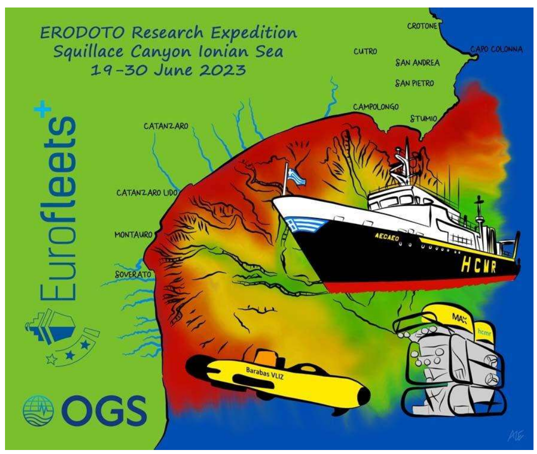
CRUISE REPORT

EROsive Dynamics Of The squillace submarine canyOn - Squillace submarine canyon (Ionian Calabrian Margin, Mediterranean Sea)

-ERODOTO23-



RV Aegaeo, Cruise No. SEA02_12

01-11 July 2021, Piraeus (Greece) – Piraeus (Greece)

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Table of Content

1 Summary

Submarine canyons are deep incisions observed along most of the world's continental margins. In particular, in the Mediterranean basin they have been observed to occur more frequently, be shorter and be more dendritic than their oceanic counterparts. (Harris and Whiteway, 2011). Generally, submarine canyons are a critical link between coastal/shelf waters and abyssal depths where water masses, sediment, nutrients, and even litter and pollutants are carried through (Amblas et al. 2018; Pierdomenico et al., 2019). They show variable morphologies and can either be slope-confined or can incise the shelf, in some cases reaching distances less than a few hundred meters from the shore (Ceramicola et al 2014a). The steep canyon morphology, often undercut and eroded by high-energy sediment flows, creates diffuse and repeated mass wasting episodes, increasing the local risk for geohazards through the occurrence of landslides and their potential to cause tsunamis. This may result in damage to and erosion of the coastline, and poses serious threats on coastal (harbours, railways, highways) as well as offshore infrastructures (pipelines, telecommunication cables; Talling et al., 2013; Carter et al., 2014) with severe economic and social repercussions. The hazard due to headwall collapse, especially when occurring retrogressively, in the direction of the coastline, is even more serious where canyons are connected to river and creek systems – particularly if ephemeral and characterised by active end powerful flash flooding. This can lead to severe coastal erosion, with risks for coastal infrastructures (highways, harbours, railways). This is a particular relevant issue in geologically-active areas, such as in Southern Italy where shelf-incising canyons and mass-wasting processes can affect from 52% up to 97% of the whole continental slope (Chiocci and Casalbore, 2017). Retrogressive canyon erosion has caused the repeated collapse of coastal infrastructures, as documented in the Gioia Tauro harbour in 1977 (Colantoni et al., 1992; Zaniboni et al., 2014; Casalbore et al., 2016); in the airport of Nice in 1979 (Sultan et al 2010), in the Cirò Marina harbour and in a chemical plant in the nearby Punta Alice in 2005 (Casalbore et al. 2012), which could have been avoided with more efficient pre-disaster geohazard assessment for coastal management. Having a good knowledge of the seabed morphologies indicating incipient erosion and mass wasting adjacent to coastal areas or deep-sea infrastructures (and developing an understanding of the main processes responsible for them) is the base for developing efficient geohazards management plans.

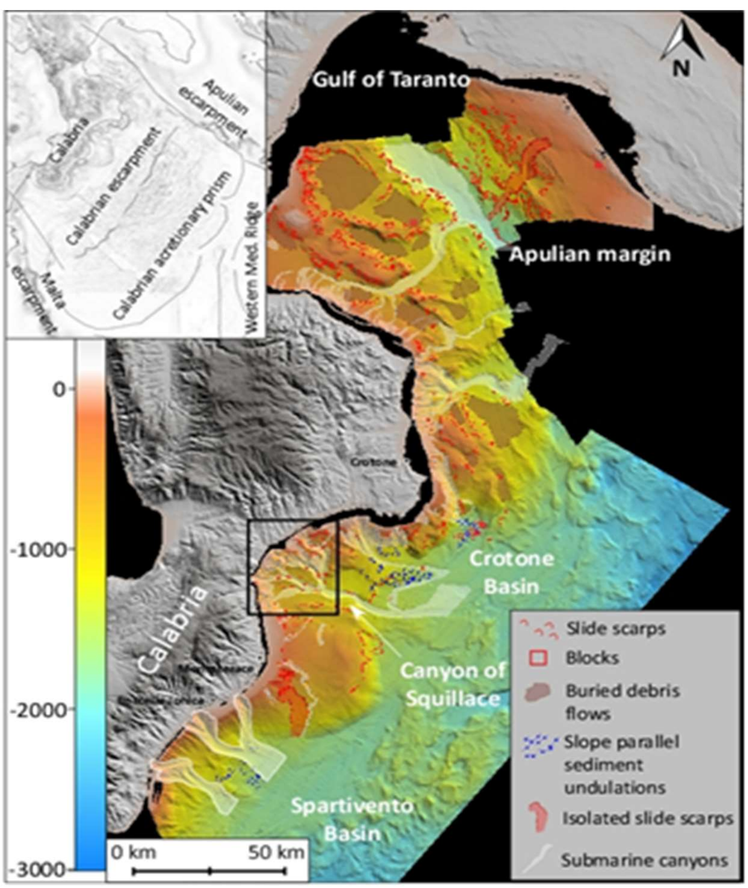

Fig. 1. On shore Ionian Calabria (in grey) and submarine morphologies (in colour) of the continental margin. The black rectangle indicates the ERODOTO acquisition area

In this context, ERODOTO proposes to analyse and quantify the active dynamics of a shelf-incising, close-to-shore submarine canyon as a model for geohazards assessment and risk management. The case study of the upper Squillace Canyon (Fig 1 and Fig 2) offshore southern Italy, that has a close connection to ephemeral river systems regionally known as '*fiumare*' (Sabato and Tropeano, 2004) will be used to measure and quantify the effect of retrogressive erosion induced by repeated sediment flows and assess its hazard in order to develop a methodological approach that can be used in other canyon systems to define precise monitoring programmes and efficient risk management plans. ERODOTO proposes to analyse and quantify the active dynamics of a shelf-incising, close-to-shore submarine canyon as a model for geohazards assessment and risk management. The case study of the upper Squillace Canyon (Fig 1 and Fig 2) offshore southern Italy, that has a close connection to ephemeral river systems regionally known as '*fiumare*' (Sabato and Tropeano, 2004) will be used to measure and quantify the effect of retrogressive erosion induced by repeated sediment flows and assess its hazard in order develop a methodological approach that can be used in other canyon systems to define precise monitoring programmes and efficient risk management plans.

