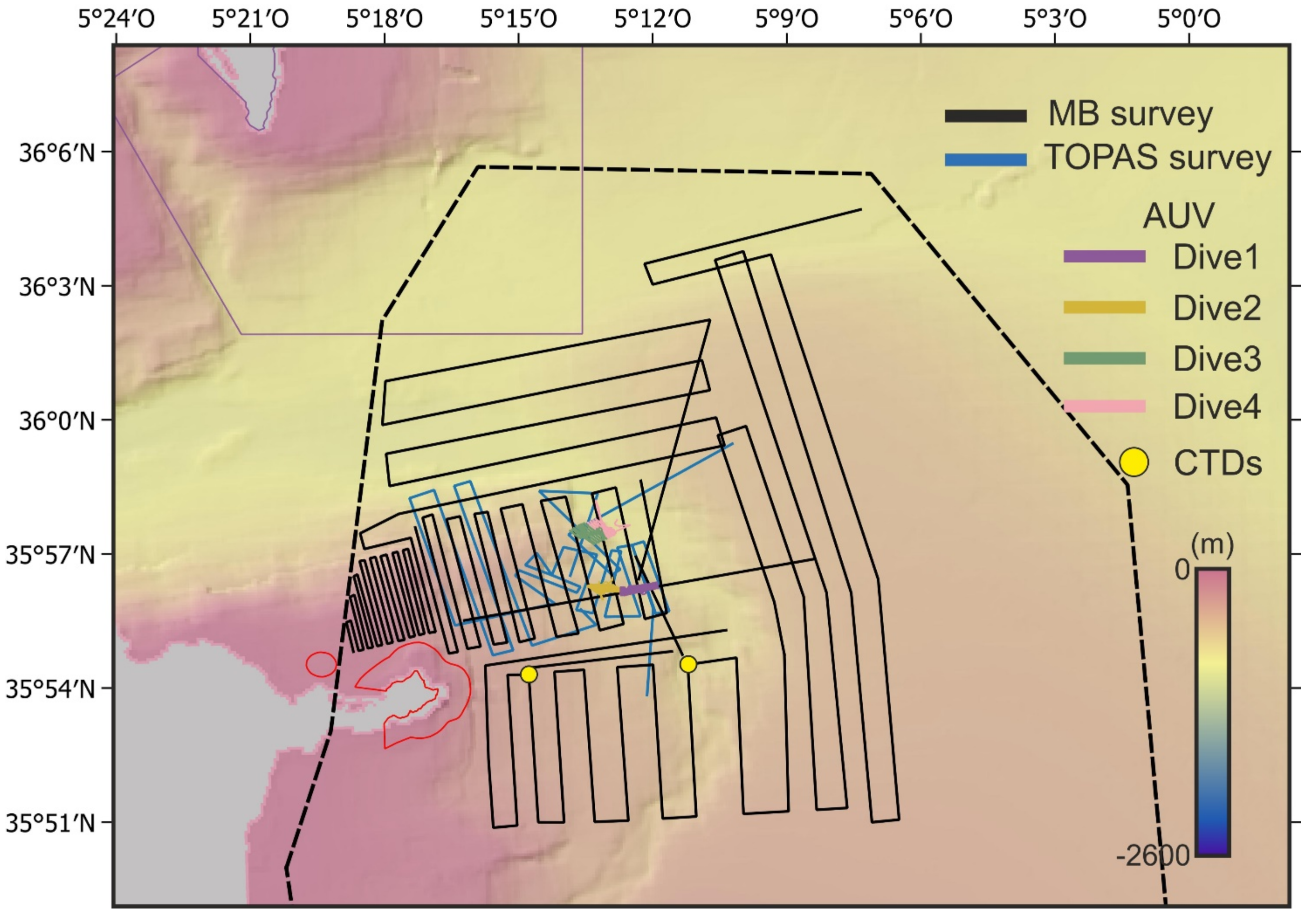


Figure 05: *Track plot of SEAQUAKE campaign 2022/11, including CTDs sites, TOPAS, multibeam and AUV lines.*

6. MEASUREMENTS AND SAMPLING

The stations are here considered as those locations in which a punctual sample was recovered. In this category, we consider the moored ADCP, all the CTD casts, as well as the sediment samples recovered using the gravity and piston core systems (Table 01).

