# MARNAUT

# 2007

# Dive report

# MARNAUT 2007
# Dive report

## LEG1
**13/05/2007-15/05/2007**

**Campagne MarNaut**
**Chef de mission : Pierre Henry / Celal Şengör**
**Travaux réalisés par le Nautile**

| | |
|---|---|
| **N° absolu de plongée** : 1641 | **Date** : 13/05/2007 |
| **Observateur**<br>- Nom : Pierre HENRY<br>- Spécialité : Géophysique<br>- Organisme : CNRS | **Pilote** : Jean-Paul JUSTINIANO<br><br>**Navigateur engin** : Franck ROSAZZA |

**Objectif(s) de la plongée** :
Recherche de zone d'expulsion de fluide
Cold seep search

**Coordonnées du point d'arrivée sur le fond**
- Longitude : 29,0588 - Latitude : 40,7846

**Profondeurs explorées pendant la plongée**
- Minimum : 1152 m - Maximum : 1265 m

**Durée totale de la plongée** : 6:04 **Durée sur le fond** : 4:24

**Equipements scientifiques**

- installés sur le submersible : Push corers

- transportés dans la navette :

- mouillés en autonome :

**Travaux réalisés sur le fond**

- Distance parcourue : 2570 m

-Travaux réalisés : Observation and sampling

- Echantillons : 2 rock samples (R1,R2) – one push core

- Nombre de bandes vidéo : 6 DVD

- Nombre de photos : 75 pentax

Nautle Dive 1641 (Marnaut 01)

Date : 13/05/2007
Latitude : N40° 47.95'
Longitude : E29° 02.9'
Maximum depth : 1265 m (13/05/2007 10H00)
Timing (GMT) begin dive : 10H30, on bottom: 10H49, leaving bottom, 15H13

**Dive objectives:** Victor ROV found only sparse evidence for active fluid seepage in Cinarcik basin. This dive site correspond to one of the few location where black patches were observed and was thus designated as a working site for fluid, gas, biological and microbiological sampling. Exploration with Nautile is also required as SAR data suggest that the zone of maximum outflow may be located at the slope break rather than on the talus explored with the ROV.

**Site survey data:** EM300, ROV microbathymetry an observations, 3.5 kHz, MCS.

**Dive course:** Start in basin, climb talus, crossing follow base of steep slope, looking for cold seeps. Find and sample outcrops on cliff.

**Instruments:** push core rack

**Sampling plan:**
Push cores in black patches/bacterial mats
Hard rock on cliff

**Main results:**

Dive 1641 confirmed the presence of very active cold seeps at the base of the Cinarcik northern slope. Little evidence of seepage was found on the talus previously explored with the ROV. The newly found sites are located on the steeper talus near the base of the cliff. Four of them are fond immediately beneath basement outcrops at depth 1169 m, 1166 m, 1166 and 1171m, respectively. The nearly constant depth and the consistency between average outcrop orientation (N290-N310) and contour line strike suggests the outcrop and associated seepage sites are structurally controlled. Elongated black patches were found associated with N300 and N340 small faults or tension gashes affecting the scree south of an outcrop before the last stop. The line of outcrops presumably corresponds to the main fault trace. More seeps were found either upslope or downslope of this scarp, notably one site at about 1152 m, located on a scree slope. Fractures striking N340±10 are observed on the outcrops as well as N0, N80 joints. N340 corresponds to a regional fracture direction affecting the Paleozoic basement. These fractures could be reactivated as normal faults or transtensive strike-slip faults in the current tectonic context.

A basement outcrop was sampled at the last stop (1642 – R1) and identified as green quartzite (likely carboniferous). Fallen blocks are common on the seafloor and generally covered with a sediment blanket of 1-10 cm tickness range. Carbonate cemented crusts are present at active seepage sites, and were sampled (1641 – R2) below the basement outcrop at the last stop. They do not form nice outcrops and their identification is not trivial based on visual evidence.

The normal seafloor is poked by burials, 1-2 cm diameter, apparently inhabited by arthropods. Small mud burrowing animals with purple retractable tentacles or branchies are also common. Zones of active seepage comprise large patches of reduced sediments inhabited by cm long tube worms (likely polychaetes) in dense carpets. Some of these black patches have minimum dimensions of 20 m, which is rather exceptional. The reduced patches are generally rimmed by bacterial colonies with globules and filaments. Their visual appearance suggests some variability. Most mats are white or yellow. Puzzling pinkish specks may correspond to bacterial colonies or to half-buried bivalvs. Urchin tests are common on the seafloor around active sites. Small bivalvs are often found, but not systematically. Living individuals can be seen half buried in the sediment within or immediately around black patches.

**Highlights :**

| Time | Depth | Lat | Lon | |
|---|---|---|---|---|
| 12:01:40-12:26:51 | 1170 | N 40 47,835 | E 029 3,363 | Active seep 1 and small outcrop, stopped for video |
| 12:34:25 | 1165 | N 40 47,849 | E 029 3,315 | 1 m high outcrop |
| 12:31:57-12:40:50 | 1166 | N 40° 47,851' | E 029° 3,307' | Active seep 2 below outcrop |
| 12:50:47-12:56:04 | 1167 | N 40 47,91 | E 29 3,18 | Active seep 3<br>Small outcrop |
| 13:17:07-13:21:00 | 1153 | N 40° 47,967' | E 029° 2,942' | Active seep 4 |
| 13:28:24-13:29:50 | 1155 | N 40 47,991 | E 29 2,832 | Active seep 5 |
| 13:47:37-13:53:32 | 1187-1179 | | | Spread out seepage |
| 13:54:23-15:09:50 | 1175-1171 | N 40 48,015 | E 29 2,691 | Active seep 6 - sampling site |
| 13:55:51 | 1171 | | | 1 m high basement outcrop |

**Sample report** :

| Sample Nb | Depth (m) | Lat | Lon | Description |
|---|---|---|---|---|
| R1 | 913 | N 40 48,015 | E 29 2,691 | Quartzite with coral, split samples ITU/CEREGE |
| R2 | 1171 | N 40 48,015 | E 29 2,691 | Breccia, ITU, too small to be split |
| PC1 | 1171 | N 40 48,015 | E 29 2,691 | Push core in black patch, discarded after 2 days in fridge |

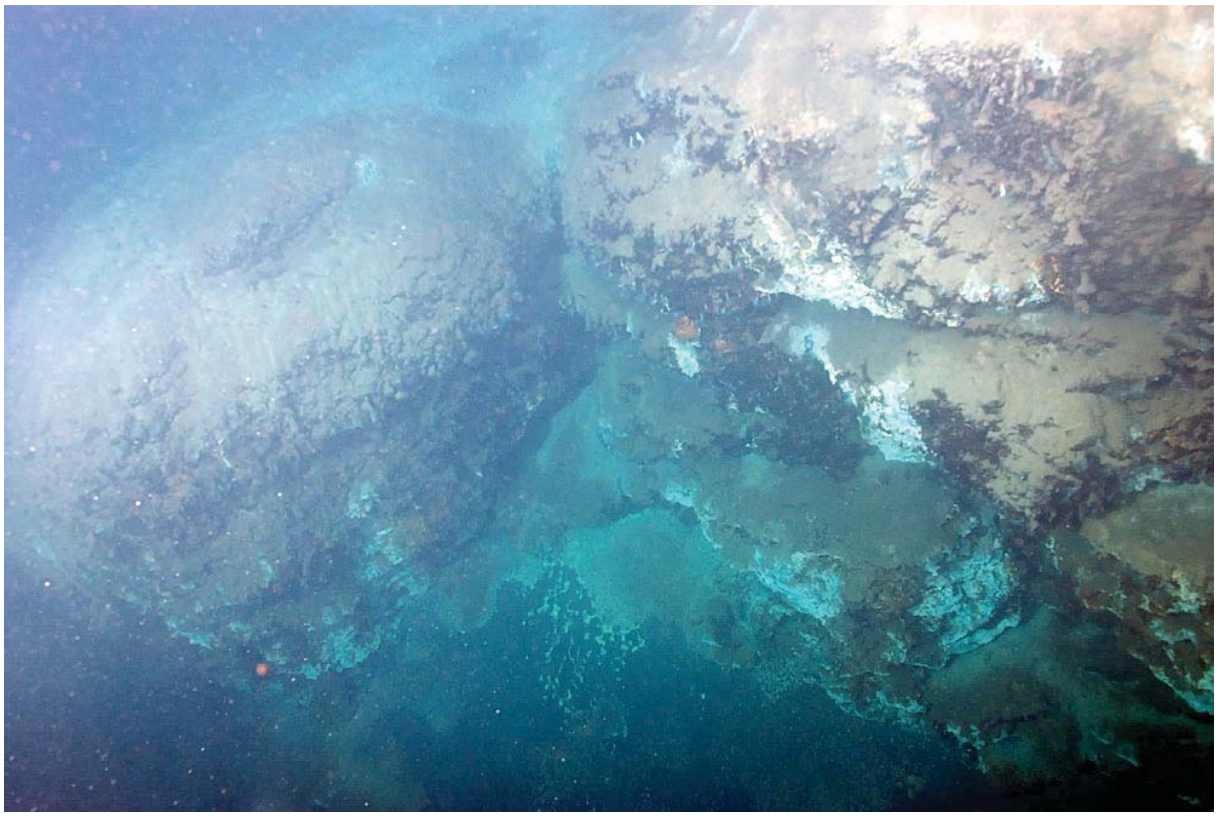


Photo 1: Basement outcrop with N340 oblique fracture

Photo 2: Polychete carpet on large reduced sediment patch. Block on the foreground are fallen blocks

Photo 3: Black patches with bacterial colonies and, likely, bivalves (pink specks)

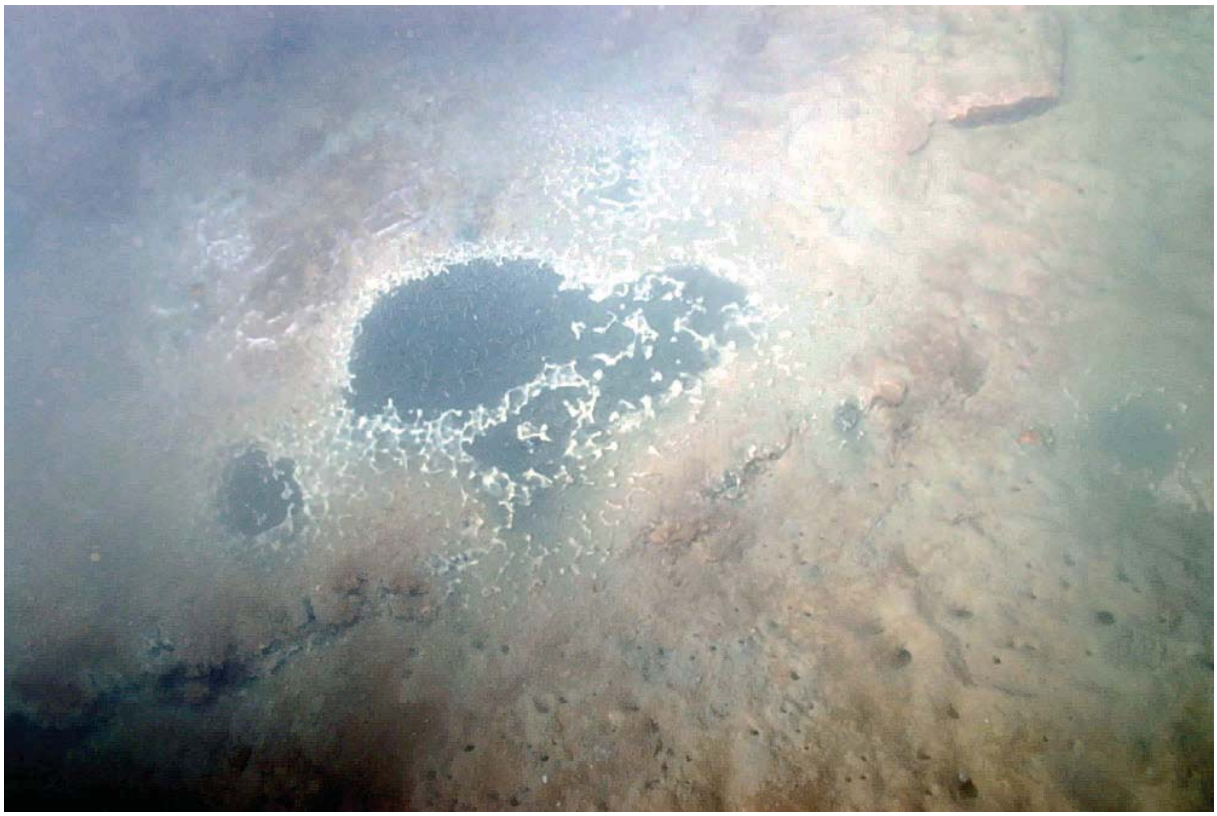
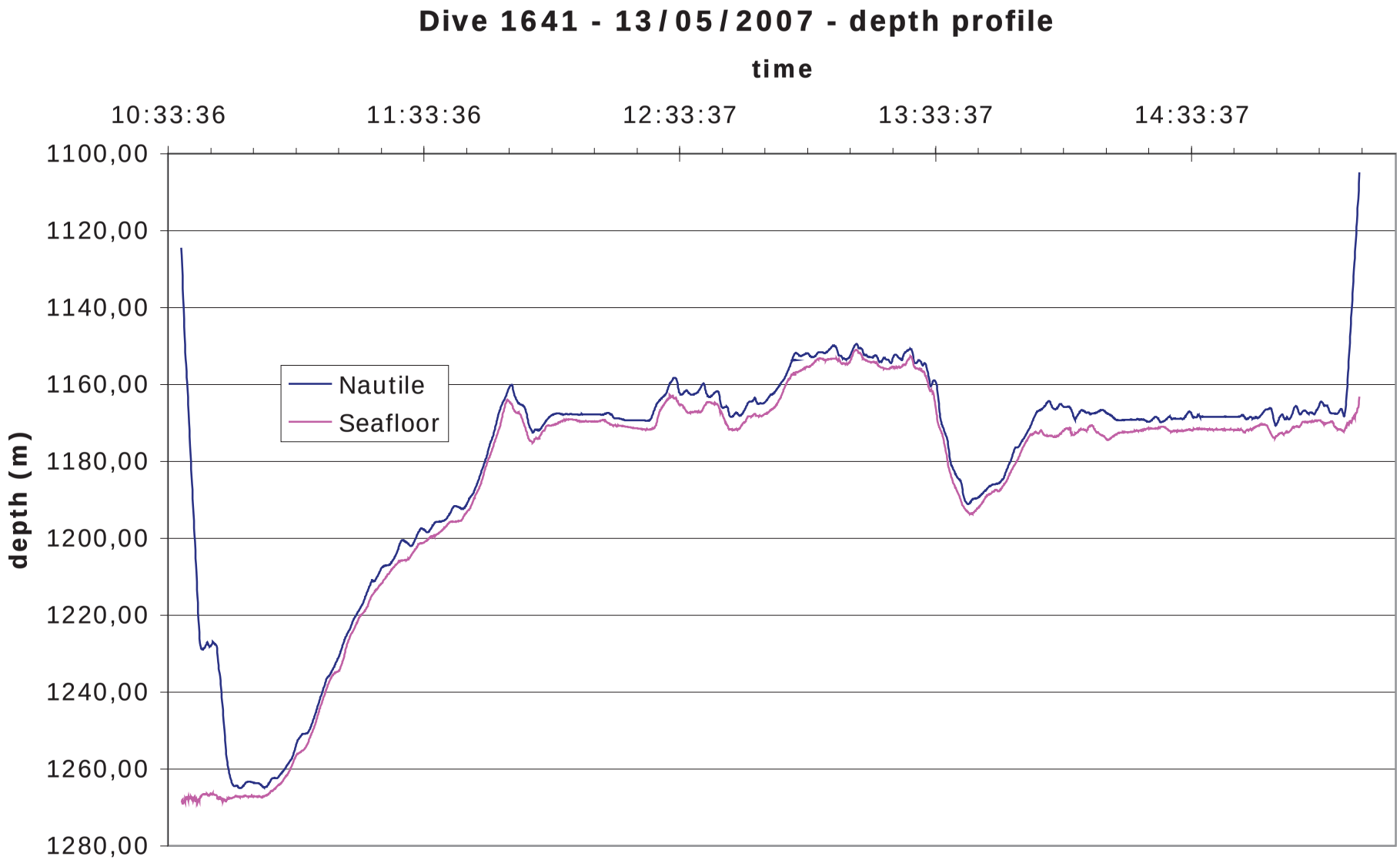
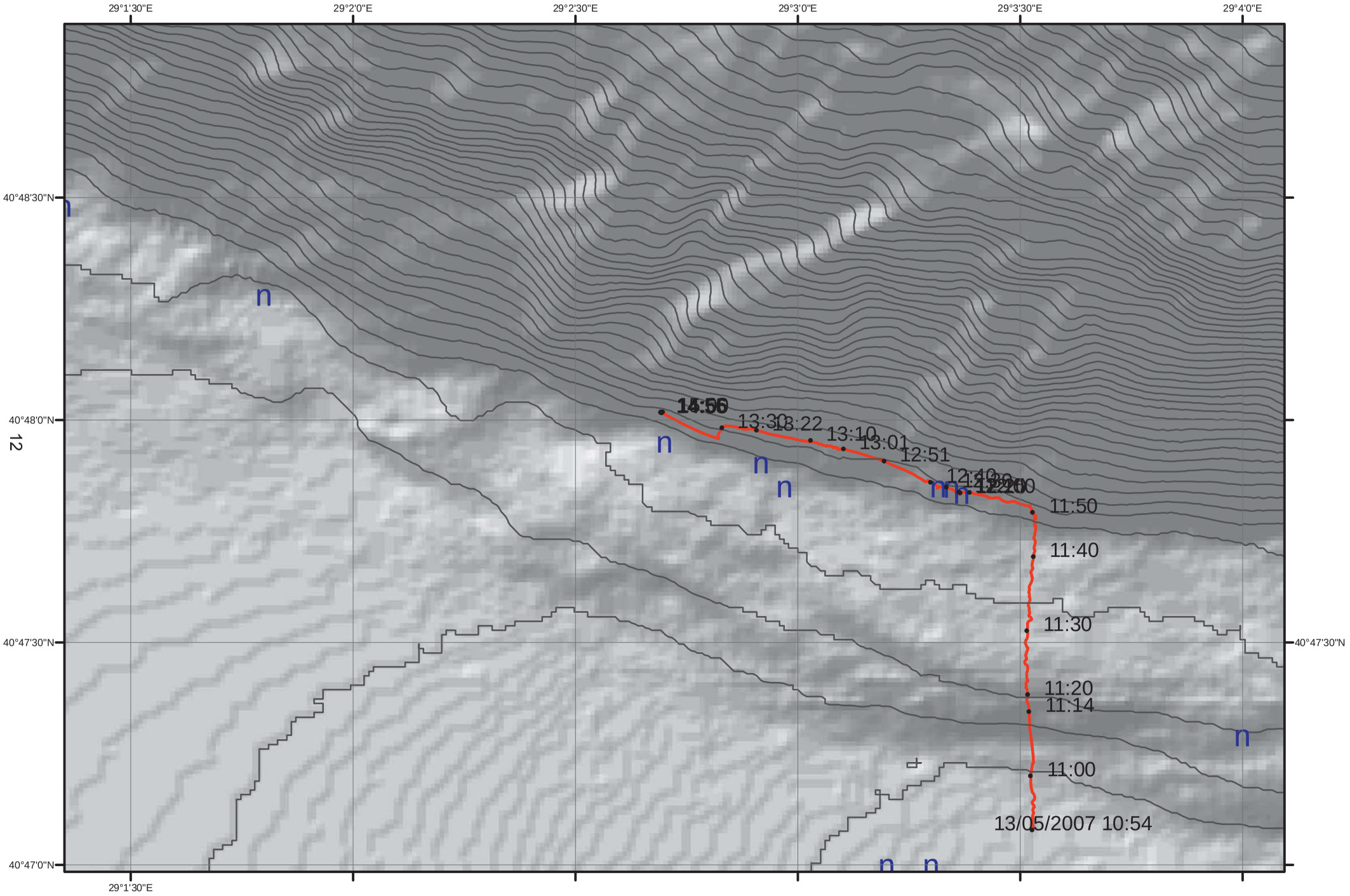