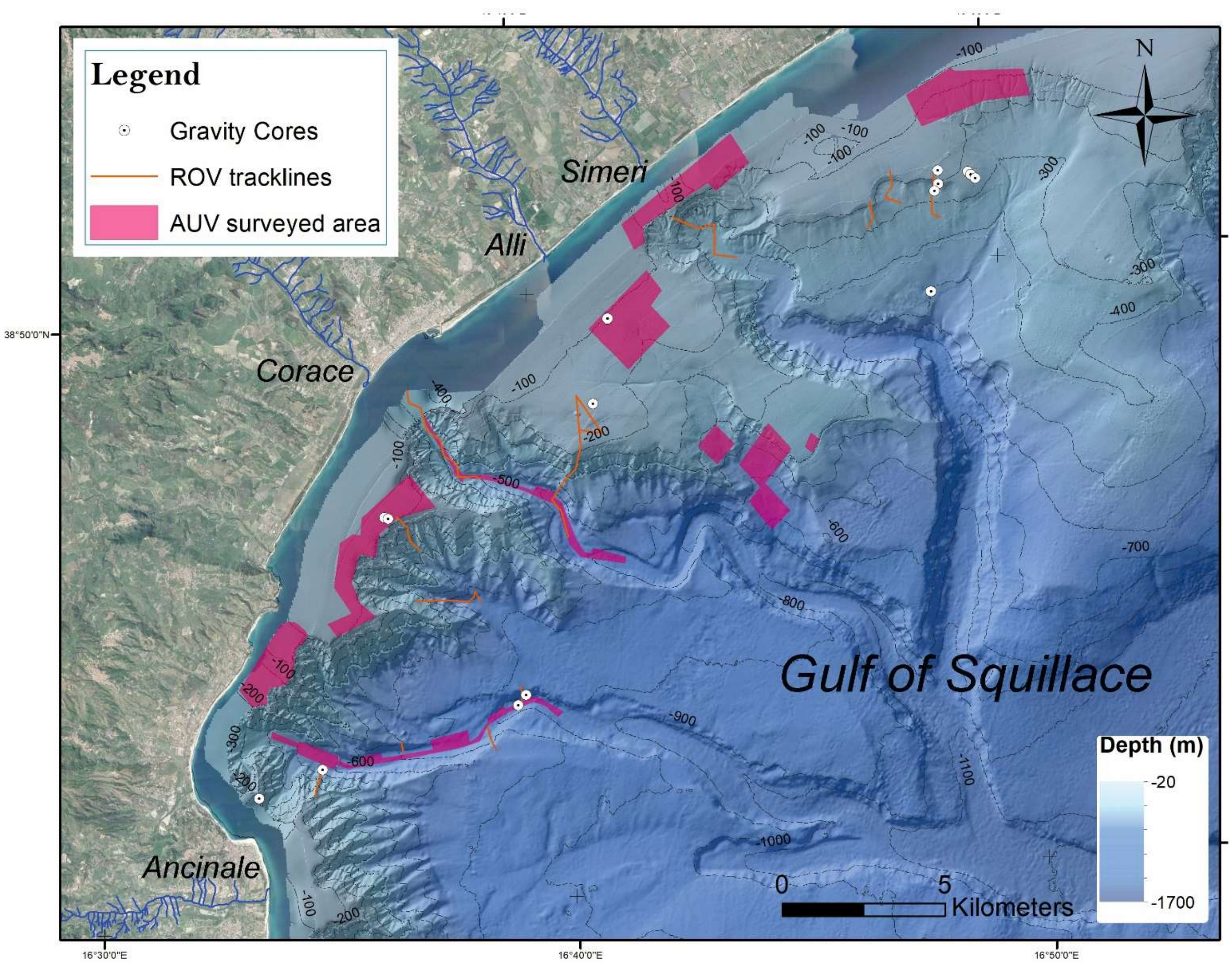

Fig. 2. ERODOTO cruise surveyed area and track lines acquired during the ERODOTO Cruise onboard of R/V Aegaeo

2 Research Objectives

ERODOTO cruise had four specific objectives:

- **Detailed documentation of canyon head morphologies**, particularly of the all geomorphological indicators of imminent/incipient sediment failure (e.g. cracks, development of scarps, creeping etc…) and related deposits (e.g. blocks, pebbles, slab slides etc…)
  Approach: detailed high-resolution bathymetric mapping using AUV (sub-metre scale). This will act as the initiation of a monitoring programme that can be continued in the future by local authorities, potentially with AUV launch from shore
- **Quantification of the dynamics of sediment flows in the combined *fiumare*-canyon system:** to measure frequency and magnitude of the events, quantify the volume of sediment mobilised and couple the onshore-offshore record
  Approach: deploy a moored ADCP in the talweg of one of the canyon branches for one year, specific cores for grainsize analysis, bedform morphological analysis, sediment dynamic modelling, drone mapping of *fiumare* on land in areas connected with the underwater headwalls under investigation, linking the timing of *fiumare* events to meteorological time series available through www.ecad.eu
- **Assessment of the geotechnical properties of the shelf sedimentary sequences incised by the headwalls**: to measure parameters such as shear strength, cohesion, consolidation able to quantify headwalls stability and thus assess susceptibility and vulnerability of coastal areas
  Approach: sediment strength/ geotechnical measurements on sediment cores, visual observations of canyon wall morphology and sediment type by ROV and sediment stability modelling
- **Development of a blueprint for coastal hazard assessment and monitoring** in proximity to submarine canyon heads: provide a pilot study and series of guidelines demonstrating the approach and methodologies for semi-autonomous hazard monitoring in shallow coastal areas adjacent to submarine canyon heads.
  Approach: by carrying out the Eurofleets cruise, we will demonstrate a 'universal' approach that can be used by local authorities and/or industries in other coastal areas prone to similar hazards, to define precise monitoring programmes and efficient hazard management plan

3 Narrative of the Cruise

Survey Log

Note: all times are in UTC GMT+2 (-1hr Shiptime)

30th July 2023: Piraeus Harbour. ROV and AUV Mobilisation starts 08.00. COVID procedures are taking place.

1st August: Piraeus Harbour. Blue skies with no cloud, light breeze. Scientific party arrive onboard at 11.00. Vessel leaves Dock. Departure at 14.00.

2nd August: Transit to study area via Corinth Strait

3rd August: Arrive on station and end transit. Start of operations:
At 03:56:00 deployment of AUV *(*AG23ER-001-AUV01/M01) AUV on board at 13.00.00
At 13:24:00. deployment of ROV (AG23ER-002-ROV01/D01*).* ROV on board at 18.30.
At 19:00 Strat of coring operations (AG23ER-003-GC01/GC01 -19:56:00). End of coring operations. Cores are split in sections sealed numbered and placed in the fridge.
At 20:53:00 CTD measurement (AG23ER-004-CTD1/P01). At 22.05 moving to location for MBES acquisition
At 22:21:00 MBES acquisition (AG23ER-005-MBES01/MB01) until AUV operation

Tiago Alves, Veerle Huvenne and Silvia Ceramicola (from left to right) watching the beautiful geology of the Corinth Strait on board of R/V Aegaeus during transit to the study area

4th August

At 03:51:00 deployment of AUV *(*mission AG23ER-006-AUV02/M02). AUV on board at 12.06
At 12:47:00 deployment of ROV dive AG23ER-007-ROV02/D02. ROV on board at 16.20
At 16:50:00 start of coring operations core AG23ER-008-GC02/GC02 is collected
At 17:04:00 core AG23ER-009-GC03/GC03 is collected
At 17:55:00 core AG23ER-010-GC04/GC04 is collected
At 18:05:00 core AG23ER-011-GC05/GC05 is collected. End of coring operations. Cores are split in sections sealed numbered and placed in the fridge.
At 19:19:00 MBES acquisition starts AG23ER-012-MBES02/MB01

5th August

At 03:42:00 deployment of AUV, mission AG23ER-013-AUV03/M03. AUV on board at 11.35

At 11:43:00 deployment of ROV, dive AG23ER-014-ROV03/D03
At 17:08:00 dive AG23ER-015-ROV04/D04. ROV on board at 19.10.
At 19:20:00 starts MBES acquisition AG23ER-016-MBES03/MB01 until next AUV operation

6th August

At 03:23:00 deployment of AUV, mission AG23ER-017-AUV04/M04. AUV onboard at 11.15
At 12:41:00 deployment of ROV, dive AG23ER-018-ROV05/D05
At 13:38:42 one push core is collected: AG23ER-018-ROV05/PSH01 is collected on board of the R
At 15:52:00 dive AG23ER-019-ROV06/D06 starts.
At 16:23:00 push core AG23ER-019-ROV06/PSH01 is collected. ROV on board at 17:12
At 17:57:00 start of coring operations core AG23ER-020-GC06/GC06 is collected
At 12:14:00 core AG23ER-021-GC07/GC07 is collected
At 18:48:00 core AG23ER-022-GC08/GC08 is collected
At 19:12:00 core AG23ER-023-GC09/GC09 is collected

At 19:23:00 core AG23ER-024-GC11/GC11 is collected
At 19:46:00 core AG23ER-025-GC10/GC10 is collected. At 20.05 end of coring operations. Cores are split in sections, sealed numbered and placed in the fridge.
At 20:20:00 starts MBES acquisition AG23ER-026-MBES04/MB04

7th August

At 03:36:00 deployment of AUV, mission AG23ER-027-AUV05/M01. AUV onboard at 12.45
At 14:19:15 deployment of ROV, dive AG23ER-028-ROV07/D07.
At 17:59:00 dive AG23ER-029-ROV08/D08. ROV on board at 19.30
At 20:07:00 starts MBES acquisition AG23ER-030-MBES05/MB05 until next AUV operation
One member of the crew tested positive to COVID patient overnight and is isolated.

8th August

At 03:27:00 deployment of AUV, mission AG23ER-031-AUV06/M06. AUV onboard at 12.45
At 14.19 deployment of ROV, dive AG23ER-032-ROV09/. ROV dive is cancelled because of fishing gears.
At 15:19:00 starts ROV dive AG23ER-033-ROV10/D10
At 16:06:10 rock sample AG23ER-033-ROV10/RCK01 is collected on board of the ROV.
At 16:10:51 rock sample AG23ER-033-ROV10/RCK02 is collected on board of the ROV.
At 16:21:21 rock sample AG23ER-033-ROV10/RCK03 is collected on board of the ROV.
At 16:32:09 rock sample AG23ER-033-ROV10/RCK04 is collected on board of the ROV. ROV onboard at 18.15
At 18:32:00 start of coring operations, core AG23ER-034-GC13/GC13 is collected
At 18:54:00 core AG23ER-035-GC12/GC12 is collected. At 19.15 end of coring operations. Cores are split in sections sealed numbered and placed in the fridge.
At 19:45:00 starts MBES acquisition AG23ER-036-MBES06/MB06 until next AUV operation
Two members of the crew tested positive to COVID overnight and are isolates. One member of the crew asks to be disembarked for family serious reasons, so he is disembarked.