A total of 13 CTD profiles were successfully recorded. These CTD profiles were recorded both at the axis of the canyon, the eastern wall, and the uppermost Ceuta Drift (Fig. 06). The CTD profile 9 was unsuccessful due to the strong current at the time caused by an incoming internal wave (Table 01). Three of these successful CTDs were recorded during SEAQUAKE working time (Table 01).

14 sediment cores were recovered in 10 different sampling locations (Fig. 07). Four of these sediment samples were obtained using the sampling system in gravity core mode (either using only the trigger, as a first test for the first sediment sample recovery ever made onboard of the vessel, or using the main system without the piston). This proved to be a very fast maneuver, but with a high rate of sediment loss. The other 10 sediment samples were recovered using the piston core system. Cores PC-03, GC-04, PC-04, PC-08 and PC-10 were waxed to carry out geotechnical analyses (Table 1).

Station No.	Date	Time	Latitude	Longitude	Water Depth	Gear	Remarks/Recovery
	2022	[GMT]	[°N]	[°W]	[m]		
01	28.04	13:30	35.834743	5.124762	402	ADCP mooring	Deployment
02	28.04	18:00	35.8068333	5.17766667	359	CTD	CTD 01
03	29.04	09:30	35.9048333	5.15383333	550	CTD	CTD 02
04	29.04	17:30	35.9096667	5.15666667	592	CTD	CTD 03
05	30.04	09:46	35.897	5.1555	516.5	CTD	CTD 04
06	30.04	17:48	35.888607	5.175854	646	Gravity Core	GC01 (1 section, 110 cm)
07	30.04	18:00	35.8888333	5.17616667	661	CTD	CTD 05
08	01.05	19:03	35.9876667	5.2585	876	CTD	CTD 06
09	02.05	08:02	35.9645	5.2145	831	CTD	CTD 07
10	02.05	19:32	35.8601667	5.1895	595	CTD	CTD 08
11	*03.05*	*11:58*	*35.9576667*	*5.20383333*	*825*	*CTD*	*SQ-CTD 09a (ABORTED)*
12	*03.05*	*14:15*	*35.9341667*	*5.17266667*	*771*	*CTD*	*SQ-CTD 09b (ABORTED)*
13	03.05	19:28	35.889543	5.156877	496	Gravity core	GC02 (0 sections, top and bottom stored in zip bags)
14	04.05	15:33	35.94829	5.134108	504	Piston core	PC01 (2 sections, 196 cm)
15	05.05	11:30	35.881282	5.15068	472	Piston core	PC02 (3 sections, 251 cm)
16	06.05	14:45	35.881282	5.15068	472	Piston core	PC03 (3 sections, 261 cm)
17	*07.05*	*16:26*	*35.9093333*	*5.1825*	*704*	*CTD*	*SQ-CTD 10*
18	08.05	08:35	35.97216	5.160872	537	Gravity core	GC03 (3 sections, 241 cm)
19	08.05	09:31	35.97216	5.160872	537	Gravity core	GC04 (2 sections, 220 cm)
20	08.05	14:09	35.873807	5.205899	547	Piston core	PC04 (1 section, 99 cm)
21	08.05	16:30	35.934148	5.172704	771	Piston core	PC05 (2 sections, 251 cm)
22	08.05	17:29	35.9355	5.172	771	CTD	CTD 11 (aprox. same location as CTD 09b)
23	09.05	06:46	35.834743	5.124762	402	ADCP mooring	Recovery
24	09.05	09:07	35.859039	5.190282	595	Piston core	PC06 (4 sections, 410 cm)
25	09.05	11:46	35.903736	5.201599	543	Piston core	PC07 (1 section, 47 cm)
26	09.05	14:28	35.94829	5.134108	504	Piston core	PC08 (2 sections, 235 cm)
27	09.05	17:03	35.94829	5.134108	504	Piston core	PC09 (2 sections, 242 cm)
28	09.05	19:00	35.9438333	5.18966667	795	CTD	CTD 12
29	10.05	11:39	35.983928	5.181093	580	Piston core	PC10 (2 sections, 224 cm)
30	*10.05*	*14:23*	*35.9118333*	*5.18783333*	*716*	*CTD*	*SQ-CTD 13*
31	*11.05*	*07:03*	*35.8693333*	*5.11933333*	*436*	*CTD*	*SQ-CTD 14*