Photo 4: Small (50 cm diameter) black patches with bacterial colonies around the edges. Patch lies on carbonate cemented breccia (sample 1641 – R2).

**Sample photos:**



Dive 1641 - 13/05/2007 - depth profile
time
10:33:36
11:33:36
12:33:37
13:33:37
14:33:37
depth (m)
1100,00
1120,00
1140,00
1160,00
1180,00
1200,00
1220,00
1240,00
1260,00
1280,00
Nautile
Seafloor


29°1'30"E
29°2'0"E
29°2'30"E
29°3'0"E
29°3'30"E
29°4'0"E
40°48'30"N
40°48'0"N
40°47'30"N
40°47'0"N
12
13:30
13:22
13:10
13:01
12:51
11:50
11:40
11:30
11:20
11:14
11:00
13/05/2007 10:54

Département Systèmes sous-Marins
**Service Ingénierie d'Intervention et Développements Mécaniques**

Auteur(s) : Claude LEVEQUE

DOP/DCM/SM/2IDM/

Le 28/05/2007

MARNAUT

# Mise en place des OBS _ plongée Nautile 1642

**N° de rattachement B.E** :

**Diffusion** :

☐ Confidentielle

☐ Restreinte

☒ Libre

| | |
|---|---|
| Date : 28/05/2007<br>Référence : DOP/DCM/SM/2IDM/<br>N° BE :<br>N° Analytique : E020703A6 | Nombre pages : 9<br>Nombre figures :<br>Nombre d'annexes:<br>Nom du fichier :<br>MARNAUT_OpérationsOBS.doc<br>Rédacteur : |

**Sujet/Titre :**

MARNAUT

# Mise en place des OBS _ plongée Nautile 1642

**Résumé :**

**Mots-clés :**

Révisions

| *Indice* | *Objet* | *Date* | *Rédigé par* | *Vérifié par* | *Approuvé par* |
|---|---|---|---|---|---|
| | | | | | |

# S O M M A I R E

# 1. Introduction

L'objectif des essais à la campagne MARNAUT qui s'inscrivent dans le cadre du prolongement du projet SUBTECH est l'intercomparaison des performances de balises autonomes d'acquisition sismique, en termes d'enregistrement des ondes sismiques P et S en fonction de la configuration de son ensemble capteurs (tête sismique) et de l'installation de ce dernier dans le substrat sous-marin (couplage au sédiment).

Parallèlement le département Géosciences Marines de l'Ifremer participe à la campagne MARNAUT afin d'étudier les méthodes et moyens de détection des évènements sismiques dans un but de prévention des risques naturels. L'implantation de réseau de capteurs de surveillance, OBS en particulier, est parmi ses objectifs ;

Pour l'opération MARNAUT IFEMER et CGG ont convenu de mettre en œuvre comparativement lors de la campagne un certain nombre d'OBS apportés :

- par l'IFREMER : plusieurs OBS type LOTOBS et si possible un MicrObs
- par CGG : 1 OBS type ARMSS et 1 OBS type TRILOBIT
- par développement commun : 2 OBS prototypes, 1 type « pieu » et 1 type « bulbe » à implanter plus ou moins profondément dans le substrat.

L'OBS « pieu » est mis en place au câble par le navire et récupéré au moyen d'une ligne avec flottabilité accrochée au pieu au fond avec l'assistance du Nautile

Les OBS IFREMER sont mis en place et récupérés depuis le navire

Les 3 autres OBS sont déployés et récupérés au fond par le Nautile avec transfert surface fond et réciproquement par ascenseur

## 2. Détail des travaux réalisés

Nuit du 13/05 : mise en place des OBS par le Navire

Journée du 14/05 : plongée Nautile pour déployer les OBS CGG au fond

**Opérations de préparation**

Mobilisation des différents OBS

Activation des électroniques, initialisation et synchronisation des horloges (chaque OBS)

Le pieu sismique est placé sur le ber de carottage

Les OBS ARMSS, TRILOBIT et « bulbe » SPAN sont disposés dans l'ascenseur sur leurs supports spécifiques au moyen de la grue du bord.

Gréement de la ligne ascenseur

**Opérations avec le navire**

Mouillage du LOTOBS au point J

40°48,234 ; 27°37,741

Mise à l'eau de l'ascenseur référence point J1(50m ouest point de mouillage LOTOBS)

40°48,237 ; 27°37,689

Mise en place du pieu au point J2

40°48,184 ; 27°37,675

*La mise en œuvre pour le mouillage du pieu est calquée sur la mise en œuvre du carottage Kullenberg, avec pour seule différence que le pieu n'est pas lié au câble grand fond :*

- *Le pieu sismique est placé verticalement sur le ber de carottage avec la grue du bord ;*
- *la ligne de poids pilote est ajustée pour obtenir une chute libre de 3 mètres avant que la pointe du pieu ne touche le sol, afin d'obtenir une pénétration de l'ordre de 3.5 mètres ;*
- *puis la procédure est identique à la mise en œuvre du carottage Kullenberg.*

**Opérations au fond avec le Nautile _ plongée N° 1642**

- Rejoindre le pieux sismique
- Noter la position

- Rejoindre l'ascenseur et prendre le SPAN
- Le Nautile sort le SPAN de l'ascenseur et va déposer l'ensemble sur le sol en allongeant le bulbe en premier à 30 m environ du pieu sismique. Puis, le bras de Nautile saisi le bulbe et l'enfoui dans le sédiment au maximum jusqu'à la poignée de manutention. Noter la position et photos de l'ensemble installé

- Retour sur le pieu
- Evaluer la verticalité et l'enfoncement du pieu → photos sous 2 directions orthogonales
- Déclenchement manuel pour la séparation de la plaque inférieure « docking »

- Rejoindre l'ascenseur et prendre l'ARMSS.
- Le Nautile sort l'ARMSS de l'ascenseur et va déposer l'ensemble sur le sol en allongeant le bulbe en premier à 30 mètres du pieu sismique et à 10 mètres du SPAN
- Vérifier bon encastrement du sismo dans le sédiment ; Noter la position et photos de l'ensemble installé
- Retour sur le pieu
- Dégagement des sacs lests entravant le dégagement du pieu

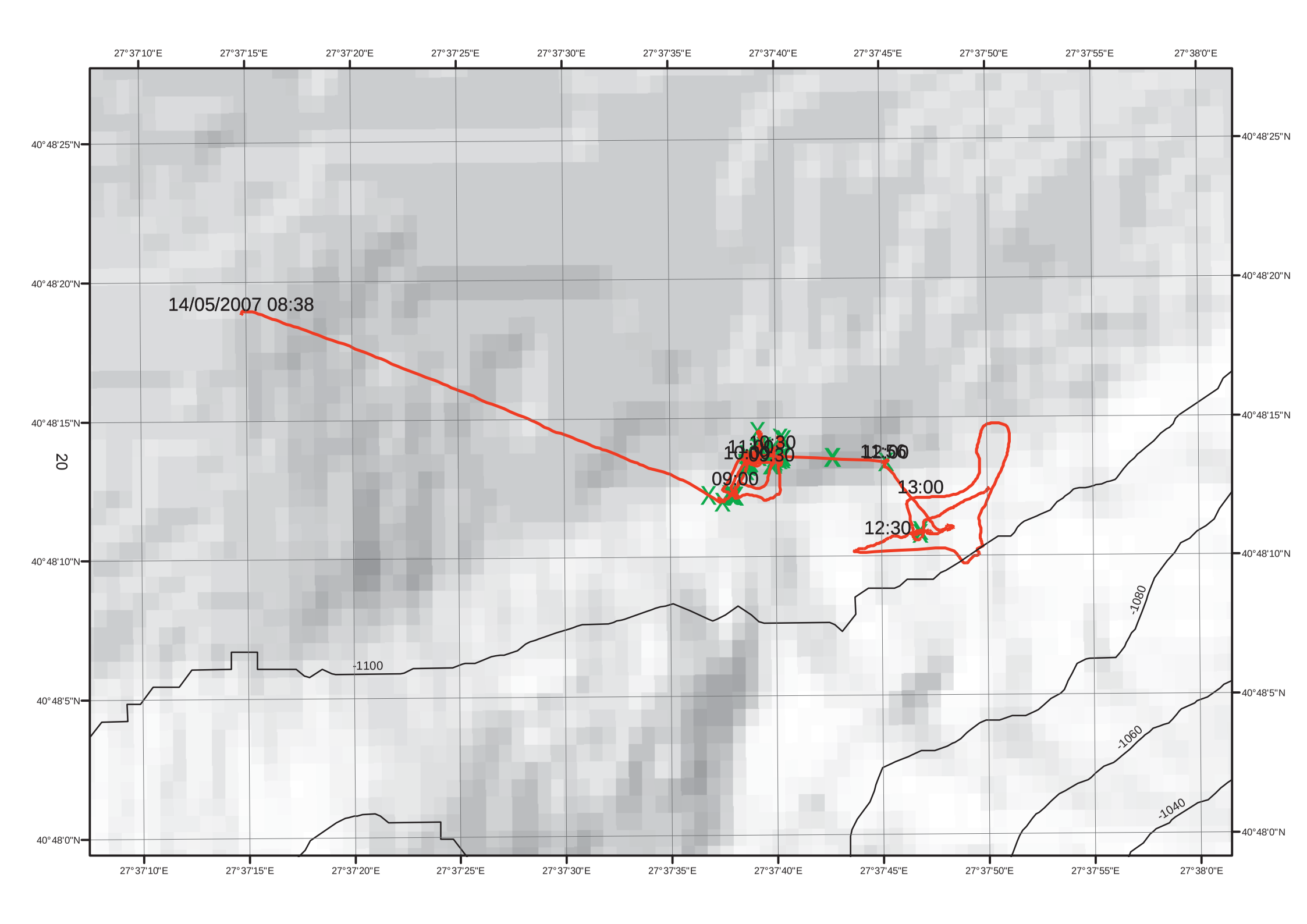
- Rejoindre l'ascenseur et prendre le TRILOBIT
- Le Nautile sort le TRILOBIT de l'ascenseur, fait un changement de main pour le maintenir horizontalement et va le déposer sur le sol à 30 mètres du pieu sismique et à 10 mètres de l'ARMSS. Noter la position et photos de l'ensemble installé.