9th August 2023

At deployment of AUV, mission 04:00:00AG23ER-037-AUV07/AUV07. AUV onboard at 12.13
At 13:07:00 deployment of ROV, dive AG23ER-038-ROV11/D11.
At 14:10:34 push core AG23ER-038-ROV11/PSH01 is collected on board of the ROV.
At 15:59:00 dive AG23ER-039-ROV12/D12 starts
At 17:24:05 push core AG23ER-039-ROV12/PSH01 is collected board of the ROV. ROV onboard at 18.40
At 19:01:00AG23ER-040-GC14/GC14
At 19:32:00 start of coring operations, core AG23ER-041-GC15/GC15. At 12.05 end of coring operations. Cores are split in sections sealed numbered and placed in the fridge.
At 20:51:00 starts MBES acquisition AG23ER-042-MBES07/MB07 until next AUV operation.
One more member of the crew is tested positive to COVID during the day. The situation becomes critical as there is no more space to isolate COVID patients. Scientific crew get squeezed to leave space to the sailors.

10th August 2023

At 04:05:00 deployment of AUV, mission AG23ER-043-AUV08/M08. At 10.28 mission is aborted due to COVID epidemy. Capitan together with 1st Officer and Chief scientist decide the situation is too critical, as crew is proved by COVID epidemy onboard and some important roles such as the chief engineer and the cook are unavailable. End of data acquisition one day earlier than funded by Eurofleets programme.
At 11.05 Departure for transit to Piraeus (Athens) via the Corinth Strait.
At 16:20 Marco Bianchini PhD student in OGS in collaboration with University of Sapienza offers to cook dinner as he owns a degree gained at the cooking school of Roma. A wonderful lamb roast with potatoes is served to more than 40 people crew for dinner.

11th August 2023

Transit to Piraeus. ROV and AUV teams are packing the instruments. Scientific crew is packing crew sections and two metallic box to sent to OGS and NOC.
At 18.30 arriving in Piraeus. Scientific party is checked for COVID by the Greek sanitary personnel disembarked transported to the hotel.

12 August 2023

08.00 Demobilization starts. ROV, AUV, core sections and two metallic box are disembarked and leave for their destination. ROV Equipment goes to HCMR Crete, AUV goes to VLIZ by truck for storage in warehouse. Core sections go to BOSCORF laboratories by refrigerated truck. OGS and NOC metallic boxes containing equipment travel to OGS and NOC respectively by plane.

Days	**Activity onboard R/V Aegaeus**	**rs. of data acquisition par day**
30th July 2023	Equipment mobilization	0
1st August	Departure to study area	0
2nd August	Transit to study area	0
3rd August at 13:00	Start of ERODOTO data acquisition	11
4th August	ERODOTO data acquisition	24
5th August	ERODOTO data acquisition	24
6th August	ERODOTO data acquisition	24
7th August	ERODOTO data acquisition	24
8th August	ERODOTO data acquisition	24
9th August 2023	ERODOTO data acquisition	24
10th August 2023 at 10.28	ERODOTO data acquisition	10.28
11th August 2023	Transit and arrival to Piraeus	0
12th August 2023 8.00	Start of eq. demobilization	0

4 Preliminary Results

The ERODOTO data acquisition started on the 3rd of August 2023 at 13:00h and ended the 10th July 2023 at the 10.20h. In Table 0 you can find the summary of the acquisition data carried out in the 7 days of acquisition.

Table 0: Summary of data acquisition during the ERODOTO campaign

No	Units	Acquisition data
11	dives	ROV dives (video, 4 pushcores, 4 rock samples)
8	missions	Gavia AUV missions (Klein interferometric sidescan sonar, photography, Temp, Sal, ADCP)
14	cores	Gravity cores
1	cast	CTD cast (temperature, salinity)
~200	Km2	ELAC Seabeam3030 multibeam data

4.1 AUV data acquisition

The Barabas AUV (VLIZ) is a modular system and has a depth range up to 1000 meters. The AUV can be equipped with a multitude of sensors including, INS-DVL module (Phins C3 with pathfinder DVL), a side scan sonar with swath bathymetry option (Klein 3500) and science module with environmental sensors (see list below). Furthermore, the AUV is equipped with USBL solution (iXBlue GAPS USBL). This system setup allows seawater, seabed and sub-seafloor measurements related to chemical, biological, physical, geological and historical research from shelves to continental slopes.
The AUV has a cruising speed of 3 knots and a maximum speed of 5 knots, transported in a number of transport cases, and comes with a launch and recovery system net that can be deployed from an A-Frame (preferred) or side crane. Acoustic modem (Benthos), Iridium satellite communication (mission data, no science data), RTK enabled GPS, iXBlue GAPS-transponder enables USBL-updates to the vehicle.

AUV Team Fred Fourie and Kobus Langedock from VLIZ, setting the AUV Barabas for deployment at sunrise.

The modules used during ERODOTO are: Nose, Battery, INS, Control Center, Science Bay, Klein, Battery, Propulsion

Klein 3500 Side Scan Sonar with swath bathymetry
3.1. RBR CTD
3.2 Aanderaa O2
3.3. Wetlabs Triplet
3.4. Suna Nitrate sensor
3.5. Pro-Oceanus, PCo2 sensor
3.6. USBL for high accuracy underwater navigation- requires GAPS on the support vessel.
4. RTK GPS capable navigation (through NTRIP)
Plates: Battery, INS, Control Center, Science Bay
o 4 Cubes in Battery rail
o 4 Cubes in the Klein rail
o 8 Cubes in the Propulsion rail
• Battery 025, 026 and 028 was used during this mission
• Propulsion modules 097 was used

Vehicle is equipped with a Launch and Recovery System (LARS) which is suitable for deployment and recovery off a large research vessel (A-Frame (preferably) or over side). Multibeam interference was observed, which manifested as false USBL detections on the hull of the vessel. The Wifi-range extender has proven invaluable yet again. The unit was installed above the crows nest and provided excellent coverage.

Detail of VLIZ AUV Barabas

Dive summary:
Basic structure of AUV Operations:
Surveys were planned to 7 to 8 hours of mission time, with maximum distance of around 50km.

Operation startup was around 04:00 (GMT+2) with time in the water being between 05:30 and 06:00. Recovery wat typically around 14:00. Depending on the depth of the target area, the dive would contain settling and descent/ascent elements. GAPS was installalled on the R/V Aegeo. Dimensions of the GAPS mounting and Acomms was send to HCMR for manufacture and fitting on the ship. This installation was midships on the port side of the Aegeo. The GAPS pole operations seemed smooth although the length of the pole was limited by where it was installed, this meant that the GAPS antenna was relatively close to the hull of the ship, this proved challenging in shallow waters. In the shallow waters the ship was asked to keep port side facing to the survey area (see figure 3, Table 1)

Mission 1
2307003-AG23ER-Station1
Standard box survey.
Mission 2
2307003-AG23ER-Station6
Head wall survey
Mission 3
2307003-AG23ER-Station13
Shallow box survey
Mission 4
2307003-AG23ER-Station17
Headwall box survey
Mission 5
2307003-AG23ER-Station27
*Multi Part canyon base
Mission 6
2307003-AG23ER-Station31
Mission 7
2307003-AG23ER-Station37
Mission 8
2307003-AG23ER-Station43

Station no.	Sample number	Date
1	AG23ER-001-AUV01/M01	03/07/2023
6	AG23ER-006-AUV02/M02	04/07/2023
13	AG23ER-013-AUV03/M03	05/07/2023
17	AG23ER-017-AUV04/M04	06/07/2023
27	AG23ER-027-AUV05/M05	07/07/2023
31	AG23ER-031-AUV06/M06	08/07/2023
37	AG23ER-037-AUV07/M07	09/07/2023
43	AG23ER-043-AUV08/M08	10/07/2023