Table 01 *List of stations carried out during the 2022/11 cruise (GRACE & SEAQUAKE Projects)*

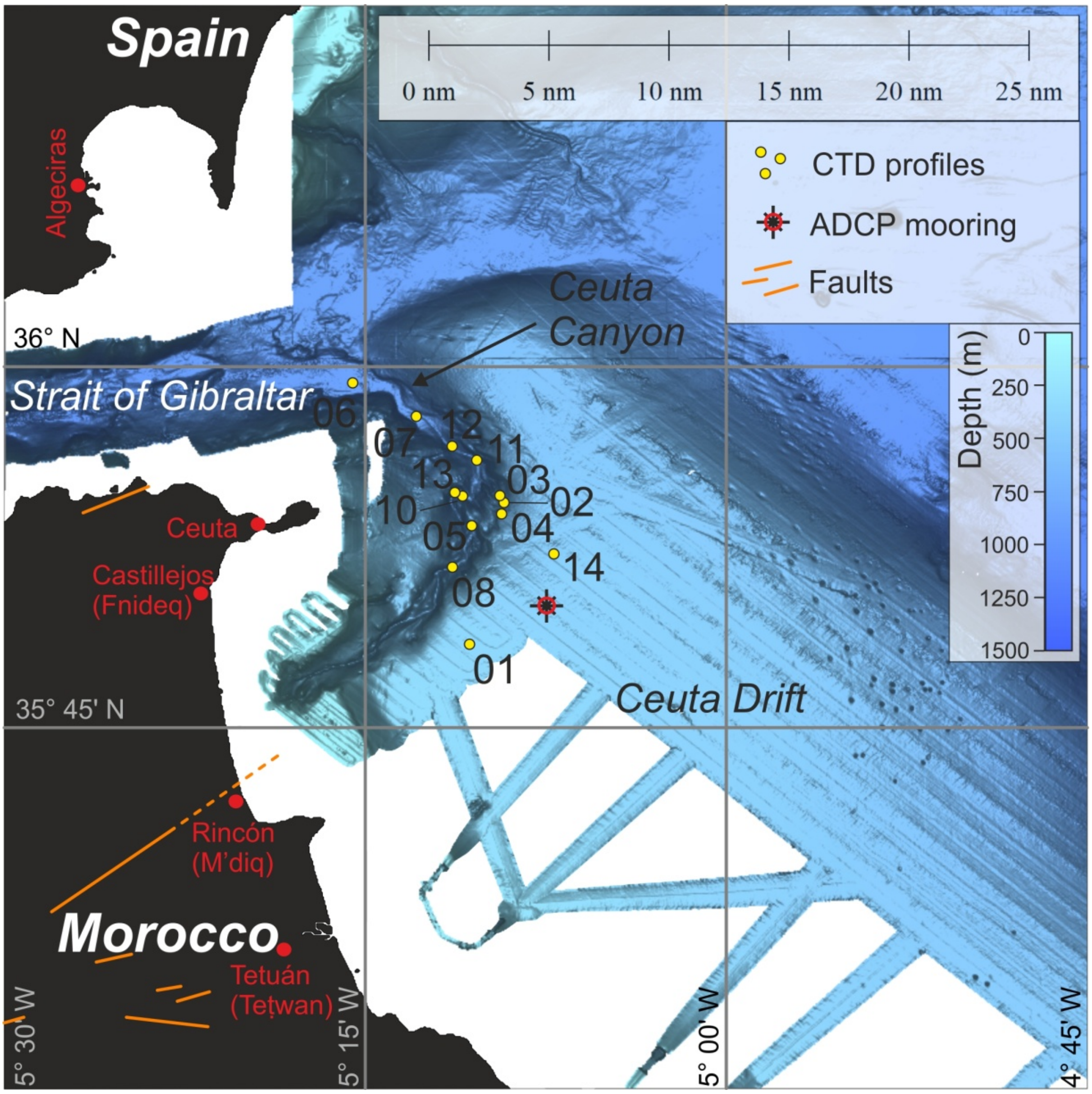


Figure 06: *Location of the CTD profiles recorded for both the SEAQUAKE and GRACE Projects, as well as the moored ADCP for the GRACE project. Background bathymetry from the CONTOURIBER Project (Published in Somoza et al., 2012).*