- Rejoindre l'ascenseur et préparer pour larguer pour sa remontée

- Rechercher le LOTOBS de référence , noter sa position et photos de la gamelle Géophone

- Aller sur le site « JACK »

| Evenement | HEURE | Séquences Video de | à |
|---|---|---|---|
| | | | |
| Nautile plonge | 8:02 | | |
| Nautile au fond | 8:35 | | |
| Ralliement pieu 1 | 8:52 | 8:52 | |
| Ralliement ascenseur 1 | 9:01 | 9:01 | |
| Ouverture couvercle | 9:04 | 9:04 | |
| Saisie SPAN | 9:17 | 9:17 | 09:18 |
| Dépose SPAN | 9:21 | 9:21 | |
| Remise en place bulbe | 9:32 | 9:32 | 09:38 |
| Ralliement pieu 2 | 9:44 | 9:44 | |
| Déverrouilage embase | 9:54 | 9:54 | 09:55 |
| Séquence photo _ vidéo pieu | 9:57 | 9:57 | |
| Raliement ascenseur 2 | 10:00 | 10:00 | |
| Ouverture panier 1 | 10:04 | 10:04 | |
| Saisie ARMSS | 10:09 | 10:09 | |
| dépose ARMSS | 10:19 | 10:19 | 10:40 |
| Ralliement pieu 3 | 10:46 | 10:46 | |
| Dégagement sacs /embase | 10:53 | 10:53 | 10:57 |
| Ralliement ascenseur 3 | 11:00 | 11:00 | |
| saisie TRILOBIT | 11:03 | 11:03 | 11:05 |
| dépose TRILOBIT | 11:13 | 11:13 | |
| Ralliement ascenseur 4 | | | |
| Préparation largage ascenseur | 11:22 | 11:22 | |
| Largage Ascenseur | 11:30 | 11:30 | |
| passage sur TRILOBIT | 11:36 | 11:36 | |
| Passage sur ARMSS | 11:38 | 11:38 | |
| Passage sur SPAN | 11:47 | 11:47 | |
| Ralliement LOTOBS point J | 11:54 | 11:54 | 12:08 |
| Ralliement zone active "Jack" | 12:24 | 12:24 | |
| Route à l'ouest : accotement | 12:53 | 12:53 | |
| Retour sur "Jack" | 13:09 | 13:09 | |
| Largage pour remontée Nautile | 13:24 | 13:24 | |
| | | | |


27°37'10"E
27°37'15"E
27°37'20"E
27°37'25"E
27°37'30"E
27°37'35"E
27°37'40"E
27°37'45"E
27°37'50"E
27°37'55"E
27°38'0"E
40°48'25"N
40°48'20"N
40°48'15"N
40°48'10"N
40°48'5"N
40°48'0"N
14/05/2007 08:38
09:00
10:30
11:30
12:30
13:00
-1100
-1080
-1060
-1040
20

**Campagne**
**Chef de mission : Pierre Henry / Celal Şengör**
**Travaux réalisés par le Nautile**

| | |
|---|---|
| **N° absolu de plongée** : 1643 | **Date** : 15/05/2007 |
| **Observateur**<br>- Nom : Christophe GERIGK<br>- Spécialité : Photographer<br>- Organisme : Géo | **Pilote** : Jean-Paul JUSTINIANO<br><br>**Navigateur engin** : Franck ROSAZZA |

**Objectif(s) de la plongée** :
Photo mosaic of brackish water seeps observed during MARMARASCARPS cruise

**Coordonnées du point d'arrivée sur le fond**
- Longitude : 40,7846 - Latitude : 29,0588

**Profondeurs explorées pendant la plongée**
- Minimum : 1104 m - Maximum : 1117 m

**Durée totale de la plongée** : 7:33 **Durée sur le fond** : 5:59

**Equipements scientifiques**

- installés sur le submersible : additional lights on Nautile manipulators.

- transportés dans la navette :

- mouillés en autonome :

**Travaux réalisés sur le fond**

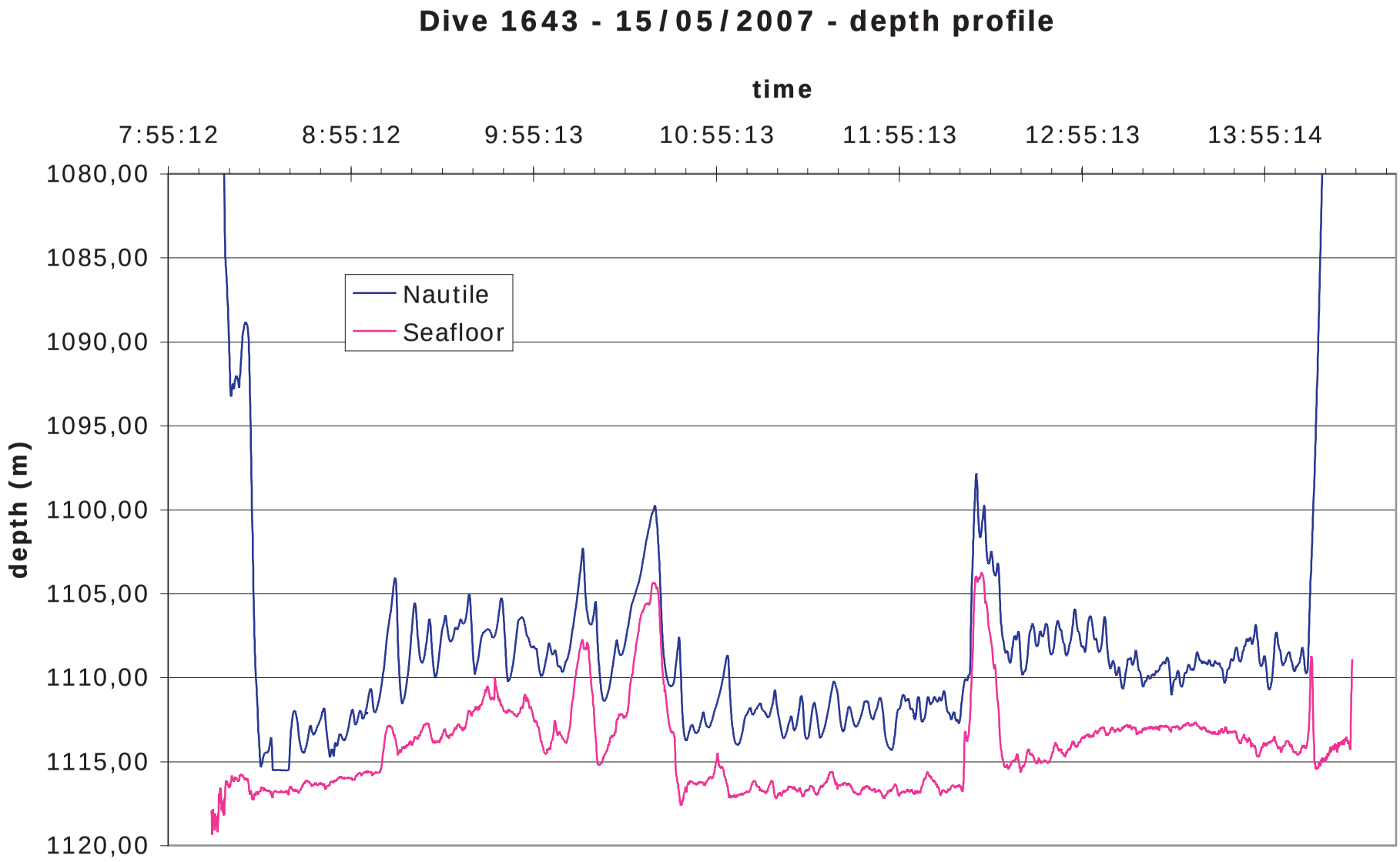
- Distance parcourue : 2500 m

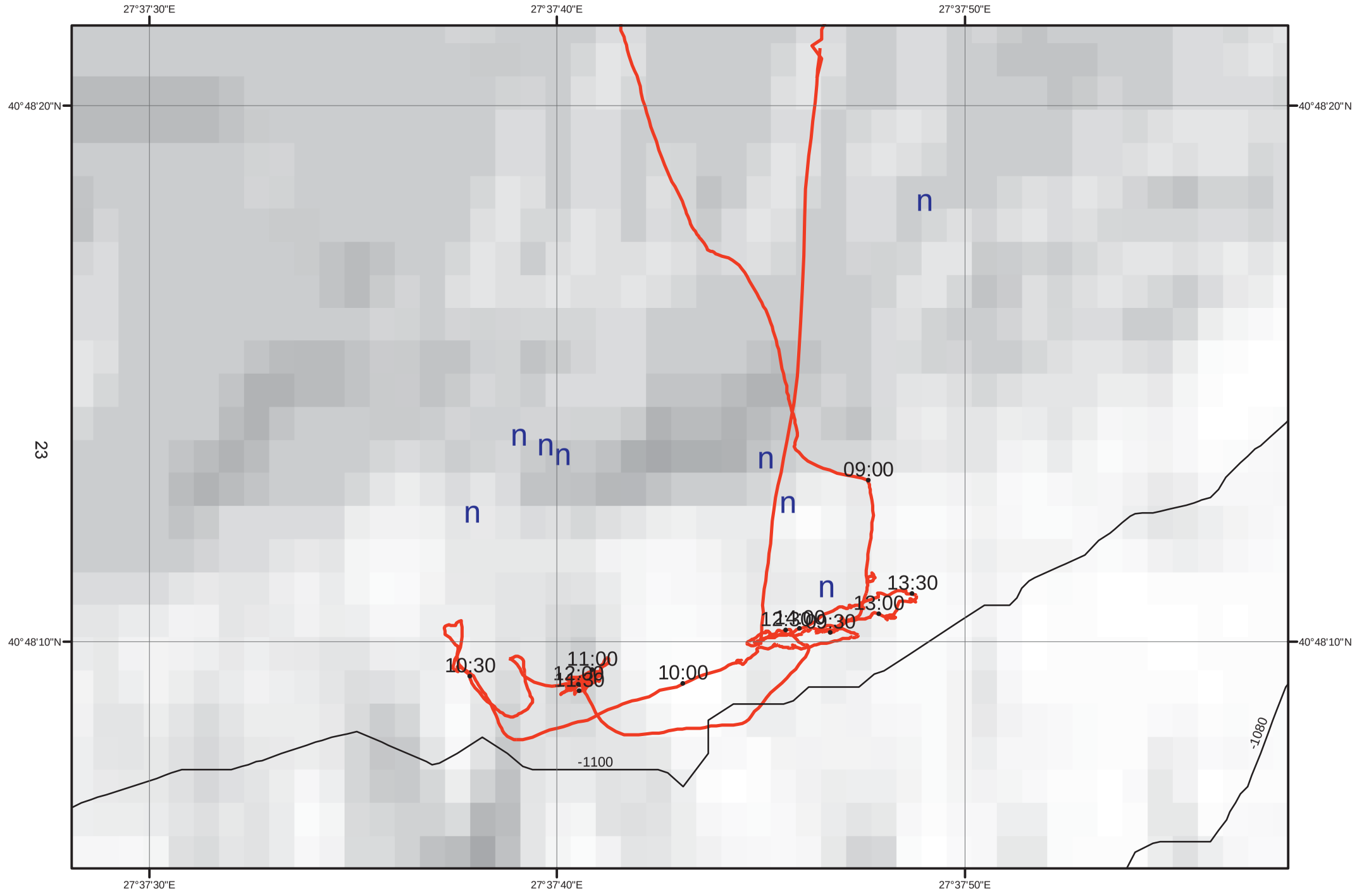
-Travaux réalisés : Photography

- Echantillons :

- Nombre de bandes vidéo : 6

- Nombre de photos :


Dive 1643 - 15/05/2007 - depth profile
time
7:55:12
8:55:12
9:55:13
10:55:13
11:55:13
12:55:13
13:55:14
depth (m)
1080,00
1085,00
1090,00
1095,00
1100,00
1105,00
1110,00
1115,00
1120,00
Nautile
Seafloor


27°37'30"E
27°37'40"E
27°37'50"E
40°48'20"N
40°48'10"N
23
n
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13:30
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10:30
11:00
10:00
-1100
-1080

# MARNAUT 2007
# Dive report

## LEG2
**16/05/2007-27/05/2007**

### *Dive 1644 – 16/05/2007*

Pilot: Xavier Placaud

Co-pilot: Patrick Cheilan

Observer: Boris Natalin

## *Objectives*

1) Reconnaissance of the foot and the lower part of the western slope of the Tekirdag Basin, Marmara Sea, by making two N-S-trending sections (see proposals for the dive and figure included in them)

2) Investigation of the scarp made by the SFT-1 Fault on the flat surface of the Tekirdag basin

3) Investigation of morphological features of the region located between the scarp and the foot of the western slope to the north of the SFT-1 Fault

4) Studies of the foot and lower part of the western slope to the north of the SFT-1 Fault aimed at establishing of structural elements that may control the regular northwestern trends of channels cutting the slope

5) Investigation of morphological features of a transitional zone between the flat surface of the Tekirdag Basin and the foot of the western slope to the south-west of the SF-1 Fault

6) Studies of the lower part of the slope that is characterized by a smooth and even inclined surface remarkably different from neighboring regions of the western slope

7) Investigation of composition and structures of bedrocks constituting the lower part of the slope but locating at higher elevations than the region mentioned in the previous clause.

## *Dive zone and motivations*

The nature of the western slope of the Tekirdag basin is enigmatic. Its simplistic explanation as a normal fault controlled margin contradicts to some recent studies that interpret the structure of the slope as a result of compression. According to the second interpretation (Okay et al. 2004, Seeber et al., 2004), the compressional tectonic is caused by a change of the strike of a principal plate boundary along which the Anatolian blocks moves to the west and southwest. Namely, east-west strike of the North-Anatolian fault to the east of the dive zone changes to the northeastern strike of the Ganos Fault to the west of the dive zone. The compressional setting leads to crustal shortening to the north of the plate boundary and therefore the rise of the Ganos Mountains. In fact, the underwater continuation of these mountains makes the western slope of the Tekirdag Basin. The suggested model implies that the passage the northern block through the deflection

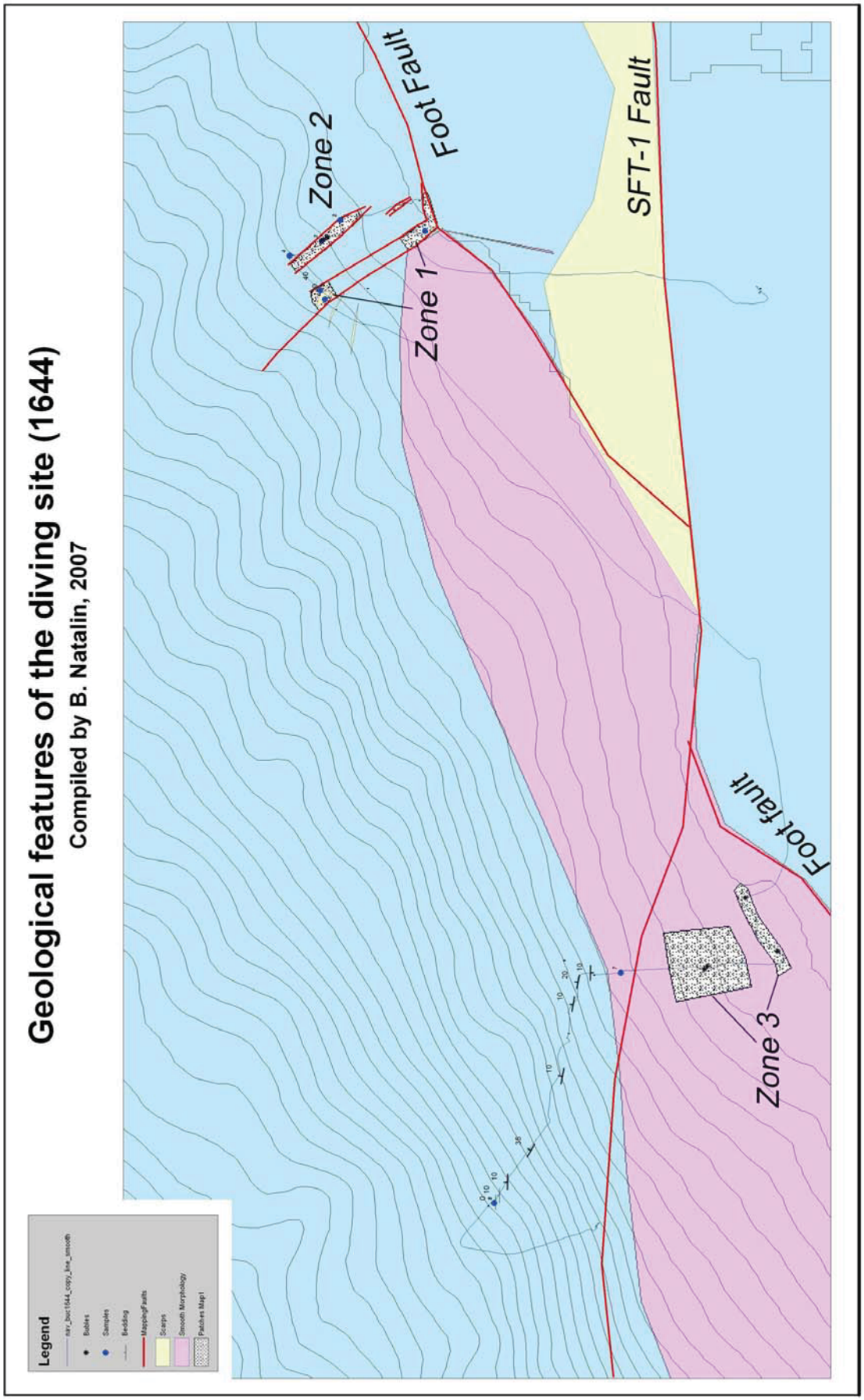



Figure. Geological features of the diving site

point should cause the change of the tectonic regime from compression to extension. The high standing Ganos Mountain and low standing floor of the Tekirdag Basin is a consequence of such a passage and tectonic regime. Thus, the structure of rocks constituting the western slope should reveal the transition from still active compression to more active extension.