Table 1 List of ERODOTO AUV missions

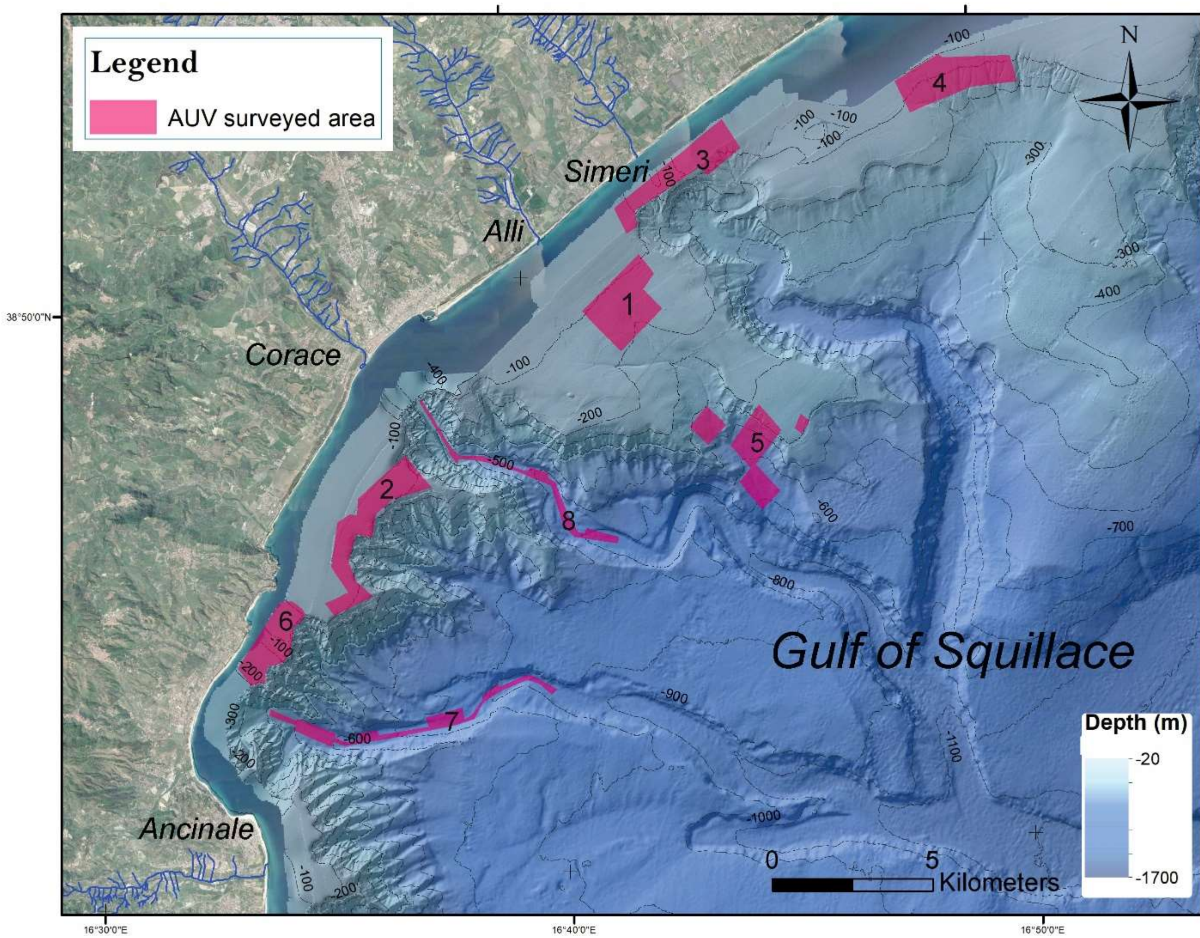

Fig. 3: Map of the AUV surveyed area in the headwalls of the Squillace canyon.

4.2 ROV data acquisition

The HCMR MAX ROVER was received in Greece in 1999 and has been used in all of the Aegean Sea. During its initial trials it was taken to a depth of 1854m between the islands of Crete and Thira. This is a remote operated underwater vehicle with the ability to dive to about 2000m. The system includes the submersible, a cable winch and a control console. It is controlled by 3 personnel (operator and technicians) and is controlled from the HCMR?s research vessels R/V AEGAEO and PHILIA.

HCMR ROV Team Antonis Kouloutzakis, Isidoros Livanos and Leonidas Manousakis preparing a ROV Dive

Detailed Specifications:
Manufacturer: Deep Sea Systems

ROV Max Rover Equipment
3 video cameras and digital still camera
Scanning and side scan sonar
Compass, altitude and depth sensors
Trackpoint system USBL
Robotic arm with 5 axis of movement

VEHICLE	Max Rover
Type	ROV
Power source	Cable
Depth (m)	2000
Power (hp)	12
Weight (kg)	800
Load (kg)	100
Robot arms	1
Cameras	4
Sonars	2

Detailed Specifications
Manufacturer: Deep Sea Systems International Inc.
Model: Max Rover
Maximum operating (dive) depth: 2000 m
Operating Time: Unlimited
Total weight: 750 kg Length: 2.2 m
Width: 0.9 m Height: 1.2 m
Payload: 68 kg
Flotation material: syntactic foam flotation
Power: ROV 14 kW, 220 V (single phase)
Winch: hydraulic winch 380 V (3 phases), 25 hp, slip ring assembly, dimensions 2x2x2 m, 4.5 tonnes weight
Umbilicals: reinforced coaxial 2.200 m winch mounted and 300 m free
Motors: 6 electric x 2.0 hp, internal, brushless, DC
Underwater speed: 2.5 knots (fwd/rev), 1.5 knots (vert/lat), bollard pull: 160 kg
Autopiloting: course, depth, altitude
Navigation: pressure depth meter, altimeter, digital and analogue compass, video graphics overlay (course, depth, date, time, compass, number of cable turns).
Positioning system: Trackpoint II USBL positioning system georeferenced through Hypack Max software
Sonars: Tritech Dual Frequency Scanning Sonar (675/1200 KHz) & Tritech Side Scan Sonar (910 KHz)
4 Cameras: Colour CCD video camera (wide angle, on pan & tilt), Colour CCD video camera (wide angle), Colour CCD video camera (macro-zoom on pan & tilt), digital
Still Camera (3.2 Mpixel, 1Gb) with 4 green lasers Lights: 2 x 100 W HID lights and 4 x 150 W Quartz lights
Manipulation: Hydrolek electro-hydraulic 5 function manipulator
Control: Computer control system, two heavy duty instrument consoles, monitors, control box.

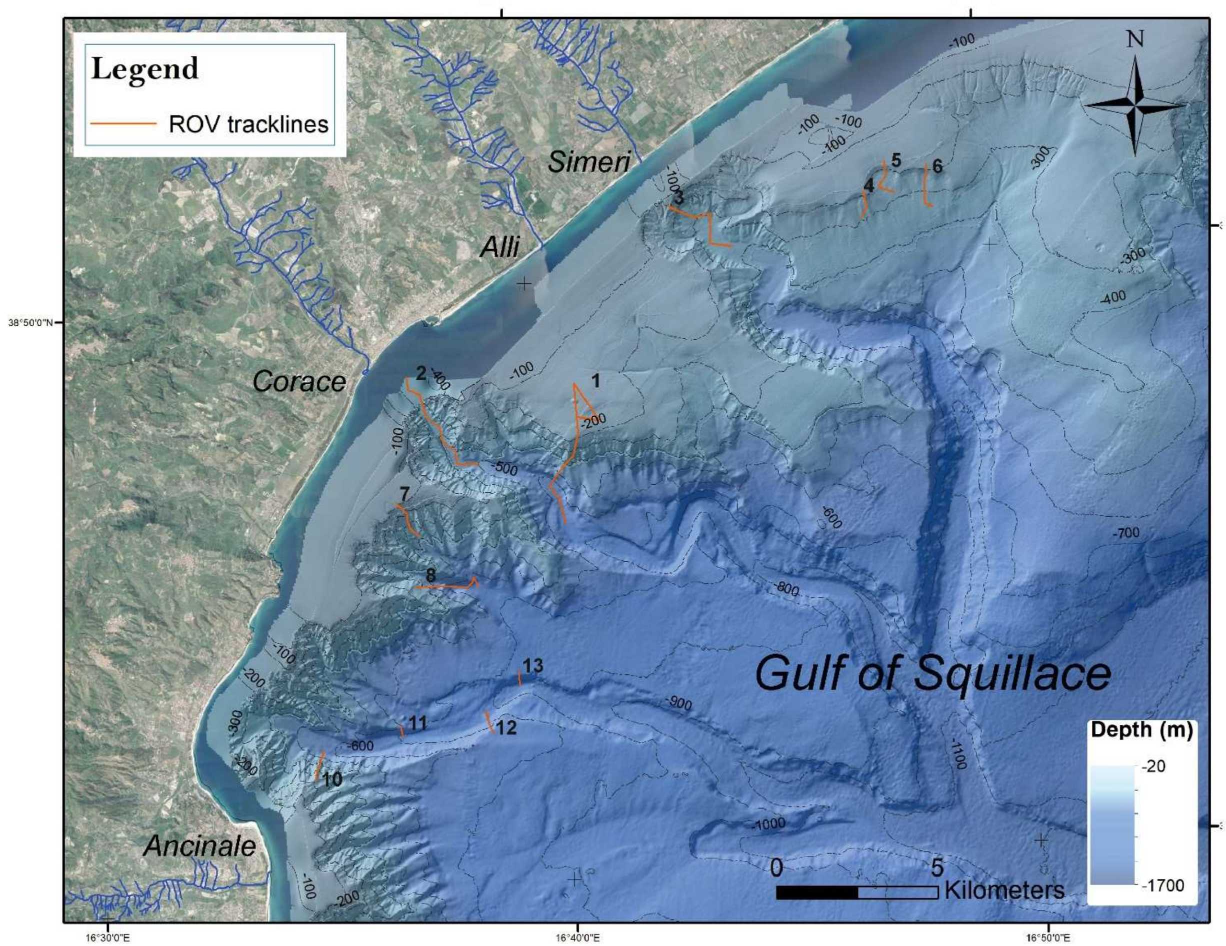

Fig. 4: Map of the ROV surveyed area in the headwalls of the Squillace canyon.