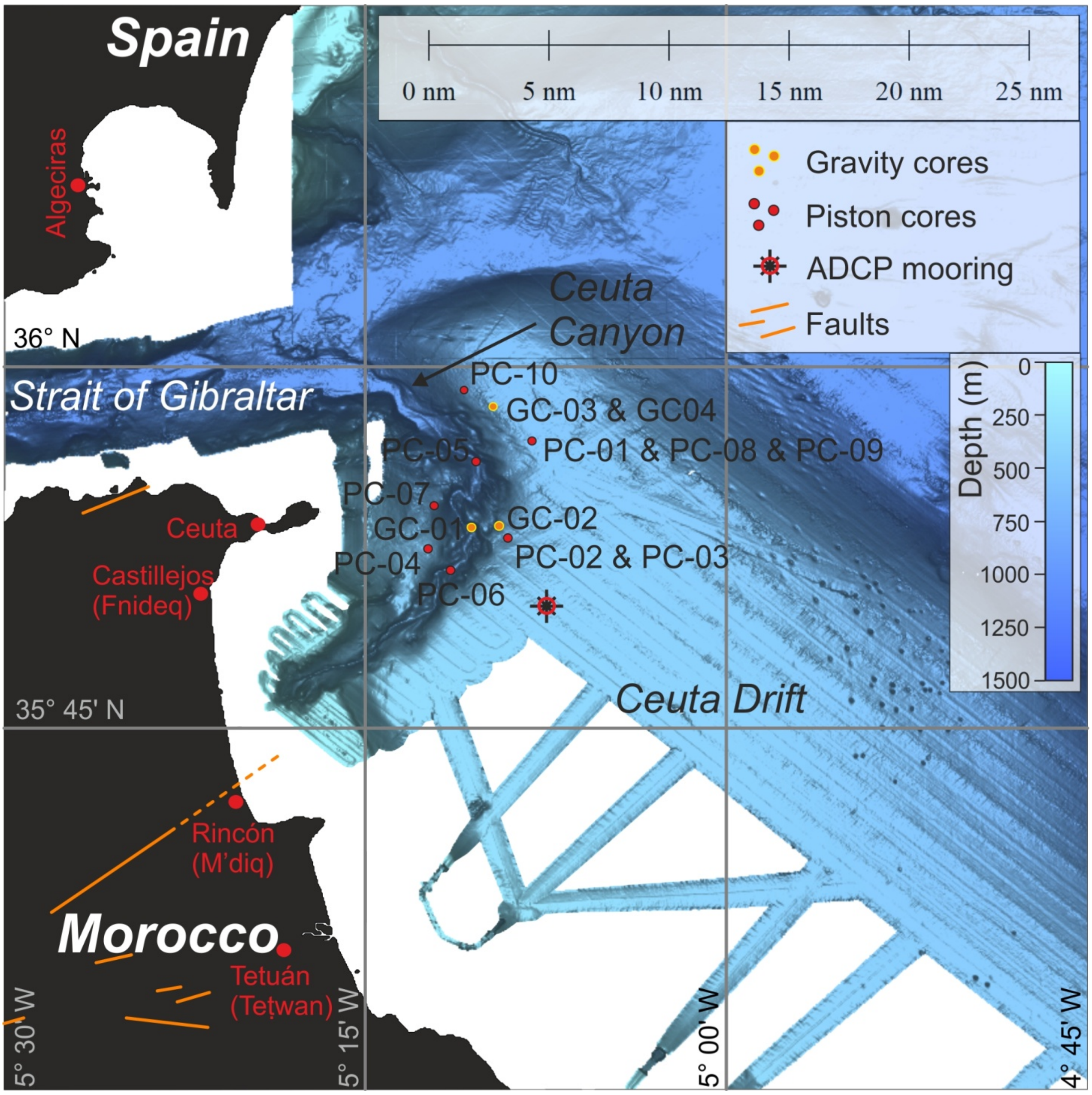


Figure 07 - *Location of the 14 sediment cores recovered during the GRACE cruise. Piston cores are marked in red and gravity cores are marked in orange. Sediment core replicas were recovered in three sampling locations, to allow a more detailed granulometry and chemical analysis parallel to the geotechnical analyses. Background bathymetry from the CONTOURIBER Project (Published in Somoza et al., 2012).*