According the previous studies the main northeast-striking fault at the foot of the western slope, the Foot Fault, is interacting with two east-west striking faults. Both of them are detected by CHIRP profiling. The southern of these faults, the SFT-1 Fault, is located in the dive zone. It forms the scarp and cuts seismic reflectors detected by 3.5 Khz echosounding. The SFT-1 fault dies out about 4 km to the east of the dive zone. The detailed bathymetry suggests that SFT-1 fault dextrally displaces the Foot Fault for 0.4 km.

All faults in the diving area are though to be active and thus controlling the emanation of fluids and gases as well as biological activity relevant to these emanations.

The western slope is cut by numerous subparrallel NW-trending channels. Their regular pattern implies some kind of structural control. However, land studies of the Ganos Mountains provide no information from which such a control can be inferred.

Finally, the lowest part of the western slope to the south f the SFT-1 Fault has a unique morphology that s difficult to interpret. There, the slope has a smooth and even surface having a rather sharp transition into a system of northwest trending channels up the slope. The transition may be interpreted as the westward continuation of the SFT-1 Fault. Why cannels do not cut the smooth slope? The answer to this question was a part of the dive plan.

## *Dive summary*

The dive can be considered as a detailed study of two N-S sections that start at the flat floor of the Tekirdag Basin and finish on the slope (Figure). The intermediate area between two sections was difficult for observation because the submersible moved down a steep slope.

### The scarp of the SFT-1 Fault

Observations started at 08:09 on the flat floor of the Tekirdag Basin. The floor is covered by bioturbated sediments doted by shrimps? cones made of white sandy material and surrounded by brownish material of perhaps the same composition. This irregular but even distribution of the cone can be used as reference frame for detecting of any possible processes modifying the very surface of the sea floor. At the beginning of the dive and later on I did not note any evidence of erosion by currents.

The scarp foot was reached at 08:16 (Figure). It was well detected by visual observations. The scarp surface has a steep (~50°) slope in its lower part with gradual transition to horizontal position in the upper part. The detection of the scarp top could not be done without continuous instrumental control of the water depth. The scarp surface has appearance that is identical to the surface of the flat sea floor except conversion of circular shapes of shrimp cones into elliptical or strongly elliptical ones. These shape changes suggest a creep type motion of uppermost sediments down the slope. Large scale slumping or exposure of bedrocks have not been observed. The height of the scarp is 20 m.

Morphology of the sea floor and 3.5 kHz echosounding profiling are the only criteria suggesting activity of the SFT-1 Fault.

## The Foot Fault in the eastern section

The location of the Foot Fault at the beginning of the eastern section was inferred from the analysis of the bathymetric map. I expected to cross this fault at 08:33. Observations from Nautile could not help in the detection of the fault position. A gentle increase and following decrease of the sea floor elevation for 2 m within an 80 m wide zone is the only evidence for activity in the zone of the inferred fault.

Later at 09:12, we did crossed the boundary between a relatively flat sea floor and the steep slope. In front of this slope we observed abundant black patches stretching in the east-west direction (Figure). A number of reasons suggest the existence of an active fault with thrust component of motion in this place. Justifications of these reasons will be provided in the next section.

## Western slope of the Tekirdag basin along the eastern section

### *First zone of black patches*

After crossing the zone of the inferred fault at the foot of the slope I changed the direction of the transect to northeastern one. At 08:49 we entered a zone covered by abundant black patches. This zone is 300 m long and 30 m wide (Zone 1 in Figure). It strikes in the northwestern direction – 320-330°.

Sizes of the patches vary from 0.2 to 2 m. Some patches reveal a distinct elongation other have equidemensional shape. Elongated patches can be traced for 5 and more meters. Northwestern strikes dominate estimated orientations of the elongations.

Small (20-40 cm) patches have distinct dark color. Larger patches are powdered by white shells of bivalves. White strips of bivalve shells may rest directly on the normal bioturbated

sediments being completely separated from black patches (e.g. IMGP0021.jpg). In places, patches have a perfect circular shape. In theses cases, a dark relatively narrow (5-20 cm) rim of sediments modified by sulfate reducing bacteria surround pile of white bivalve shell occupying the central part of circles.

Besides, the black patches the sea floor is sported by tabular blocks (20-50 cm across) of sedimentary rocks. Our attempts to take a sample of these rocks failed. Pushing the mechanical arm of Nautile into sediments has shown that the arm does not go deeper than 10-20 cm. It means that blocks represent exposures of bedrocks. All of these suggest that recent sediments form a thin veneer above the bedrocks, which perhaps belong to the Kesan Formation constituting the Ganos Mountains.

If this inference is correct, the northwestern elongations of black sports reflect orientations of fractures in the bedrocks that were used as conduits for methane escape. Having this hypothesis in mind we continued our transect in the northeastern direction and at 08:48 arrived to the northeastern boundary of the zone with abundant black patches. The strike of this boundary is 320°. The width of the zone along the transect is 25 m (Figure).

At this point we turned to the southeast trying to determine how the strike of the northeastern boundary is consistent. The 320° strike was consistent for 35m and then changed to 330° (Figure). This strike was traced for additional 30 m and then it drastically changed to the east-west direction (Figure). Following black patches in this direction we observed the frequent occurrence of tabular bocks of bedrocks popping up among recent sediments dotted with black patches. Shapes of black patches along the east-western trending segment of the Zone 1 are remarkably different. All of them have equidemensional shapes and small sizes. Being within the zone of black patches at 09:12 we arrived at a foot of a steep slope where the Foot Fault controlling the western slope of the Tekirdag Basin should be. Thus, it became clear that the east-west trending segment of the Zone 1 can be related to this fault. The black patches indicate its present day activity.

Note that the change of the strike of the Zone 1 is correlative with the change of shapes of black patches. Elongated black patches are characteristic for the long northwestern segment of the zone while equidemensional black patches are characteristic for the segment striking in the east-west direction. Obviously, these two directions should have different stress state within the complicated stress field of the North Anatolian Fault.

Two segments of the first zone with different strikes developed within a thin cover of recent sediments resting on the lithified bedrocks of the Eocene Kesan Formation. Thus besides the modern stress state, the geometry of black patches is mostly controlled by the structural skeleton

of the bedrocks. This inference was confirmed by observations made in the northern part of the Zone 1 where turbidites of the Kesan Formation are exposed. There, medium- to thin-bedded turbidites gently dip to the northeast –dip direction is 30° and dip angle is 20° (30°/20° in following text). Bedding is coherent and parallel showing a very low strain of rocks. Two systems of fractures dominate the outcrop: 330°/70-80° and 60°/80-90°. Both of them have approximately the same spacing varying from 2-7 cm to 20-40 cm. Further studies of these systems during the dive have shown that the second system striking to the northwest (60°/80-90°) could be a weak cleavage. In places, surfaces of this fracture/cleavage are coated with white bacterial films (e.g. IMGP0041.jpg, IMGP0049.jpg) while same films were never observed along fractures striking to the northeast. Observations at a foot of a rocky cliff crossed at 10:45 have clear show that black patches are controlled by the northwest striking fractures/cleavage. This system (weaken zones) was reactivated by the North Anatolian fault. Opening of the fractures of this direction for methane escape and creation of tensile crack emanating gases (see the following section) suggest the minimal principal stress is subhorizontal and oriented in the northeast direction.

### *The second zone of black patches and venting sites*

The second zone of black patches strike in NW direction parallel with the first zone (Zone 2 in Figure). These two zones are separated by a uniform 45-65 m wide strip of normal bioturbated sediments. In the south, a narrow (5 m) strip of black patches was found between them however equidemensional shapes of patches did not allowed to make a judgment about the strike of this zone.

The second zone is 200 m long and 25-30 m wide. Similar to the first zone bedrocks are very close to the surface and tabular “blocks” of the Kesan turbidites in fact represent uncovered parts of outcrops. We managed to sample the rocks.

Many black patches have clear elongation varying between 330-350°.

Three localities of gas emanation have been discovered in the northern part of the zone. All of them are close to each other and connected by narrow continuous strips of black patches. Gas emanation occurs from elongated narrow (7-15 cm wide) opened holes in bedrocks. Walls of these holes are coated by thin films of white bacteria (e.g. see IMGP0028.jpg, IMGP0030.jpg, and IMGP0032.jpg). Detailed studies of these venting sites have been done by Pete Burnan during the separate dive on

Walls of openings are uneven that is typical to tensile cracks. Their strikes are parallel with the general strikes of the first and the second zones of black patches.

## Zone of black patches at the foot of the western slope

This zone is located at the beginning of the second transect (11:33) and stretches parallel with the strike of the foot of the western slope and consequently with the strike of the Foot Fault (southern part of the zone 3 in Figure). The assumption about the strike of the zone derived from tracing for more than 150m of a narrow (35-40 m) zone of black patches located at the very foot of the slope. Black patches located up the slope we observed only along the transect therefore their strike remain unknown (upper part of zone 3 in Figure).

All black patches exposed at the foot are relatively small and have equidemensional shape. “Blocks” of bedrocks are present among black patches. A check of their in situ position has not been done. Emanations of gas were encountered in two localities: 11:36 and 11:55

The second region of black patches located on the steep slope. Its length along the transect is 150 m. Black patches are relatively small and of equidemensional shape. One locality of gas emanations were observed at 12:10 (see the upper part of zone 3 in Figure).

Morphologies of black patches suggest that fractures striking 330-340° do not control their formation at the foot of the western slope at the beginning of the second transect. Random distribution of equidemensional patches implies squeezing of the material in the thrust zone and consequent escape of fluids and gases long tube-like conduits.

## Segment of the west slope with the smooth surface

The origin of the smooth morphology of the western slope remains as unresolved problem. Its region is bounded in the north by ST-1 Fault. The northwestern boundary is determined by steep cliffs consisting of Kesan turbidites. These cliffs are cut by numerous U-shape channels separated by ridges with relatively sharp crests. During the dive I did not observed blocks of bedrocks that could slide from neighboring cliffs onto the smooth but steeply inclined surface at the base of the slope. Along the transect, these blocks appear very close (10 m) to the cliffs. Besides zones with black patches, the smooth surface is represented by normal bioturbated sediments. A couple of tries by mechanical arm of Nautile has shown that this sediments are underlain by greenish-gray very sticky clay. A sample of this clay is available.

To my opinion it is difficult to explain how this clay could be accumulated at the foot of the steep and high (>1000m) cliffs of Ganos Mountains. Tectonic elimination of a zone of scree deposits seems to be the most reliable solution of the problem.

## Exposures of the Kesan Formation

The continuous exposures of the Kesan turbidites started at 12:24. We observed these rocks in almost vertical cliffs till the end of the dive. Existing tectonic models (Okay et al., 2004)

suggest that submarine continuation of Ganos Mountains represents a steep dipping (50°) monocline. Observation made at the northern part of the transect are in odds with this model. According to continuous observation for 500 m, bedding has gentle (11-20°) dip angle to the north and northeast. Similar dip angles and dip direction we observed in the north of the eastern section.

Turbidites are medium-bedded. Bedding planes are parallel. This suggest a very low strain of rocks.

Bedding is cut by two systems of fractures striking ~330° and 40-50°. Surfaces of these fractures are even suggesting their origin because of shearing. In places, the first system resembles a weak cleavage.

Locally, surfaces of shear fractures striking to the northwest are covered by films of white bacteria (e.g. IMGP0181.jpg, IMGP0192.jpg, or IMGP0194.jpg) indicating on their later opening due to initiation of the North Anatolian fault. To the contrary, fractures striking to the northeast are never coated by bacteria. For some unclear reasons sponges and solitary corals prefer to dwell on surfaces of northeastern direction (see file IMGP0167.jpg, IMGP0177.jpg, or CapPh_008a.jpg).

## *Recommendation for the following studies*

1) Emanation of gases and fluids(?) in the zone 2 occurs from bedrocks and therefore their chemical composition may be different from the venting sites in other places of the Marmara Sea.

2) A similar studies should be made for venting sites located in the zone 3 that is controlled by the Foot Fault.

3) The origin of clay material underlying the smooth surface can be resolved by coring. Establishing of well preserved sedimentary structure of disrupted structure of this rock in cores will guide us to find the explanation to enigmatic features observed during the dive.