Table 2: List of ROV dives during the ERODOTO campaign

Station no	Gear	Sample number	Date	Start Time (GMT)	Start Lat	Start Long	Start Water depth (m)
2	*ROV*	*AG23ER-002-ROV01/D01*	*3/7/2023*	*13:24:00*	*387,663*	*16,674,843*	*631,0*
7	*ROV*	*AG23ER-007-ROV02/D02*	*4/7/2023*	*12:47:00*	*387,828*	*16,645,448*	*497,0*
14	ROV	AG23ER-014-ROV03/D03	5/7/2023	11:43:00	388,378	16,742,672	377,0
15	ROV	AG23ER-015-ROV04/D04	5/7/2023	17:08:00	387,892	16,642,817	360,0
18	ROV	AG23ER-018-ROV05/D05	6/7/2023	12:41:00	388,502	16,801,877	279,0
18	ROV	AG23ER-018-ROV05/PSH01	6/7/2023	13:38:42	388,528	1,679,613	246,0
19	ROV	AG23ER-019-ROV06/D06	6/7/2023	15:52:00	388,444	16,787,039	285,0

19	ROV	AG23ER-019-ROV06/PSH01	6/7/2023	16:23:00	388,460	16,789,993	260,0
28	ROV	AG23ER-028-ROV07/D07	7/7/2023	14:19:15	387,503	1,664,115	670,0
29	ROV	AG23ER-029-ROV08/D08	7/7/2023	17:59:00	387,652	16,621,002	388,0
32	ROV	AG23ER-032-ROV09/					
33	ROV	AG23ER-033-ROV10/D10	8/7/2023	15:19:00	387,082	16,581,775	574,0
33	ROV	AG23ER-033-ROV10/RCK01	8/7/2023	16:06:10	387,072	16,580,727	530,0
33	ROV	AG23ER-033-ROV10/RCK02	8/7/2023	16:10:51	387,068	16,580,537	520,0
33	ROV	AG23ER-033-ROV10/RCK03	8/7/2023	16:21:21	387,073	16,580,615	466,0
33	ROV	AG23ER-033-ROV10/RCK04	8/8/2023	16:32:09	387,065	16,580,323	426,0
38	ROV	AG23ER-038-ROV11/D11	9/7/2023	13:07:00	387,100	16,609,112	710,0
38	ROV	AG23ER-038-ROV11/PSH01	9/7/2023	14:10:34	387,119	16,609,523	621,0
39	ROV	AG23ER-039-ROV12/D12	9/7/2023	15:59:00	387,221	16,653,295	839,0
39	ROV	AG23ER-039-ROV12/PSH01	9/7/2023	17:24:05	387,250	16,652,645	698,0

Table 3: List of push-cores collected during the ROV dives.

Station identifier	Sample Identifier	n° of Sections	Section Identifier	Date Sample Collected	Decimal Latitude	Decimal Longitude	Water Depth
AG23ER_18	AG23ER_18_ROV05_PSH01	1	AG23ER_18_ROV05_PSH01	06/07/2023	38,8528	16,7961	-246
AG23ER_19	AG23ER_19_ROV06_PSH01	1	AG23ER_19_ROV06_PSH01	06/07/2023	38,8460	16,7900	-260
AG23ER_33	AG23ER_33_ROV10_RCK01	1	AG23ER_33_ROV10_RCK01	08/07/2023	38,7072	16,5807	-530,0
AG23ER_33	AG23ER_33_ROV10_RCK02	1	AG23ER_33_ROV10_RCK02	08/07/2023	38,7068	16,5805	-520,0
AG23ER_33	AG23ER_33_ROV10_RCK03	1	AG23ER_33_ROV10_RCK03	08/07/2023	38,7073	16,5806	-466,0

AG23ER_33	AG23ER_33_ROV10_RCK04	1	AG23ER_33_ROV10_RCK04	08/07/2023	38,7065	16,5803	-426,0
AG23ER_38	AG23ER_38_ROV11_PHS01	1	AG23ER_38_ROV11_PHS01	09/07/2023	38,7119	16,6095	-621,0
AG23ER_39	AG23ER_39_ROV12_PSH01	1	AG23ER_39_ROV12_PSH01	09/07/2023	38,7250	16,6526	-698,0

4.3 Gravity core collection

A gravity corer (3 m long) was deployed from the Aegaeo during the night. The instrument consisted in:
Head: consisting of a cylindrical galvanized iron mass with a variable weight of 200 to 800 Kg which provides the momentum necessary for the instrument to penetrate into the sedimentary layers.
Barrel: in galvanized iron with a 105 mm external diameter and a variable length of 2 to 6 metres. A longer dimension is achievable by using a proper connecting sleeve. Inside the barrel a liner in PVC meets the right housing, with a 90 mm external diameter (84 internal), implemented to hold the sample.
Nose, including cutter and catcher: the lowermost part of the barrel is reinforced by a core nose which ends with a stainless-steel cutter. A device with 4 spades of triangular shape locks the nose needed to keep the sample during the corer's recovery. The closure of the spades is controlled by the liner at the start of the extraction of the seabed.

Core locations are showed in figures 2, 5 and 6 . The list of gravity cores collected in the headwalls and along the branches of the Squillace canyon and related acquisition parameters are listed in Table 4. On board gravity cores were not split and were stores in a refrigerated area. Once on land in Piraeus (Greece) the cores sections were transferred from Athens to BOSCORF laboratories, the British Ocean Sediment Core Research facilities, in NOC, Southampton (UK).