7. REMARKS

The weather was in overall terms quite good, with one day of bad weather (02/05/2022) in which the team focused on multibeam acquisition, and with a warning for strong winds by the end of the cruise that forced the early recovery of the moored ADCP.

Due to poor synchronization between the Kongsberg EM 2040 and EM 304 multibeam echo-sounders and the Kongsberg TOPAS PS18 sub -bottom profiler was impossible to acquire simultaneously bathymetric and TOPAS data. This unusual fact, which is perhaps due to an incorrect installation of the instruments, caused a considerable loss of time, since it was necessary to navigate each location twice to acquire the desired data or choose between them.

The TOPAS PS18 sub-bottom profiler had problems to receive the depth from the EK80 system, and in addition failed twice during the cruise. Both times the problem was related to a transducer, and on the second occasion there was no replacement part and the problem could not be fixed. The SEAQUAKE TOPAS profiles were acquired between the first and second failures, acquiring only half of the planned profiles.

The AUV Barabas experienced a technical failure during the 10th day of the cruise (07/05/2022), while surveying SQ-AUV-3 site. The technical problem was related to the AUV's propeller. As there was no spare part, the instrument could not be used again despite the efforts of the technicians to fix the problem, losing all the remaining acquisition days for both the SEAQUAKE and GRACE teams.

8. DATA STORAGE

GRACE Project

All the data recorded during the GRACE project will endure a 2-year embargo, so the data will not be publicly available in freely accessible databases such as SeaDataNet until the 12th May of 2024.

The raw multimeam, TOPAS and Sparker data is stored at the ICM-CSIC (Barcelona, Spain) (Contact person: Gemma Ercilla) and at the IEO-CSIC (Cádiz, Spain). The team of the University of Ghent has also loaded the raw Sparker data on their institutional database, but not made publicly available yet. After a first processing, a Kingdom Suite project has been built. This project has been made available to all the teams involved in the GRACE project (including onboard and remote participants), so currently exists at least one copy of these data in each institution.

The sediment cores have been stored at the ICM-CSIC core depository (Barcelona, Spain) (Contact person: David Casas). The waxed core replicas are in the process of being moved to the storage of University of Salamanca (Salamanca, Spain) for their analysis.

One copy of the oceanographic data (moored ADCP, hull-mounted ADCP, CTD) is held at IEO-CSIC (Cádiz, Spain), and another at University of Cádiz (Campus Puerto Real, Spain), where the team of oceanographers working on the data is rooted (Contact person: Miguel Bruno).

Last, the raw AUV data is stored at the IEO-CSIC (Cádiz, Spain), the ICM-CSIC (Barcelona, Spain), and at the VLIZ (Oostend, Belgium), where it is currently being reprocessed (Contact person: Wieter Boone).

SEAQUAKE Project

All the data acquired during the SEAQUAKE cruise has been transferred on May 31, 2022 to the Hellenic National Oceanographic Data Centre (HNODC, contact person: Sissy Iona) and to the Marine Technology Unit (UTM-CSIC; contact person: Susana Diez), which is our National Data Center. The data has two years of embargo. Processed bathymetric data will be available on EMODnet after the embargo period. Stored data includes: multibeam bathymetry, TOPAS profiles, AUV data and CTDs data.

Additionally, the IP of the SEAQUAKE project has two copies of the data on hard drives and is stored at the Barcelona Centre for Sub-surface Imaging (B-CSI) Group belonging to the Marine Geosciences Department of the Institut de Ciències del Mar – CSIC (Barcelona). The IP of the GRACE project and all the partner institutions of the SEAQUAKE project received a hard disc with a copy of the data.

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