## *Conclusions*

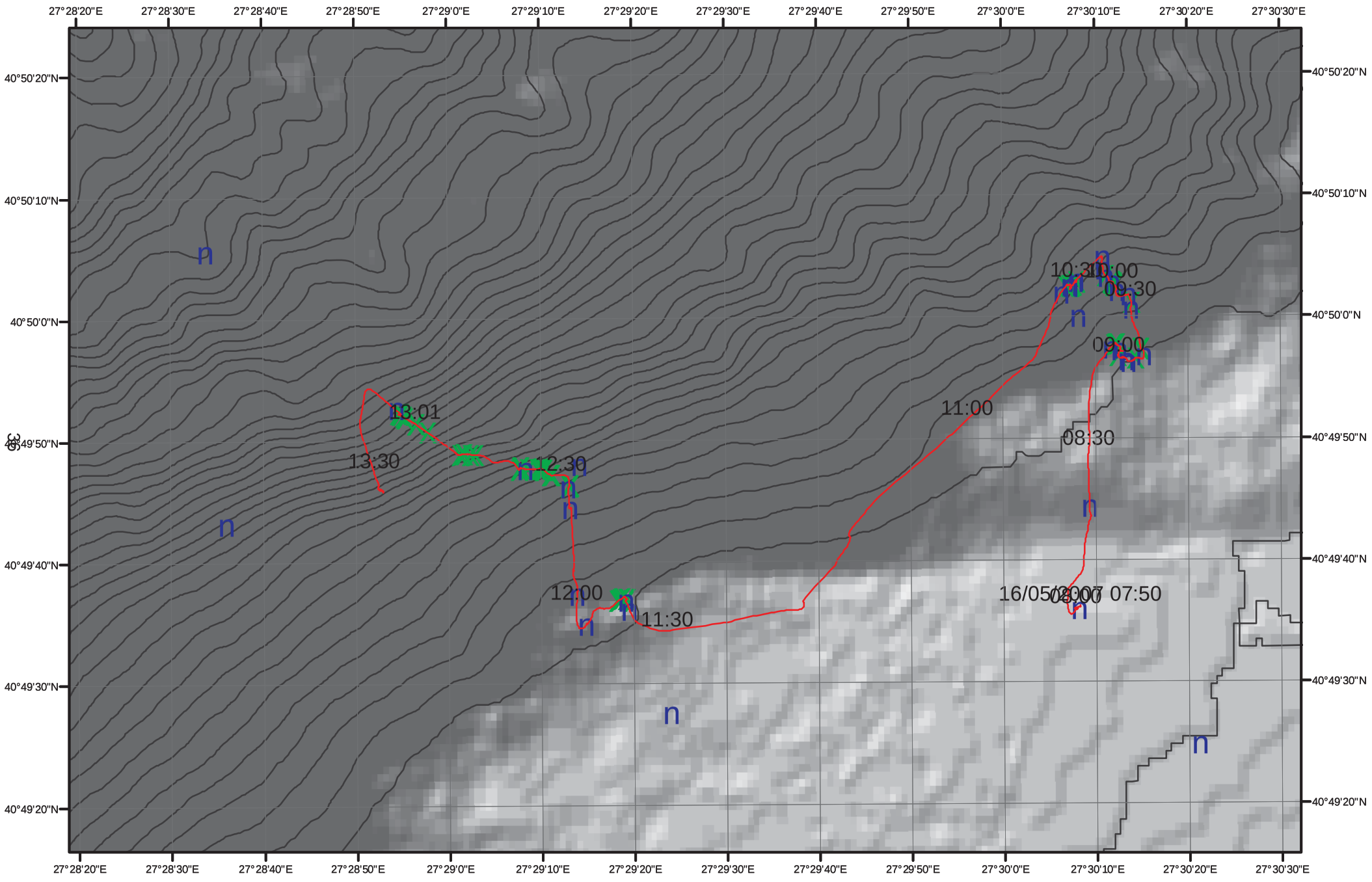
1) Zones of black patches and gas venting sites have clear manifested structural control.

2) The zone 1 and zone 2 of black patches are controlled by shear fracture (weak cleavage) striking 330°. Being closed shear surfaces during their formation these fractures was opened during initiation of the North Anatolian fault.

3) Fractures striking 330° controlled the position of channels cutting the western slope of the Tekirdag Basin.

4) The Foot Fault controls the orientation clusters of black patches in the southern segment of zone 1 and southern part of the zone 3. I infer that the northern part of the zone 3 is also related to the activity of the Foot Fault.

5) Geometric shape of individual black patches depends on the structural setting and consequently on the state of stress. Black patches in zones of extension or transtension often have elongated shapes. Black patches in zones of compression are equidemensional. My inference is based on local observation of the dive 1644. I think that think that all observation of black patches made during other dives should be checked from the point of view of this hypothesis.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Nautile Dive 1645 – 17 May, 2007

Pilots:
- Rosazza
- Fauvin

Scientist:
- Tryon

Location:
- Tekirdag site near Jack the Smoker

Objectives:
- Deploy 2 flow meters
- Collect fluid samples
- Collect push cores
- Collect microcat data

Equipment:
- 2 flow meters (deployed by wire on prior night)
- 4 titanium syringe fluid samplers
- 4 push cores
- microcat CTD

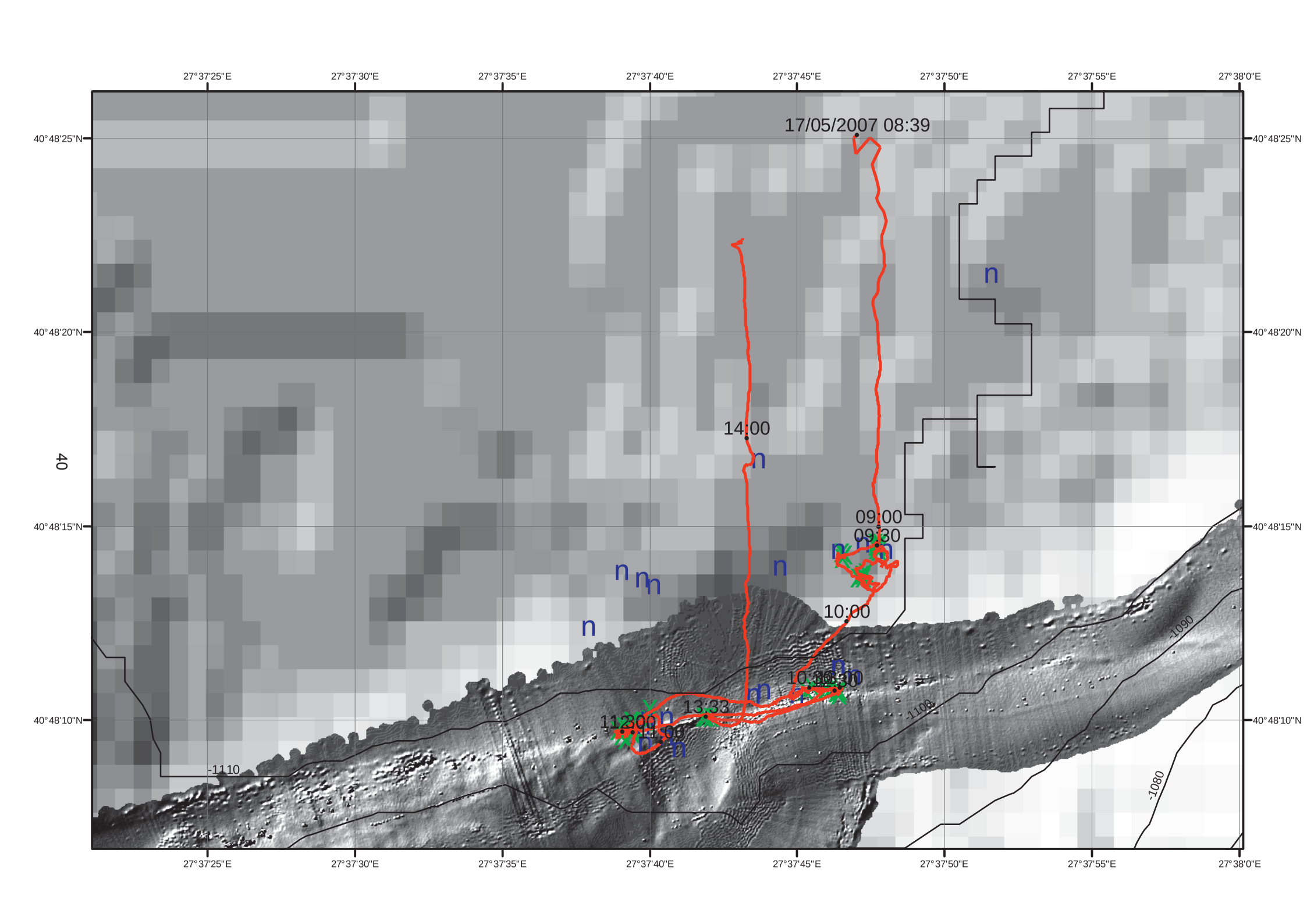
Dive narrative:

The 2 flow meters were rapidly found at the drop location. Meter N, which has a pressure sensor added, was deployed at the drop location which is near the central OBS and the Jack-the-Smoker site. We took a push core in this location. Meter K was carried to the escarpment for deployment. After searching likely candidates for deployment, and finding none that were optimal, the meter was deployed at the base of the scarp on a patch of sulfidic sediment. At this location a push core was taken and a water sample. The later was taken in the water column, not at the sediment. We traversed the scarp to the Jack site. On the way we passed over a line of sulfide patches coincident with the scarp but in an area where there was no scarp. White bacterial mat was seen on one small area with this. At Jack we acquired two water samples, one about 5 cm above the vent and the second at the top of the vent. A third sample was taken at a smaller vent visibly emitting shimmering fluids. We attempted to take a microcat reading at Jack but the handle failed and the task was aborted. We traversed back to the site where the microbial mat was seen and took a final push core. At that point we were out of time and returned to the surface.

My impression is that, in spite of the high activity of Jack, this is not a very active site currently and the activity that exists is no conducive to the sampling techniques we are employing. There are a large number of black patches of sediment but they rarely indicate current activity as evidenced by their lack of visible live biology. The white spots seen on video and photos that were thought to possibly be bacteria were actually small white shells. These sites are most likely inactive or dead seep sites where the sulfidic sediment persists but the chemosynthetic communities have died or moved on. The indicators of current fluid flow activity appear to be restricted to the escarpment itself, typically exiting the face of the scarp or at the scarp-slope intersection. There appears to be a carbonate cap on the exposed scarp face with seepage primarily coming from the base of this cape. The fluid flow paths are likely along horizontal permeable pathways in the lithified sediment of the slope and vertically along fault controlled pathways. The latter may be diverted laterally along the base of the carbonate cap to exit at the scarp or their intersection with the fault. The one site of bacterial mat on sediment appeared to also be controlled by the fault scarp, only in this case the scarp was buried by soft sediment that has flowed downslope over it and through which the fluid was seeping. The top of

the scarp may be very close in this spot because we encountered hard rock on the first attempt to core there. There also appeared to be a subtle trough across the slope coincident with the black patches and bacteria patch. This could be potentially due to winnowing of the sediment by flow or, more likely by vertical activity of the fault since the time of the burial of the scarp.

| date | time | description | designation | lat deg | lat min | lon deg | lon min | depth | comment |
|---|---|---|---|---|---|---|---|---|---|
| 17/05/2007 | 8:41 | on bottom | | 40 | 48.418 | 27 | 37.800 | 1112 | |
| 17/05/2007 | 9:02 | K found | | 40 | 48.244 | 27 | 37.820 | 1109 | |
| 17/05/2007 | 9:15 | N found | | 40 | 48.244 | 27 | 37.808 | 1110 | |
| 17/05/2007 | 9:30 | N deployed | FM-N | 40 | 48.253 | 27 | 37.816 | 1110 | background site, pressure measurement |
| 17/05/2007 | 9:40 | push core 1 | PC-1645-1 | 40 | 48.247 | 27 | 37.799 | 1114 | background |
| 17/05/2007 | 9:55 | K picked up to move | | 40 | 48.238 | 27 | 37.816 | 1110 | |
| 17/05/2007 | 10:14 | begin exploring scarp | | 40 | 48.184 | 27 | 37.777 | 1109 | |
| 17/05/2007 | 11:20 | flow meter location found | | 40 | 48.162 | 27 | 37.689 | 1111 | |
| 17/05/2007 | 11:35 | K deployed | FM-K | 40 | 48.164 | 27 | 37.690 | 1113 | sulfidic sediment patch at base of scarp |
| 17/05/2007 | 11:49 | push core 2 | PC-1645-2 | 40 | 48.172 | 27 | 37.690 | 1114 | sulfidic sediment  patch |
| 17/05/2007 | 12:10 | water sample 1 | FS-1645-1 | 40 | 48.176 | 27 | 37.690 | 1113 | background near scarp |
| 17/05/2007 | 12:16:21 | begin sulfide patches on slope | | 40 | 48.186 | 27 | 37.749 | 1111 | |
| 17/05/2007 | 12:17:40 | microbial mat | | 40 | 48.187 | 27 | 37.756 | 1111 | |
| 17/05/2007 | 12:20:42 | end sulfide patches on slope | | 40 | 48.190 | 27 | 37.771 | 1111 | |
| 17/05/2007 | 12:27 | arrive at Jack the Smoker | | 40 | 48.197 | 27 | 37.799 | 1111 | |
| 17/05/2007 | 12:29 | water sample 2 | FS-1645-2 | 40 | 48.197 | 27 | 37.800 | 1111 | Jack the Smoker - 5 cm from orifice |
| 17/05/2007 | 12:32 | water sample 4 | FS-1645-4 | 40 | 48.197 | 27 | 37.799 | 1111 | Jack the Smoker - at orifice |
| 17/05/2007 | 12:39 | water sample 3 | FS-1645-3 | 40 | 48.197 | 27 | 37.799 | 1111 | Jack petit |
| 17/05/2007 | 12:53 | microcat attempt - failed | | 40 | 48.197 | 27 | 37.799 | 1111 | |
| 17/05/2007 | 13:30 | push core 4 | PC-1645-4 | 40 | 48.184 | 27 | 37.749 | 1113 | sulfidic sediment with white bacteria |
| 17/05/2007 | 13:37 | end dive | | 40 | 48.184 | 27 | 37.749 | 1113 | |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# Dive 1646

# South-eastern Tekirdağ Basin

**Date** : 18/05/2006, from 07:04 (on sea) to 13:36 (on board)

**Immersion point** : N40°42.977 – E027°23.405

**Scientist** : Mercier de Lépinay, Bernard

**Pilots :** Patrick Cheilan, Séverine Béraud

**Localisation** : South-eastern termination of Tekirdağ Basin, at the eastern mouth of Dardanelles canyon, offshore termination of Ganos Fault.

**Dive objectives :**

Geometry of the offshore prolongation of Ganos Fault

Sign of activity along the main fault and/or secondary structures, characterisation of the south Tekirdağ basin submarine landslide and its northern boundary with the basin itself.

**Dive summary :**

The results of this dive have been somewhat disappointing : we were not able to reach our objectives. The main cause was the mechanical problem (gear blocked on the starboard side) that occurred in the first moments of the dive. We decided to continue with reduced capacities, trying to save the dive, but the time was short to reach the interesting area of the possible offshore termination of Ganos Fault.

Before the incident, we observed and sampled the Tekirdağ cliff (European side), yet studied and sampled during previous dives]. At the toe of the cliff, we observed a flat area with a large elongated area of reduced black sedimented, with numerous shells of dead Lamellibranches and sea urchins. According to the previous dives, such black patches corresponds to actives fault (probably secondary strike-slips faults)

At the base of the landslide (southern boundary of Tekirdağ basin) (with reduced capacities of observation) we couldn’t find any indication of tectonic activity : the topographic scarp is

completely covered by smooth unconsolidated recent sediment, at less where we cross the assumed fault. We observed that the landslide is also blanketed by recent sediment, with infrequent outcrops of  light-grey soft sediments (pelites or marls) showing disorganised bedding, pending parallel to the local slope at the place we sampled. This small outcrop on the landslide, at 750m depth, shows EW near-vertical fault gouge structures, perpendicular to the slope. Even if that direction fit with the prolongation of Ganos fault, we lack of continuous information to establish this interpretation. The presence of such prolongation of Ganos fault would also explain why we observe true outcrop only a this point of our cross-section, below the uniform blanket of soft, bioturbated recent sediment.

Due to the low maximum speed of the wounded Nautile, we couldn't reach the trace of Ganos fault, where it was discovered by the Victor-6000 microbathymetry during Marmarscarps cruise, missing the main objective of the dive.