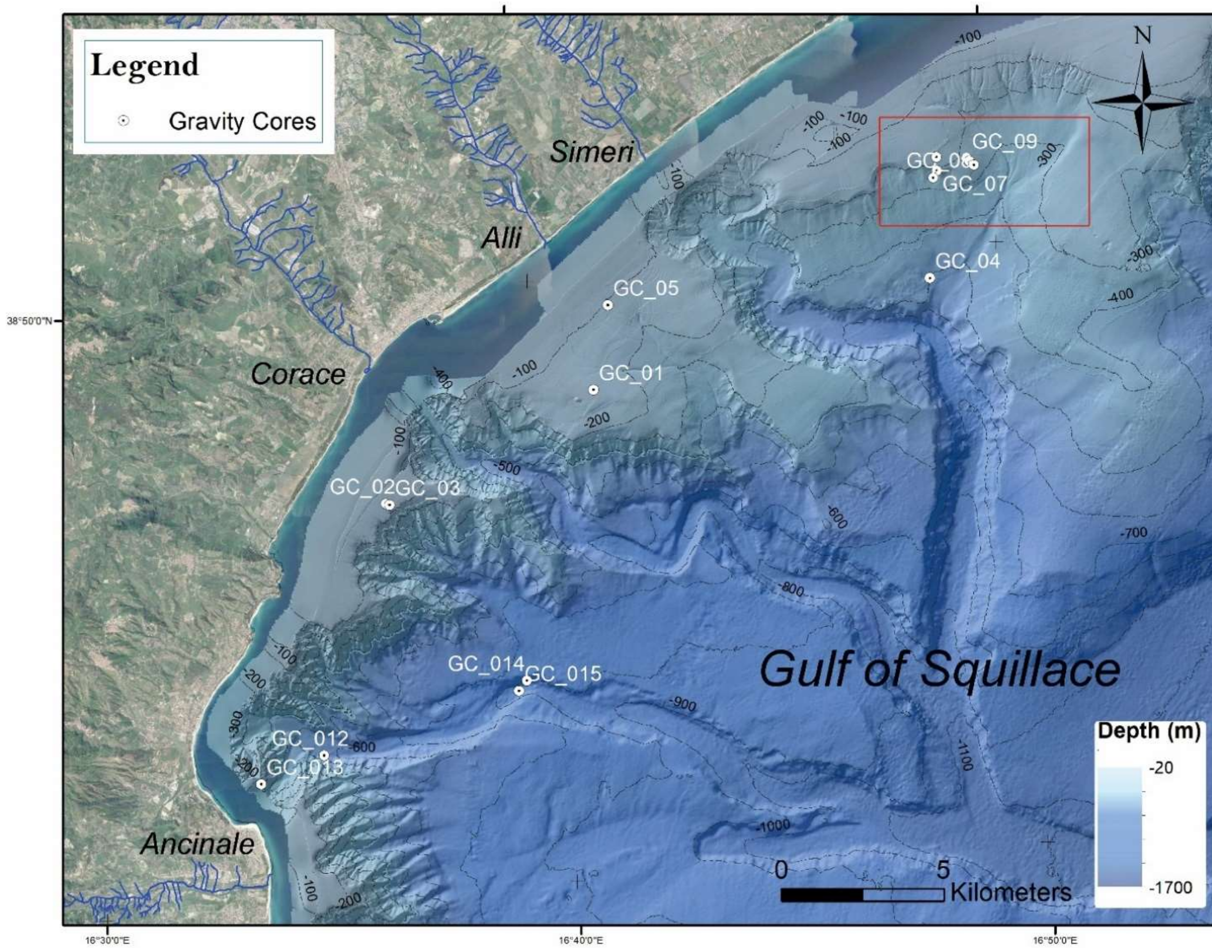

Fig. 5: Location of the gravity cores collected in the headwalls and along the branches of the Squillace canyon. The red inset is shown in fig. 6.

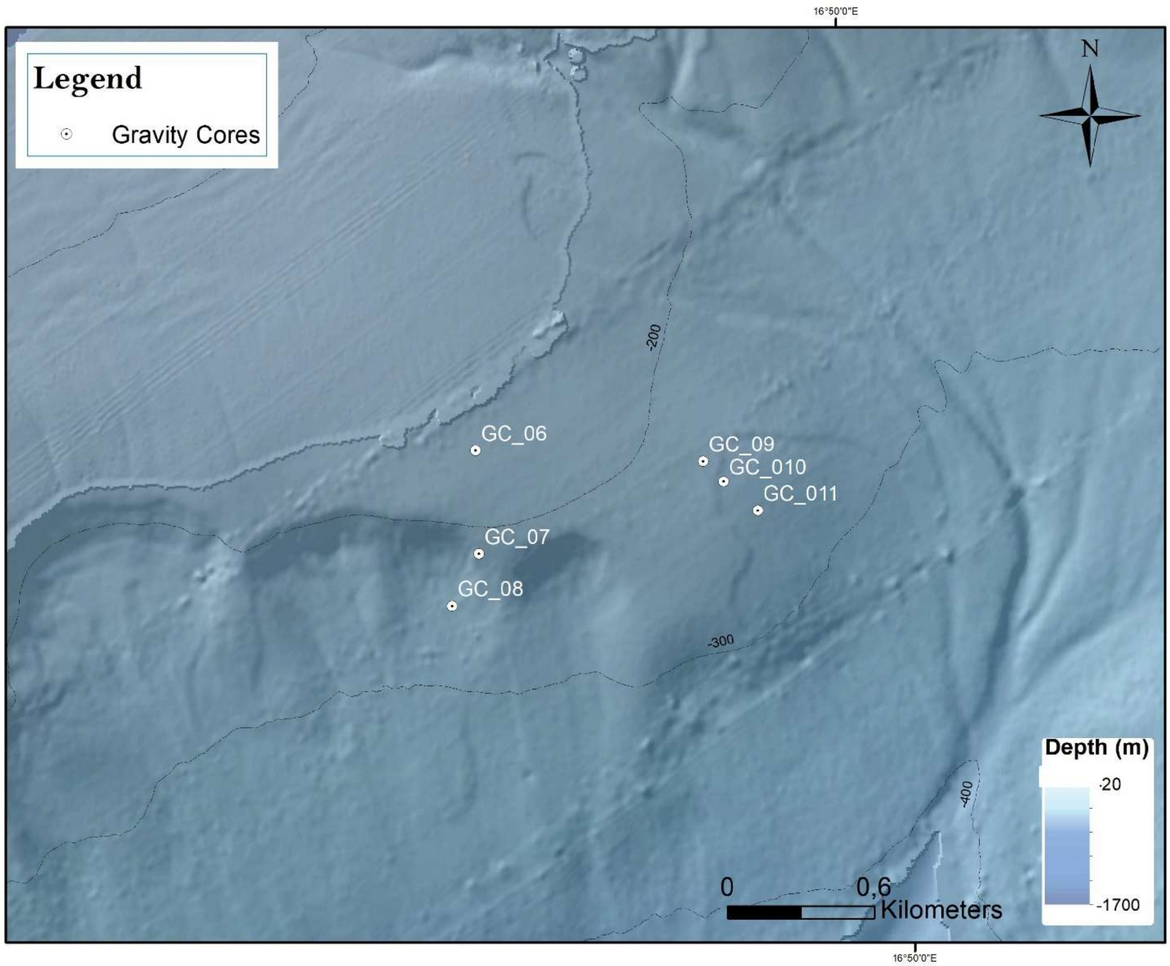

Fig. 6: Location of the gravity cores collected in the eastern headwalls of the Squillace canyon in the inset of figure 5.

Table 4: List of gravity cores collected in the headwalls and along the branches of the Squillace canyon. Core location showed in figs 2, 5 and 6.

Station no	Core names	No of core sections	Name of core sections	Date	Lat	Long	Water Depth (m)	Core Length (cm)	Section Length (cm)
AG23ER_03	AG23ER_GC01	3	AG23ER_GC01_01	03/07/23	16,68660	38,80210	-136	211	92
AG23ER_03	AG23ER_GC01	3	AG23ER_GC01_02	03/07/23	16,68660	38,80210	-136	211	92
AG23ER_03	AG23ER_GC01	3	AG23ER_GC01_03	03/07/23	16,68660	38,80210	-136	211	28
AG23ER_08	AG23ER_GC02	3	AG23ER_GC02_01	04/07/23	16,61004	38,77557	-84,4	193	92
AG23ER_08	AG23ER_GC02	3	AG23ER_GC02_02	04/07/23	16,61004	38,77557	-84,4	193	91
AG23ER_08	AG23ER_GC02	3	AG23ER_GC02_03	04/07/23	16,61004	38,77557	-84,4	193	12
AG23ER_09	AG23ER_GC03	4	AG23ER_GC03_00	04/07/23	16,61129	38,77507	-77	212	
AG23ER_09	AG23ER_GC03	4	AG23ER_GC03_01	04/07/23	16,61129	38,77507	-77	212	92
AG23ER_09	AG23ER_GC03	4	AG23ER_GC03_02	04/07/23	16,61129	38,77507	-77	212	92
AG23ER_09	AG23ER_GC03	4	AG23ER_GC03_03	04/07/23	16,61129	38,77507	-77	212	28
AG23ER_10	AG23ER_GC04	4	AG23ER_GC04_00	04/07/23	16,80851	38,82547	-99,83	223	
AG23ER_10	AG23ER_GC04	4	AG23ER_GC04_01	04/07/23	16,80851	38,82547	-99,83	223	92
AG23ER_10	AG23ER_GC04	4	AG23ER_GC04_02	04/07/23	16,80851	38,82547	-99,83	223	92
AG23ER_10	AG23ER_GC04	4	AG23ER_GC04_03	04/07/23	16,80851	38,82547	-99,83	223	39
AG23ER_11	AG23ER_GC05	4	AG23ER_GC05_00	04/07/23	16,69417	38,82520	-109,9	213	
AG23ER_11	AG23ER_GC05	4	AG23ER_GC05_01	04/07/23	16,69417	38,82520	-109,9	213	92
AG23ER_11	AG23ER_GC05	4	AG23ER_GC05_02	04/07/23	16,69417	38,82520	-109,9	213	92
AG23ER_11	AG23ER_GC05	4	AG23ER_GC05_03	04/07/23	16,69417	38,82520	-109,9	213	30
AG23ER_20	AG23ER_GC06	3	AG23ER_GC06_01	06/07/23	16,81447	38,85825	-180	220	92
AG23ER_20	AG23ER_GC06	3	AG23ER_GC06_02	06/07/23	16,81447	38,85825	-180	220	92
AG23ER_20	AG23ER_GC06	3	AG23ER_GC06_03	06/07/23	16,81447	38,85825	-180	220	37
AG23ER_21	AG23ER_GC07	3	AG23ER_GC07_01	06/07/23	16,81422	38,85447	-210	226	92
AG23ER_21	AG23ER_GC07	3	AG23ER_GC07_02	06/07/23	16,81422	38,85447	-210	226	92
AG23ER_21	AG23ER_GC07	3	AG23ER_GC07_03	06/07/23	16,81422	38,85447	-210	226	42
AG23ER_22	AG23ER_GC08	3	AG23ER_GC08_01	06/07/23	16,81275	38,85264	-295	238	92

AG23ER_22	AG23ER_GC08	3	AG23ER_GC08_02	06/07/23	16,81275	38,85264	-295	238	93
AG23ER_22	AG23ER_GC08	3	AG23ER_GC08_03	06/07/23	16,81275	38,85264	-295	238	53
AG23ER_23	AG23ER_GC09	4	AG23ER_GC09_00	06/07/23	16,82510	38,85715	-230	204	
AG23ER_23	AG23ER_GC09	4	AG23ER_GC09_01	06/07/23	16,82510	38,85715	-230	204	92
AG23ER_23	AG23ER_GC09	4	AG23ER_GC09_02	06/07/23	16,82510	38,85715	-230	204	92
AG23ER_23	AG23ER_GC09	4	AG23ER_GC09_03	06/07/23	16,82510	38,85715	-230	204	21
AG23ER_24	AG23ER_GC11	3	AG23ER_GC11_01	06/07/23	16,82745	38,85517	-252	224	92
AG23ER_24	AG23ER_GC11	3	AG23ER_GC11_02	06/07/23	16,82745	38,85517	-252	224	93
AG23ER_24	AG23ER_GC11	3	AG23ER_GC11_03	06/07/23	16,82745	38,85517	-252	224	40
AG23ER_25	AG23ER_GC10	3	AG23ER_GC10_01	06/07/23	16,82596	38,85634	-242	230	92
AG23ER_25	AG23ER_GC10	3	AG23ER_GC10_02	06/07/23	16,82596	38,85634	-242	230	92
AG23ER_25	AG23ER_GC10	3	AG23ER_GC10_03	06/07/23	16,82596	38,85634	-242	230	47
AG23ER_34	AG23ER_GC13	3	AG23ER_GC13_01	08/07/23	16,55786	38,70102	-220	202	93
AG23ER_34	AG23ER_GC13	3	AG23ER_GC13_02	08/07/23	16,55786	38,70102	-220	202	93
AG23ER_34	AG23ER_GC13	3	AG23ER_GC13_03	08/07/23	16,55786	38,70102	-220	202	18
AG23ER_35	AG23ER_GC12	1	AG23ER_GC12_01	08/07/23	16,58095	38,70749	-573	31	31
AG23ER_40	AG23ER_GC14	3	AG23ER_GC14_01	09/07/23	16,65445	38,72353	-815	170	
AG23ER_40	AG23ER_GC14	3	AG23ER_GC14_02	09/07/23	16,65445	38,72353	-815	170	92
AG23ER_40	AG23ER_GC14	3	AG23ER_GC14_03	09/07/23	16,65445	38,72353	-815	170	79
AG23ER_41	AG23ER_GC15	1	AG23ER_GC15_01	09/07/23	16,65150	38,72076	-830	0	0

5 Data and Sample Storage / Availability

The post-cruise processing and analyses will be carried out in synergy between both onboard and onshore team and according to the scheduled timeframe and deliverables have been defined in Table 5. The necessary funding for data processing and interpretation will be provided by OGS in cooperation with the National Recovery and Resilience Plan Project RETURN Multi-risk science for resilient communities under a changing climate. Gravity cores are stored at the BOSCORF Laboratories, the British Ocean Sediment Core Research facilities in NOC Southampton (UK). A grant of the Royal Society has been submitted in September 2023 to fund core sampling and analyses and traveling costs for OGS and NOC researchers to travel between the two countries. Geotechnical analyses will be funded in collaboration between OGS and IFREMER (Nabil Sultan). AUV Side Scan Sonar and MBES data processing will be carried out by Nora Markezic in a frame of a collaboration between OGS VLIZ and NOC. Further opportunities for funding will be pursued (also in collaboration with local authorities and civil protections) to guarantee future regular monitoring plans of the Squillace canyon erosive features analysed in ERODOTO (e.g time lapse bathymetry, mooring strategy) and possibly set the base for a fixed monitoring observatory system.

Nr	Task description	Responsible	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	**Geomorphological analysis**																									
1.1	shipboard acoustic data processing	Bulzachelli/Wintersteller																								
1.2	AUV acoustic data processing	Huvenne/Wintersteller																								
1.3	Drone data processing	Alevizos	D2				D3																			
1.4	ROV video/stills analysis	Huvenne																								
1.5	3D photogrammetry	Huvenne																								
1.6	Data integration interpretation	Ceramicola/Casalbore												D5												
2	**Analysis of sediment flow regime**																									
2.1	Bedform analysis	Cartigny/Caburlotto																								
2.2	Grainsize analysis from pushcores	Cartigny																								
2.3	ADCP data analysis	Cardin/Cartigny																								
2.4	Sediment transport modelling	Cartigny/Cardin																						D7		
3	**Geotechnical analysis**																									
3.1	Oedometer-consolidation tests	Sultan																								
3.2	Triaxial tests	Sultan																								
3.3	Slope stability modelling	Sultan																		D6						
4	**Geohazard monitoring advice**																									
4.1	Cruise reporting	Ceramicola	D1					D4																		
4.2	Overall synthesis	Ceramicola, All																						D8		
4.3	Scientific reporting	Ceramicola, All												D10					D10							D11
4.4	Outreach/stakeholder communication	Casalbore/Ceramicola																						D9		

6 Participants

ERODOTO scientific party
Left to right: Nora Markezic, Silvia Ceramicola, Fred Fourie, Kobus Langedock, Marco Bianchini, Veerle Huvenne, Denise Petronelli, Tiago Alvez, Mitja Jankovic

List of participants on board, their tasks and role. Asterix indicate the participants funded by Eurofleets+ (*)

No.	Name	Early career (Y/N)	Gender (F/M)	Affiliation	Task on-board
1	Silvia Ceramicola	N	F	OGS, IT	Chief scientist
2	Veerle Huvenne*	N	F	NOC, UK	Co-chief scientist
3	Tiago Alves*	N	M	Cardiff Uni, UK	MBES/Coring
4	Nora Markezic*	Y	F	OGS, IT	MBES/coring
5	Denise Petronelli*	Y	F	UniSapienza,IT	MBES/Coring
6	Marco Bianchini*	Y	M	UniSapienza,IT	MBES/coring
7	Mitja Jankovic*	Y	M	NovaGraphica,IT	Data manager
8	Fred Fourie*	N	M	VLIZ, B	AUV data acquisition
9	Kobus Langedock*	N	M	VLIZ, B	AUV data acquisition
10	Ioannis Morfis*	N	M	HCMR, GR	MBES data acquisition
11	Isidoros Livanos*	N	M	HCMR, GR	MBES data acquisition
12	Manolis Kallergis*	N	M	HCMR, GR	ROV technician
13	Leonidas Manousakis*	N	M	HCMR, GR	ROV technician
14	Antonis Kouloutzakis*	N	M	HCMR, GR	ROV technician
15	Vasilis Stasinos*	N	M	HCMR, GR	ROV recovery/deployment
16	Vasilis Mpampas*	N	M	HCMR, GR	ROV recovery/deployment

Chief scientist Silvia Ceramicola (OGS) and co-Chief scientist Veerle Huvenne (NOC) before deploying AUV Barabas at 5.30 in the morning. In the background the sunrise on the Calabrian Ionian coastline.

List of remote participants, their tasks and role in processing the data/samples

ERODOTO SHORE BASED TEAM							
No.	Name	Gen.	Affiliation, country	Main task	Career status	Expertise	hindex (GS)
1	Evangelos Alevizos	M	NOC, UK	drone pilot	ECR	habitat & geomorphology mapping	
2	Nabil Sultan	M	IFREMER, FR	geotechnics	senior	marine geotechnics & slope stability	32
3	Daniele Casalbore	M	CNR, I	data interpretation		marine geohazards assessment	20
4	Francescp L. Chiocci	M	Uni. La Sapienza, I	geohazards managment	senior	marine geohazards managment	30

7 Station List

Table 5: Station list of all operation during the ERODOTO campaign .