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**Sample report** :

| Sample Nb | Depth (m) | Lat | Lon | Description |
|---|---|---|---|---|
| 1 | 913 | N 40°46.9254 | E 027°25.0662 | Massive obscure rock |
| 2 | 754 | N 40°46.137 | E 27°25.4052 | Light gray soft sedimentary rock (marl? pelite?) |

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**Dive report :**

| Time (UT) | depth (m) | Heading (°) | Observations |
|---|---|---|---|
| 07:40 | 1060 | | Arrival on sea bottom : smooth sedimented area with numerous bioturbations (open burrows) |
| 07:50 | 1031 | 285 | Transit to the base of the cliff (first point of the dive) : flat, highly sedimented sea floor |
| 07:55 | 1000 | 286 | Sedimented  sea floor  is now gently dipping to the SSE |
| 07:59 | 995 | 233 | Base of the Tekirdağ  cliff : flat terrace after a 2-3m high smooth scarp, covered by grey/black  reducted sediments, with numerous dead shells of Lamellibranches and sea urchins. |
| 08:00 | 980 | 287 | On the slope, several blocks of hard rock |
| 08:03 | 957 | 282 | Rocky outcrops, emerging from places to places from the sedimentary blanket, with hummocky surface : massive, black to brown rock. These rocks appears to be irregularly bedded (15/20cm beds), |
| 08:05 | 949 | 284 | Small smooth ridge descending from the main scarp, trending roughly N-S (no visible structure) |
| 08:06 | 939 | 289 | Chaotic outcrop of massive rock. An irregular dipping can be evaluated, approximately conform to the dipping of the slope, dipping to N135 (~) |
| 08:09 | | | Smooth sedimented slope |

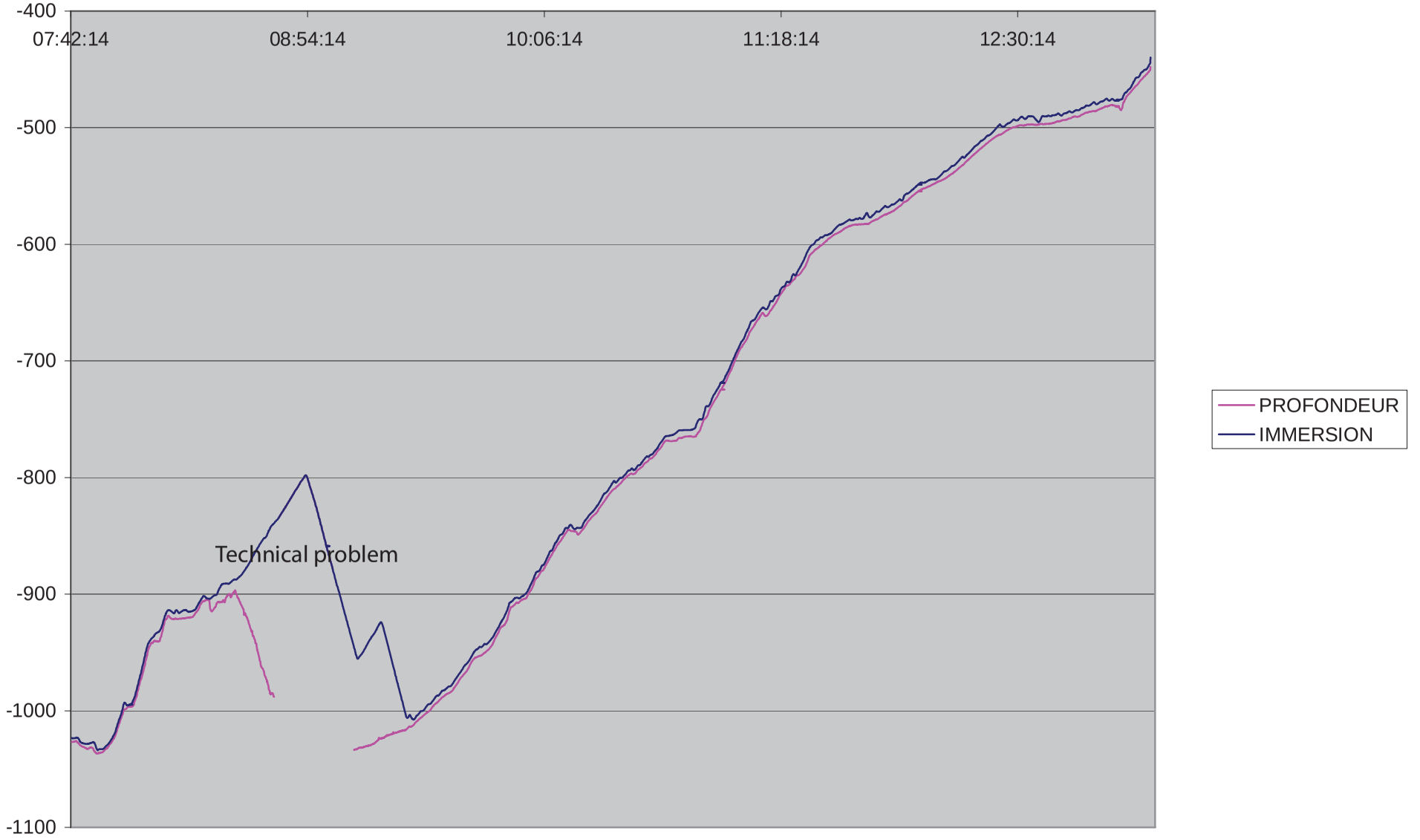
| | | | |
|---|---|---|---|
| 08:13 | 915 | 14 | Massive, obscure rock, outcropping sparsely below recent sediment => **Sample N°1 N40°46.9254 –E027°25.0662** |
| 08:17 | 915 | 47 | Bedding N105 dipping 40° southward |
| 08:18 | | | View of the sampled outcrop |
| 08:20 | | | Several outcrops of a dark massive rock distributed on the sedimented slope |
| 08:21 | | | Stratified outcrops |
| 08:23 | | | Steep slope covered by smooth sediments, with fallen blocks of rocks |
| 08:24 | | | Gear problems : we spent a while trying to fix the problem, unsuccessfully. The gear seems to be blocked on the starboard side : Nautile tend to turn constantly to the left. The submersible is not more able to run straight without the use of the lateral propeller. We continue the dive at a speed reduced at only 15 to 20% of the normal velocity. The vehicle appears very difficult to control, being oblique to the course with an angle varying in relation with local currents and topography. |
| 09:20 | | | Muddy, flat seafloor, with many bioturbations (burrows) as usual |
| 09:43 | 956 | 138 | The sedimented slope is slightly dipping northwestward |
| 09:52 | 927 | 137 | Steep slope, (buried scarp?), covered by unconsolidated sediments |
| 09:57 | 903 | 123 | Nothing to see (too far from sea bottom) |
| 10:00 | 899 | 147 | Sedimented cliff |
| 10:02 | 888 | 131 | Good view of bioturbated sediment on sea floor |
| 10:25 | 810 | 198 | A fish (Selacian, small shark) |
| 10:37 | 781 | 202 | The muddy slope is dipping to the SSE (left of the submersible) |
| 10:38 | 780 | 204 | A fish (Selacian, small shark) |
| 10:41 | 771 | 205 | Dip of the slop is now very steep : it’s a sedimented cliff (less bioturbation), no outcrop of bedrock. |
| 10:43 | 764 | 211 | Outcrop of light grey sedimentary rock, with dense bioturbations. Unregular bedding in the same direction than the slope, 45° to the south. Strange animals on this outcrop, identified as Bonnelia [incertae sedis] (to be checked) |
| 10:45 | | | Small outcrops of soft argillaceous grey sedimentary rock, with bedding pending to SSW. |
| 10:51 | 754 | | Sampling => Light gray soft sedimentary rock (marls ? pelites ?) **Sample N°2 : N 40°46.137 – E 27°25.4052** |
| 10:54 | 749 | 203 | Near-vertical slope (or cliff), roughly bedded soft rocks, highly fractured and triturated (fault gouge ?), pointing below a thin blanket of recent unconsolidated sediment, hell brown to yellowish. The “slices” of pelites are roughly E-W vertical and sub-perpendicular to the slope. |
| 10:56 | | | Very steep sedimented slope, with small active micro-canyons |
| 11:00 | 718 | 208 | A fish, swimming eastward above the very boring sedimented and bioturbated sea-floor. |
| 11:02 | 707 | 209 | A little black shark |

| | | | |
|---|---|---|---|
| 11:03 | 702 | 210 | Flat sedimented area, slightly West dipping |
| 11:12 | | | A fish |
| 11:13 | 655 | 209 | Flat stone, covered by sediments on the slope. Couls be a debris from above (?) |
| 11:17 | 642 | 184 | Smooth sedimented sea floor (all along the next hour) |
| 11:32 | | | A small shark |
| 12 :04 | 544 | 235 | Sedimented seafloor |
| 12 :20 | | | Sedimented seafloor (nice view?) |
| 12:37 | 491 | 252 | A dark-grey Ray (Selacian, Raja) |
| 13:03 | 466 | 226 | A bright red-orange shrimp |
| 13:04 | | | END of this (catastrophic) dive |

# Dive 1646

## Sample list

| Sample Nb | Depth (m) | Lat | Lon | Description |
|---|---|---|---|---|
| 1 | 913 | N 40°46.9254 | E 027°25.0662 | Massive obscure rock |
| 2 | 754 | N 40°46.137 | E 27°25.4052 | Light gray soft sedimentary rock (marl? pelite?) |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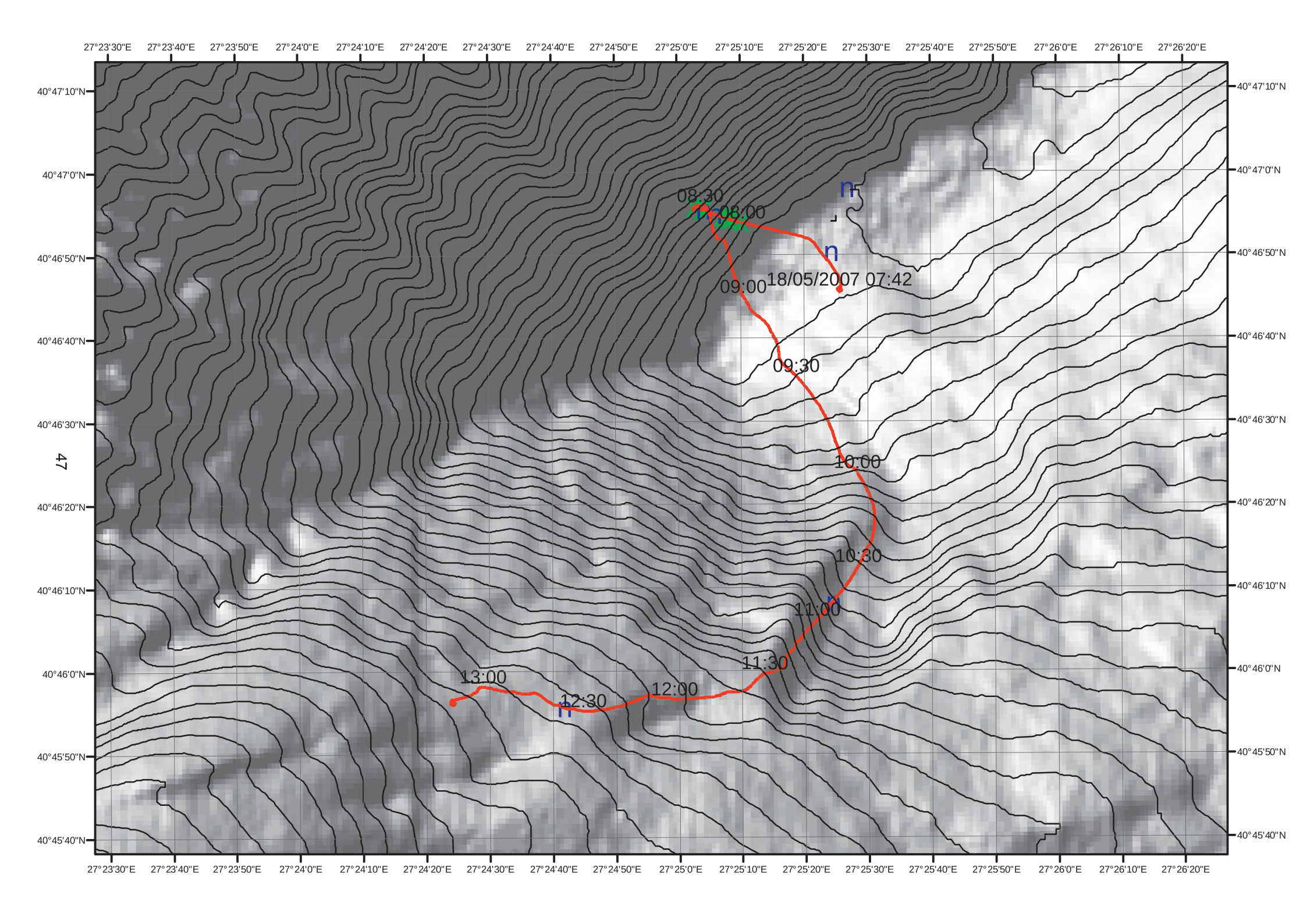
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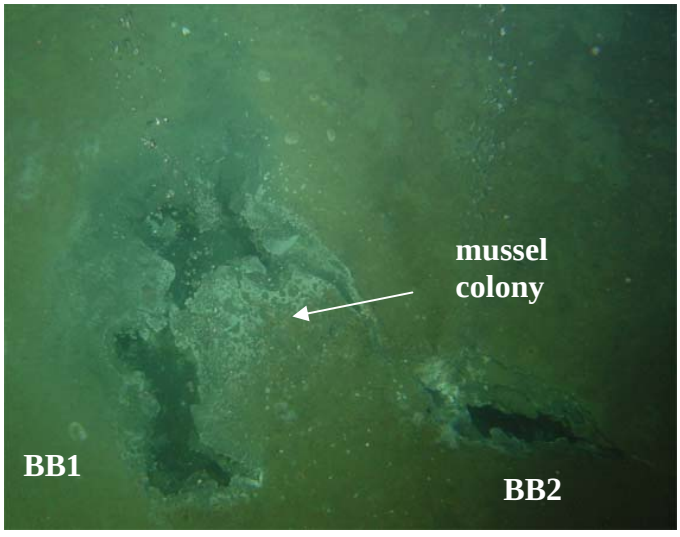
Nautile Dive 1647, 19/05/2007

Scientist on board: Pete Burnard, CRPG-CNRS, BP20, 54501 Vandoeuvre-les-Nancy, France (peteb@crpg.cnrs-nancy.fr)
Pilots: Xavier Placaud and Jean-Paul Justiniano

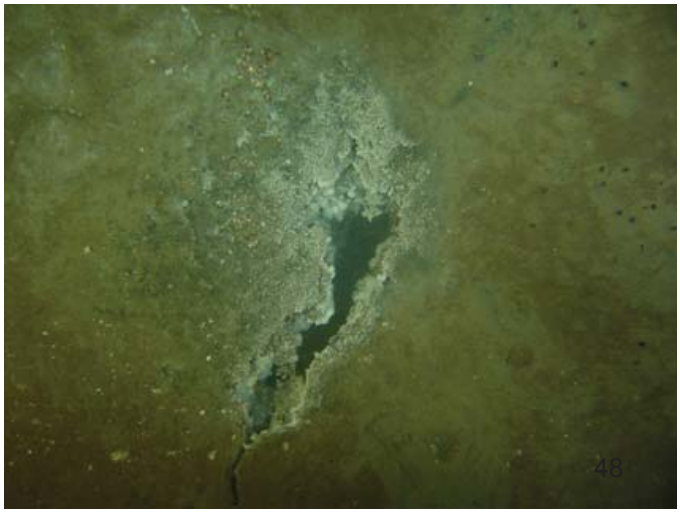
Objectives
1. Obtain photo mozaic of the 'Boris's Bubblers' (BB) site in the northern Tekirdag basin
2. Sample gas issuing from BB using PEGAZ pressurized gas sampler
3. Sample fluids from BB using multiple fluid sampler
4. Collect mussels growing next to gas emanations
5. Sample carbonates (crusts around or concretions/stalctites growing in the ponds)
6. Examine and sample fluids (with multiple fluid sampler) coming from probable bubble sources lying c. 2km west of BB, identified by EK60 survey the morning of 19/05/07

Equipment: PEGAZ pressurized gas sampler; MicroCAT; Titanium water sampler array (4 tubes); two 'biobox' containers

Narrative.
The venting sites were quickly found by heading upslope (NNE) from the dive location, passing over scarps with signifcant, extensive black patches, occasionally well-colonized by mussels. Boris's Bubblers (BB) consists of three small ponds, 1,5 - 2m along the longest dimension, aligned along a well-defined fracture which trends approx. 320; these were designated, from N to S, BB1, BB2, and BB3. The ponds lie on a small flat section several tens of meters across on the otherwise steep northern margin of the Tekirdag basin.




**BB1 and BB2.** Bubble streams can be seen emanating from each of the ponds; the white material is almost entirely bacterial in nature, wafting around when disturbed. Well-formed (carbonate) crusts line the ponds; it seems unlikely that the hard rock at the pool margins represent bedrock, rather deposited carbonates.



**BB3.** Again, actively bubbling with masses of bacterial activity; here, a plume of bacterial material, disturbed by the passage of the submarine, rises up along with the bubbles.

Once photographed, the PEGAZ sampler was placed over the bubble stream coming from BB2; it took some time (25 minutes) to fill the funnel to overflowing as we had to rise, let sediment settle, and after some delay continue filling the funnel. After, Ti samplers were filled from as close as possible to the bubble streams coming from BB2 and BB3. MicroCAT surveys were taken in all ponds, but an instrument malfunction resulted in no data collected. The temperature log (attached to the Ti samplers) did not show any temperature anomaly (all at 14.8 °C).

A core was succesfully taken from the pelagic mud next to BB1, from directly over one of the small holes seen ubiquitously (with the aim of trapping the organism). A second core was attempted in a black patch, with lots of white bacterial filaments on the surface; however, this core was unsuccesful.

We then went to make an instrument exchange with instruments in the elevator, which took a long time (50 minutes between leaving the BB site and returning); however, on returning, a fourth bubbling pond was discovered, lying a little to the north of the main fissure. Depressingly, a white plastic bag could be seen inside the pond.

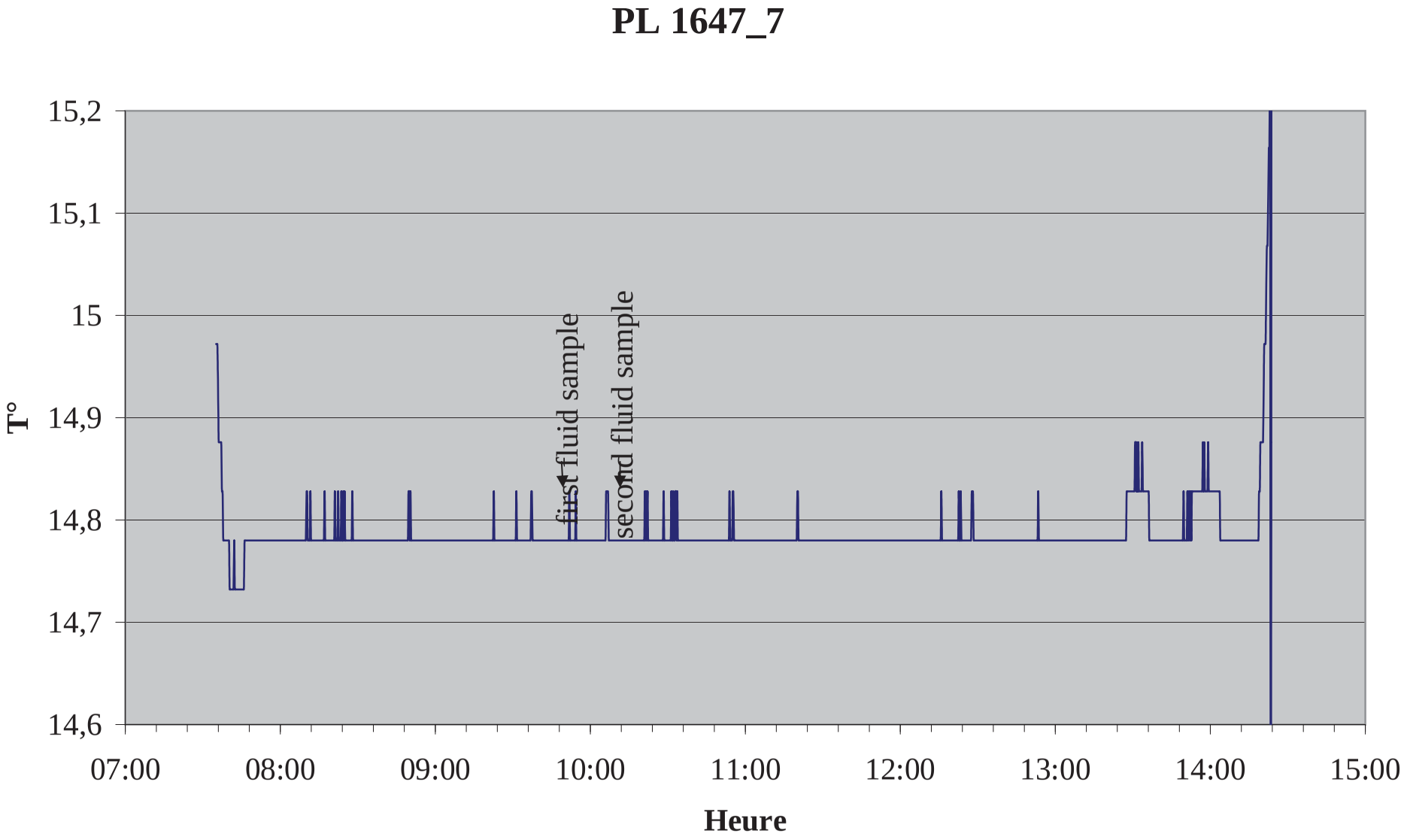
Samples of mussels were scraped of the small flat area between BB1 and BB2 and deposited in the biobox (there did not appear to be many mussels in the box from inside the submarine, but at surface, a good number had been collected).

The most promising carbonate crust appeared to be from BB4 where a shelf of crust projected over the pond, facilitating sampling; this was relatively easy to break off.

A second instrument exchange with the elevator was required, in order to redeposit the bioboxes in the elevator. From the elevator, we set off in search of the bubblers identified from the EK60 survey, unfortunately unsuccesfully.

| Point # | Time (UTC) | Immersi | Sample | Comments |
|---|---|---|---|---|
| 1 | 8:14 | 1077 | | Passing upslope (030) from descent point; large angular blocks (0.2 - 1 m) of rubble lying unoriented on sediment on an extensive black patch; many mussels, mostly dead on the sediment floor and black patches but alive on blocks; blocks often covered with a white film, particularly on one side |
| 2 | 8:16 | 1075 | | cleared from large black patch onto sediments with slight greying; all mussels dead; some dead sea urchins ; no blocky rubble |
| 3 | 8:18 | 1073 | | exposure of bedrock; angular fractured blocks with black patches with bacterial colonies at base and in amongst sediments; heavily sedimented between outcrops |
| 4 | 8:22 | 1071 | | blocky talus (irregular, jumbled, angular brown blocks) on steep slope, sitting ontop of black sediments with mussels growing on blocks; some blocks with white bacterial material on one face (?? Westward) |
| 5 | 8:24 | 1069 | | into flatter sediment no black patches; some curious linear depressions (oriented ?? 330, few cm wide, 1m or so long), very occasional large rounded boulders heavily draped with sediments (eg at 8:28). Generally poor visibility |
| 6 | 8:31 | 1056 | | first sight of Boris's Bubblers (BB) from 4,5 m above seafloor in poor visibilty. Essentially see the white track of the southernmost part of the fissure and the southern most pond (BB3) |
| 7 | 8:35 | 1056 | | photo mozaic of Boris's Bubblers |
| 8 | 8:38 | 1057 | | nice zoom into BB3 clearly showing how the fissure changes angle just north of BB3 with white bacterial mat on east side without much black sediment, and plenty of bacterial filaments and masses within the hole; plume of bacterial matter rising from the hole |
| 9 | 8:48 | 1057 | | zoom into BB1 and BB2 showing mussles (sampled later; see entry# 26) and details of carbonate crust at 8:52 |
| 10 | 8:57 | 1040 | | taking PEGAZ sampler; rinsing with seawater |
| 11 | 9:09 | 1057 | | started accumulating gas from BB2 in PEGAZ sampler |
| 12 | 9:15 | 1057 | | cloud of sediment; had to rise up to clear PEGAZ of sediment |
| 13 | 9:30 | 1057 | | continued filling PEGAZ funnel from BB2 |
| 14 | 9:32 | 1058 | 1047 | PEGAZ closed |
| 15 | 9:32 | 1058 | | rinising of PEGAZ funnel |
| 16 | 9:38 | 1057 | | replaced PEGAZ in basket; took fluid sampler |
| 17 | 9:51 | 1058 | 1047-6 | Fluid sample taken in BB2 |
| 18 | 10:06 | 1059 | 1047-5 | Fluid sample taken in BB3 |
| 19 | 10:19 | 1058 | | microCAT acquisition; microCAT emplaced well inside BB1, 2 and 3 but malfunction of microCAT = no data |

| | | | | |
|---|---|---|---|---|
| 20 | 10:38 | 1061 | | stumble on new bubbler (BB4) a few m off to the N of the main fissure but well to the east (20m) of the other bubble sites; similar in appearance to other BB sites with well developed crust. Very active bubbling (and a plastic bag in the bottom). |
| 21 | 10:49 | 1058 | Core 8 | core taken in soft sediments just to N of BB1, directly over small bio hole (shrimp, fish, crustacean?); corer did not completely lock closed, half core lost |
| 22 | 11:05 | 1058 | | core attempted in small black patch with plenty of bacterial activity c. 20m N of BB1; core only penetrated few (<10) cm, consequently all material in corer fell out |
| 23 | 11:24 | 1082 | | small bubbles can be seen leaking from top of PEGAZ (while searching from elevator; only visible on fixed camera |
| 24 | 11:38 | 1066 | | elevator found |
| 25 | 11:49 | 1071 | | fracture with aligned black patches (+ dead mussels) found on way back to BB site; fracture aligned 280 before forking; N most fork has small scarp on it; eventually fissure/scarp fades into a sedimented slope trending c. 300 |
| 26 | 12:03 | 1057 | ?? | started sampling mussels from slight flat between BB1 and BB2 |
| 27 | 12:54 | 1061 | ?? | crust sample taken from BB4; sample taken from small shelf on of side of pond, right next to bubble stream |
| 28 | 13:07 | 1067 | | return to elevator and placed samples in elevator |
| 29 | 13:20 | various | | headed west to try find second bubble site; only found expanses of bioturbated muds, no black patches |
| 30 | 13:59 | 1106 | | fluid sample taken (#7, for background seawater); although clearly depressed fluid sampler, no fluid was in the sampler |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T°
first fluid sample
second fluid sample
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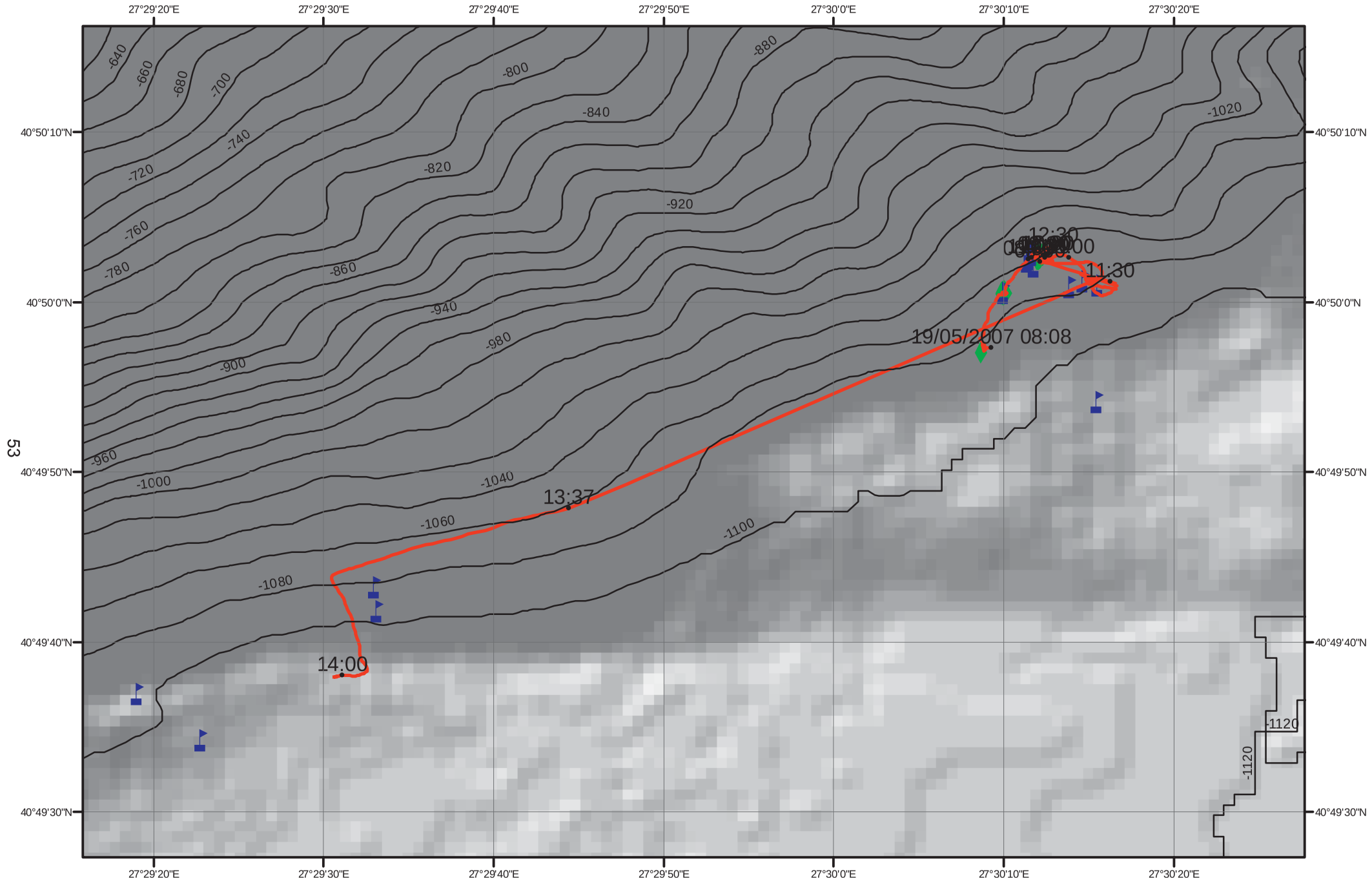
Heure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-1080
-1100
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12:30
11:30
19/05/2007 08:08
13:37
14:00

Nautile Dive 1648 – 20 May, 2007

Pilots:
Rosazza
Cheilan
Scientist:
Géli
Location:
Western High – Mean Lat. N 40°48.0' – Mean Long. E 27°44.0'
near suspected active site inferred from Side-Scan Sonar and EK-60 acoustic anomalies
Objectives:
Identify source of EK-60 acoustic anomalies
Collect Pressurized Gaz
Collect fluid samples
Collect push cores
Collect microcat data
Equipment:
1 PEGAZ system flow meters
4 titanium syringe fluid samplers
4 push cores
microcat CTD

Rationale :

Dive 1648 is an attempt to find the source of gas bubbles that are supposed to originate the acoustic anomalies in the water column. These anomalies were detected on the Western Ridge : 1) in September 2000, using the 112 kHz Side Scan Sonar system towed behind R/V Le Suroit and 2) during the MarNaut cruise, prior to the dive, using Simrad EK-60 38 kHz echosounder. The dive route was designed to explore sites where acoustic anomalies were found along EK-60 Line A, namely A2 - centered on N 40°48.886' , E 27°46.608'- (Fig. 1) and A3 - centered on N 40°48.728 , E 27°45.862'.