Station no	Gear	Final sample number	Date	Start Time (GMT)	Start Lat	Start Long	Start Water depth (m)	Comments
1	*AUV*	*AG23ER-001-AUV01/M01*	*03/07/2023*	*03:56:00*	*38,8277*	*16,696983*	*105,7*	*First AUV mission, we did a ballast test at the start*
2	*ROV*	*AG23ER-002-ROV01/D01*	*03/07/2023*	*13:24:00*	*38,7663*	*16,674843*	*631,0*	
3	*GC*	*AG23ER-003-GC01/GC01*	*03/07/2023*	*19:56:00*	*38,8021*	*16,686598*	*136,0*	*Core overpenetrated? 212cm recovery. 3 sections 92cm, 92cm, 28cm.*
4	*CTD*	*AG23ER-004-CTD1/P01*	*03/07/2023*	*20:53:00*	*38,7780*	*16,697333*	*549,0*	
5	*MBES*	*AG23ER-005-MBES01/MB01*	*03/07/2023*	*22:21:00*	*38,7475*	*16,717167*	*691,5*	
6	*AUV*	*AG23ER-006-AUV02/M02*	*04/07/2023*	*03:51:00*	*38,7530*	*16,59778*	*96,0*	
7	*ROV*	*AG23ER-007-ROV02/D02*	*04/07/2023*	*12:47:00*	*38,7828*	*16,645448*	*497,0*	*Limited visibility, very high turbidity. Too much wind interrupts acquisition: Dive aborted because ship cannot hold position (problem bow thruster)*

8	*GC*	*AG23ER-008-GC02/GC02*	*04/07/2023*	*16:50:00*	*38,7756*	*16,610038*	*84,0*	*Time and location is core on deck, no notes taken when core reaches seabed. Total length 193cm, three sections: 92, 91 and 12 cm.*
9	*GC*	*AG23ER-009-GC03/GC03*	*04/07/2023*	*17:04:00*	*38,7752*	*16,611507*	*77,0*	*Total length 212cm, three sections: 92, 92 and 28 cm*
10	*GC*	*AG23ER-010-GC04/GC04*	*04/07/2023*	*17:55:00*	*38,8253*	*16,691538*	*99,0*	*Total lenth: 223cm, three sections: 92, 92, 39cm*
11	*GC*	*AG23ER-011-GC05/GC05*	*04/07/2023*	*18:05:00*	*38,8249*	*16,69469*	*109,0*	*Total length: 213cm, three sections: 92, 92, 30cm*
12	*MBES*	*AG23ER-012-MBES02/MB01*	*04/07/2023*	*19:19:00*	*38,7805*	*16,73544*	*575,0*	
13	*AUV*	*AG23ER-013-AUV03/M03*	*05/07/2023*	*03:42:00*	*38,8518*	*16,709438*	*76,0*	
14	ROV	AG23ER-014-ROV03/D03	05/07/2023	11:43:00	38,8378	16,742672	377,0	
15	ROV	AG23ER-015-ROV04/D04	05/07/2023	17:08:00	38,7892	16,642817	360,0	
16	MBES	AG23ER-016-MBES03/MB01	05/07/2023	19:20:00	38,8006	16,649792	232,0	
17	AUV	AG23ER-017-AUV04/M04	06/07/2023	03:23:00	38,8794	16,810548		
18	ROV	AG23ER-018-ROV05/D05	06/07/2023	12:41:00	38,8502	16,801877	279,0	Problems with OFOP at the start - notes taken on paper
18	ROV	AG23ER-018-ROV05/PSH01	06/07/2023	13:38:42	38,8528	16,79613	246,0	
19	ROV	AG23ER-019-ROV06/D06	06/07/2023	15:52:00	38,8444	16,787039	285,0	
19	ROV	AG23ER-019-ROV06/PSH01	06/07/2023	16:23:00	38,8460	16,789993	260,0	

20	GC	AG23ER-020-GC06/GC06	06/07/2023	17:57:00	38,8583	16,814473	180,0	time and position is when core came back on deck. Total length: 220cm, three sections, 92, 92 and 37cm
21	GC	AG23ER-021-GC07/GC07	06/07/2023	12:14:00	38,8549	16,81383	210,0	total length: 226cm, three sections: 92, 92, 42cm
22	GC	AG23ER-022-GC08/GC08	06/07/2023	18:48:00	38,8504	16,816175	295,0	Unreliable core: core stayed in water off the bottom due to machine overheating. Total length: 238cm, three sections: 92, 93, 53cm
23	GC	AG23ER-023-GC09/GC09	06/07/2023	19:12:00	38,8561	16,825772	230,0	total length: 204 cm, three sections: 92, 92, 21cm
24	GC	AG23ER-024-GC11/GC11	06/07/2023	19:23:00	38,8552	16,827448	252,0	Note: gravity cores have been labelled after waypoints, hence numbering is out of order. total length: 224 cm, three sections: 92, 93, 40cm
25	GC	AG23ER-025-GC10/GC10	06/07/2023	19:46:00	38,8556	16,827287	242,0	Note: gravity cores have been numbered after WPs, hence numbering is out of order. total length: 230cm, three sections: 92, 92, 47cm
26	MBES	AG23ER-026-MBES04/MB04	06/07/2023	20:20:00	38,8228	16,8255	444,0	
27	AUV	AG23ER-027-AUV05/M01	07/07/2023	03:36:00	38,7903	16,727385	20,0	AUV aborted mission at 05:57, was given new command and dived again to continue survey
28	ROV	AG23ER-028-ROV07/D07	07/07/2023	14:19:15	38,7503	16,64115	670,0	ROV ran into fishing line. Dive aborted
29	ROV	AG23ER-029-ROV08/D08	07/07/2023	17:59:00	38,7652	16,621002	388,0	
30	MBES	AG23ER-030-MBES05/MB05	07/07/2023	20:07:00	38,7682	16,618677	113,0	
31	AUV	AG23ER-031-AUV06/M06	08/07/2023	03:27:00	38,7415	16,568947		AUV had several short aborts and nav may not be good

32	ROV	AG23ER-032-ROV09/						ROV Dive 09 was cancelled because of fishing gear in the water. The dive did not take place
33	ROV	AG23ER-033-ROV10/D10	08/07/2023	15:19:00	38,7082	16,581775	574,0	
33	ROV	AG23ER-033-ROV10/RCK01	08/07/2023	16:06:10	38,7072	16,580727	530,0	Debrite
33	ROV	AG23ER-033-ROV10/RCK02	08/07/2023	16:10:51	38,7068	16,580537	520,0	Debrite
33	ROV	AG23ER-033-ROV10/RCK03	08/07/2023	16:21:21	38,7073	16,580615	466,0	Debrite
33	ROV	AG23ER-033-ROV10/RCK04	08/08/2023	16:32:09	38,7065	16,580323	426,0	Debrite
34	GC	AG23ER-034-GC13/GC13	08/07/2023	18:32:00	38,7010	16,577893	220,0	Note: gravity cores were labelled after waypoints, hence numbering is out of order. Total length: 2.02m, three sections: 93, 93, and 18 cm
35	GC	AG23ER-035-GC12/GC12	08/07/2023	18:54:00	38,7075	16,580948	570,0000	Short section of ***cm, stuck in core catcher. Very consolidated mud. To conserve the section, a piece of liner was split in half and the core placed inside, with the core catcher.
36	MBES	AG23ER-036-MBES06/MB06	08/07/2023	19:45:00	38,7157	16,567193	444,0	
37	AUV	AG23ER-037-AUV07/AUV07	09/07/2023	04:00:00	38,7159	16,567193		
38	ROV	AG23ER-038-ROV11/D11	09/07/2023	13:07:00	38,7100	16,609112	710,0	
38	ROV	AG23ER-038-ROV11/PSH01	09/07/2023	14:10:34	38,7119	16,609523	621,0	
39	ROV	AG23ER-039-ROV12/D12	09/07/2023	15:59:00	38,7221	16,653295	839,0	
39	ROV	AG23ER-039-ROV12/PSH01	09/07/2023	17:24:05	38,7250	16,652645	698,0	
40	GC	AG23ER-040-GC14/GC14	09/07/2023	19:01:00	38,7235	16,654448	800,0	total length: 170cm, 2 sections: 92 and 17 cm

41	GC	AG23ER-041-GC15/GC15	09/07/2023	19:32:00	38,7208	16,6515	830,0	core failed - empty. On top of core catcher there was a small amount of sand, which was stored.
42	MBES	AG23ER-042-MBES07/MB07	09/07/2023	20:51:00	38,7978	16,69741	170,0	
43	AUV	AG23ER-043-AUV08/M08	10/07/2023	04:05:00	38,7848	16,633695	395,0	AUV mission aborted to enable ship to go back to port immediately, to deal with covid outbreak

8 Acknowledgements

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360 view of the R/V Aegaeo during operations.