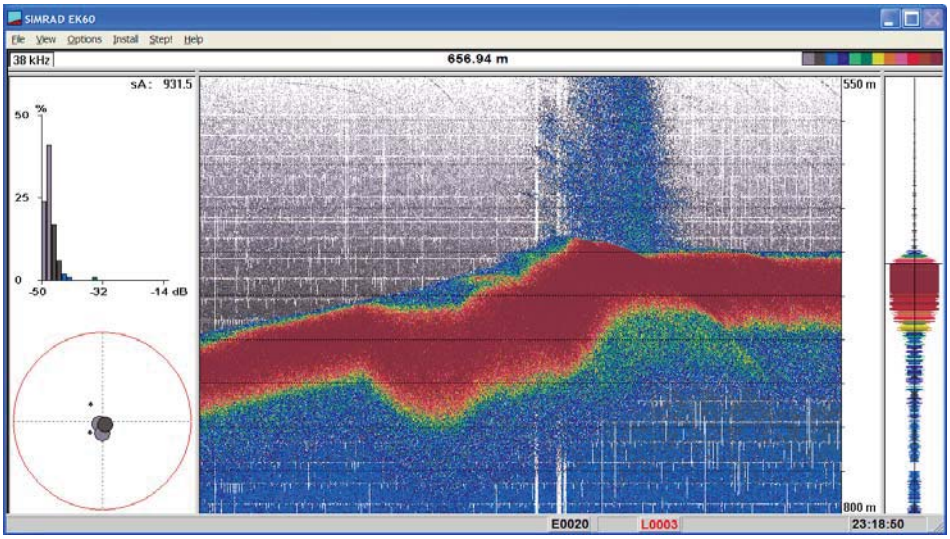



*Fig.0 : Example of acoustic anomaly A2 detected near the diving site. Dive 1648 was designed to find out the source of this anomaly.*

Short dive narrative:

Dive started in the fault valley by 707 m, at a site where black patches and bacterial mats were found using ROV Victor during cruise Marmarascarps in 2002. Very bad visibility. No particular traces of biological activities were found as the Nautile touched the seabottom. To reach waypoint A2, the Nautile climbed up hill (14% slope).

The area near waypoint A2 was explored between 8:00 and 9:50 with a series of profiles, about 250 m long and oriented back and forth N 260 and N 80. A high density of active sites were found all over the place : black patches with white bacterial mats and carbonate crusts (Fig. 1 to 5). Most particularly, between 9:36 and 9:43 massive carbonate crusts were found. Clams were found at some black patches. After a careful re-examination of the DVDs, fluid escapes from black patch can be seen on the video at 9:36.

Exploration near A2 was abandoned at 9:50. Nautile headed for about 950 m, in the N260 direction towards waypoint A3, along a crest located north of the fault valley. On the way, dispersed bacterial mats were detected, at 10:13 and 10:18 respectively, suggesting activity over the full area between A2 and A3.

Site near A3 was reach at about 10:30 and explored until 11:30. Numerous black batches with white bacterial mounds were found near A3, the coverage being though less dense than near site A2. It is important to note that all black patches found during Dive 1648 where associated with white bacterial mats, mostly in the center of the patch.

Two series of cores were taken near site A3, from two nearby black patches. Gas bubbles were observed as cores # 8 and # 5 were pushed into sediments.

Unfortunately, the source of the acoustic anomaly was not found, suggesting that it is probably very localized. According to additional EK-60 profiles carried out after the dive, the source is likely located less than 200 m to the northeast of A2. A new dive will be scheduled on the site to finalize the search during Leg 3.

Selected pictures are shown in the present report to illustrate the most significant features disovered during the dive. A total of 6 DVDs were produced during the dive : 3 DVDs from the fixed camera and 3 from the mobile one :

- DVD 1 between 07:23 and ~ 09:30
- DVD 2 between ~ 09:30 and ~ 11:00
- DVD 3 between ~11:00 and ~13:00

The list of samples is described in the table below :

| Sample Name | Time | Lat | Long. | Imm. | Observations |
|---|---|---|---|---|---|
| PC-1648-8 | 11:41:00 | 40,8131000 | 27,7676333 | 662 | Bubbles degassing while pushing core # 8 in sediments |
| PC-1648-7 | 11:42:00 | 40,8131000 | 27,7676500 | 662 | push core # 7 inserted in same black patch |
| PC-1648-4 | 12:01:00 | 40,8130667 | 27,7676167 | 661 | Push core # 4 in nearby black patch |
| PC-1648-5 | 12:02:00 | 40,8130667 | 27,7676333 | 661 | # 5in same black patch as # 4. Bubbles as corer is pushed in |

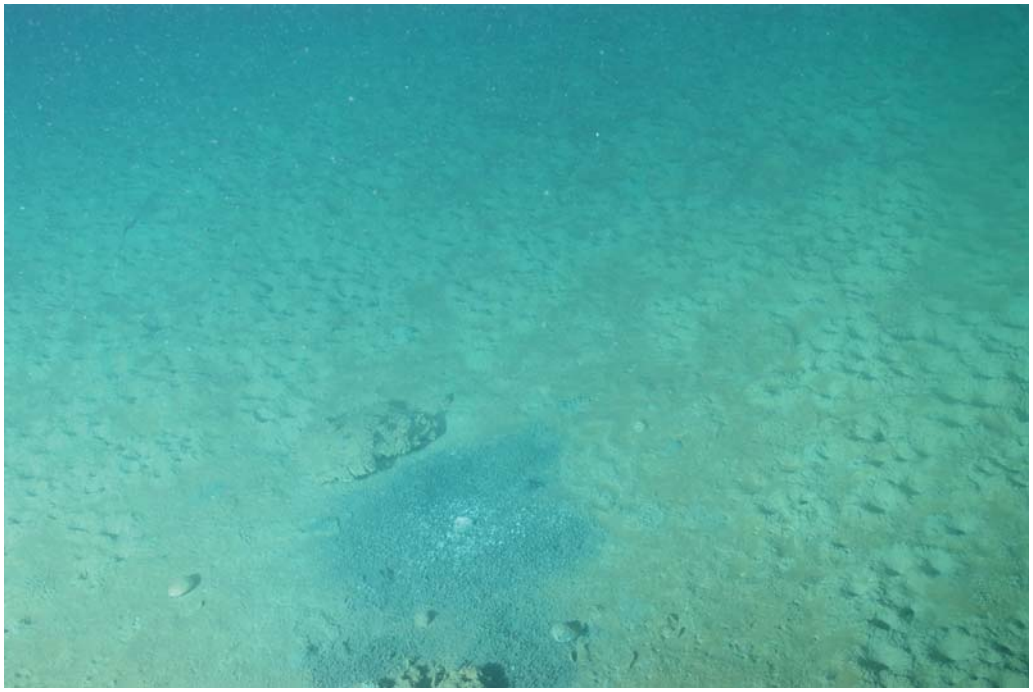


Figure 1 : PENTAX Photograph, shot ca 09:01. Observe the black patch with white bacterial mats in the middle. Note the carbonate concretions and clams.

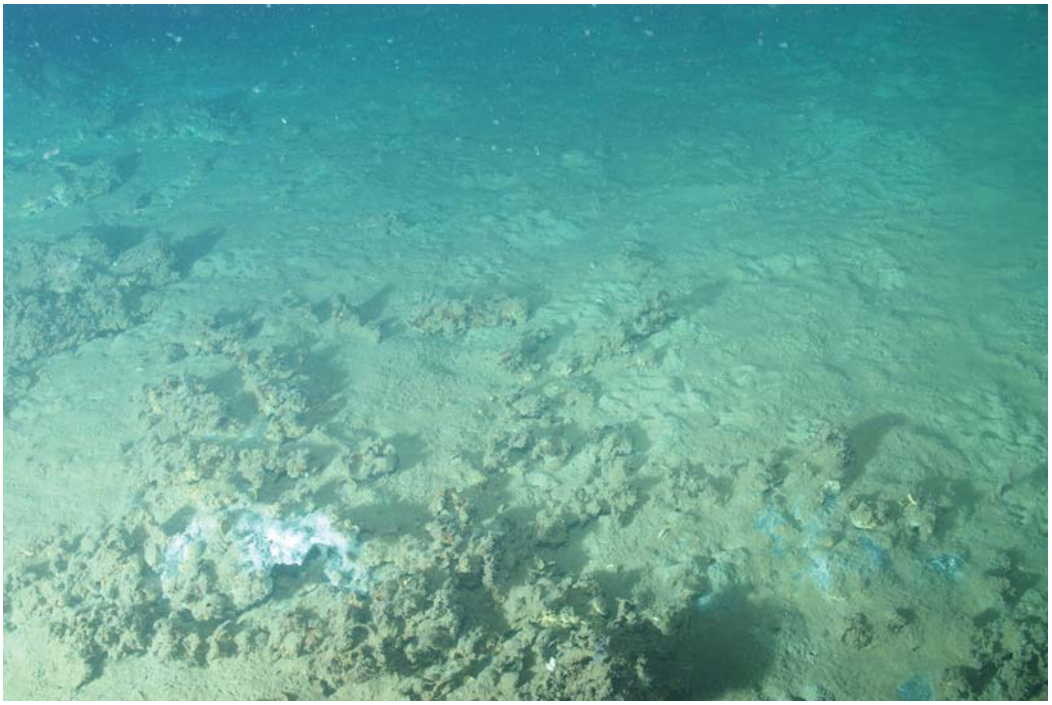


Figure 2 : PENTAX Photograph, shot ca 09:36. Carbonate crusts. Note the black patch with white bacterial mats.

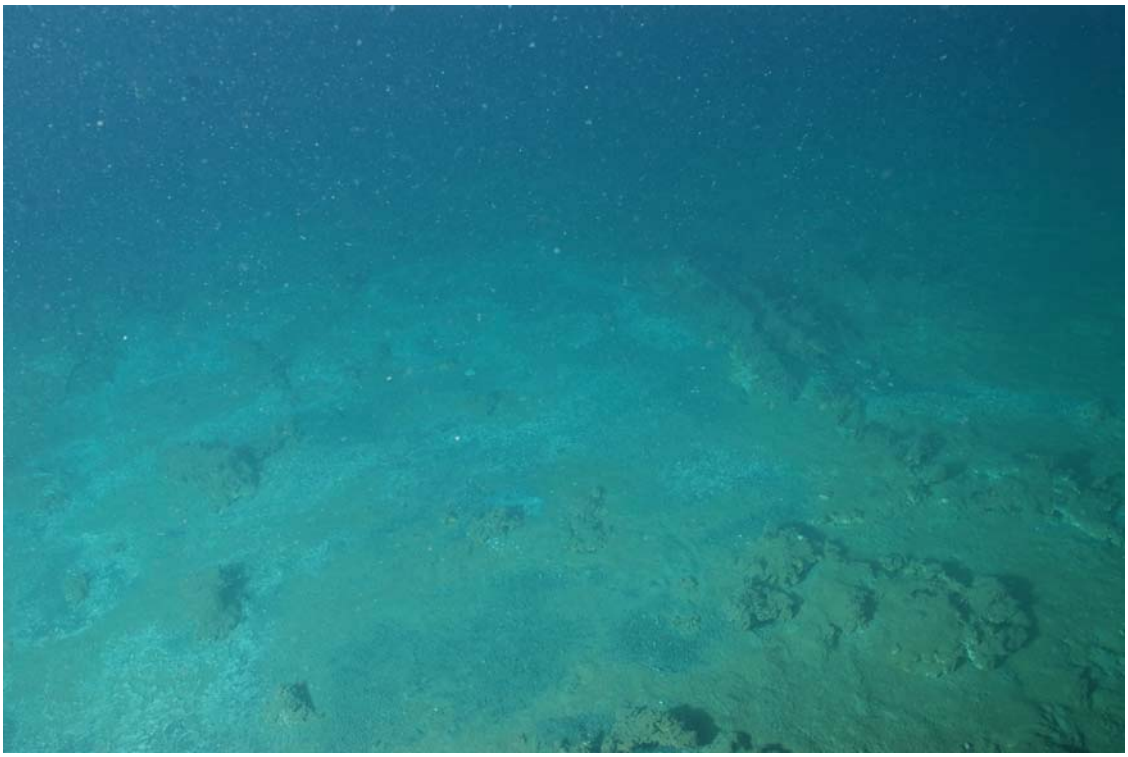


Fig. 3 : PENTAX photograph shot ca 09:38. Remarquable point. Full screen covered with black patches with white bacterial mats and carbonate crusts.

Fig. 4 : PENTAX photograph shot ca 09:40. Massive carbonate crusts.
Note also the black patches with white bacterial mats.

Fig. 5 : PENTAX photograph shot ca 10:43. Little dispersed black patch with white bacterial mats observe near site A3.

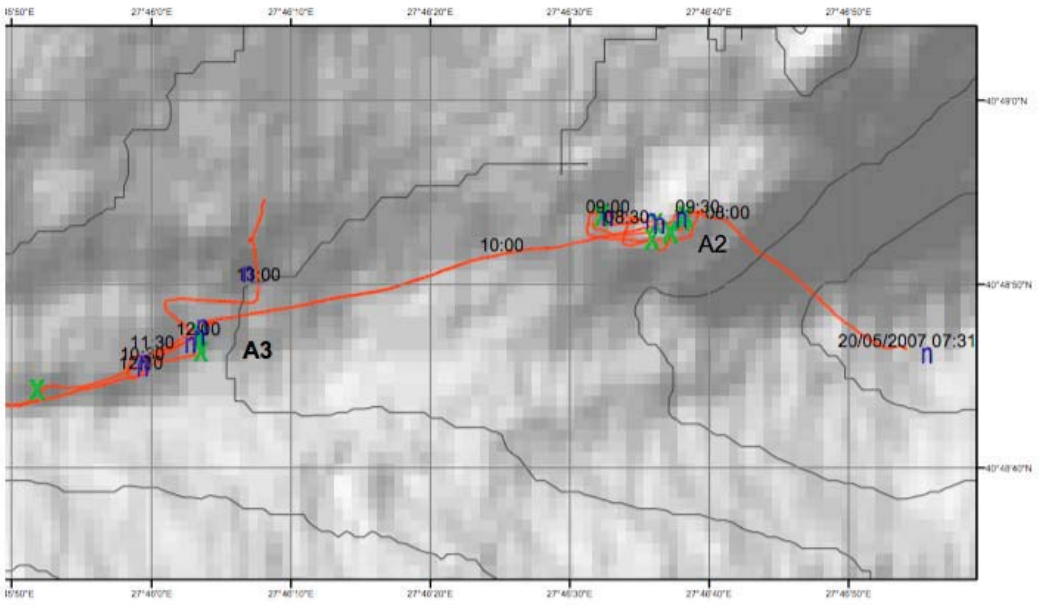
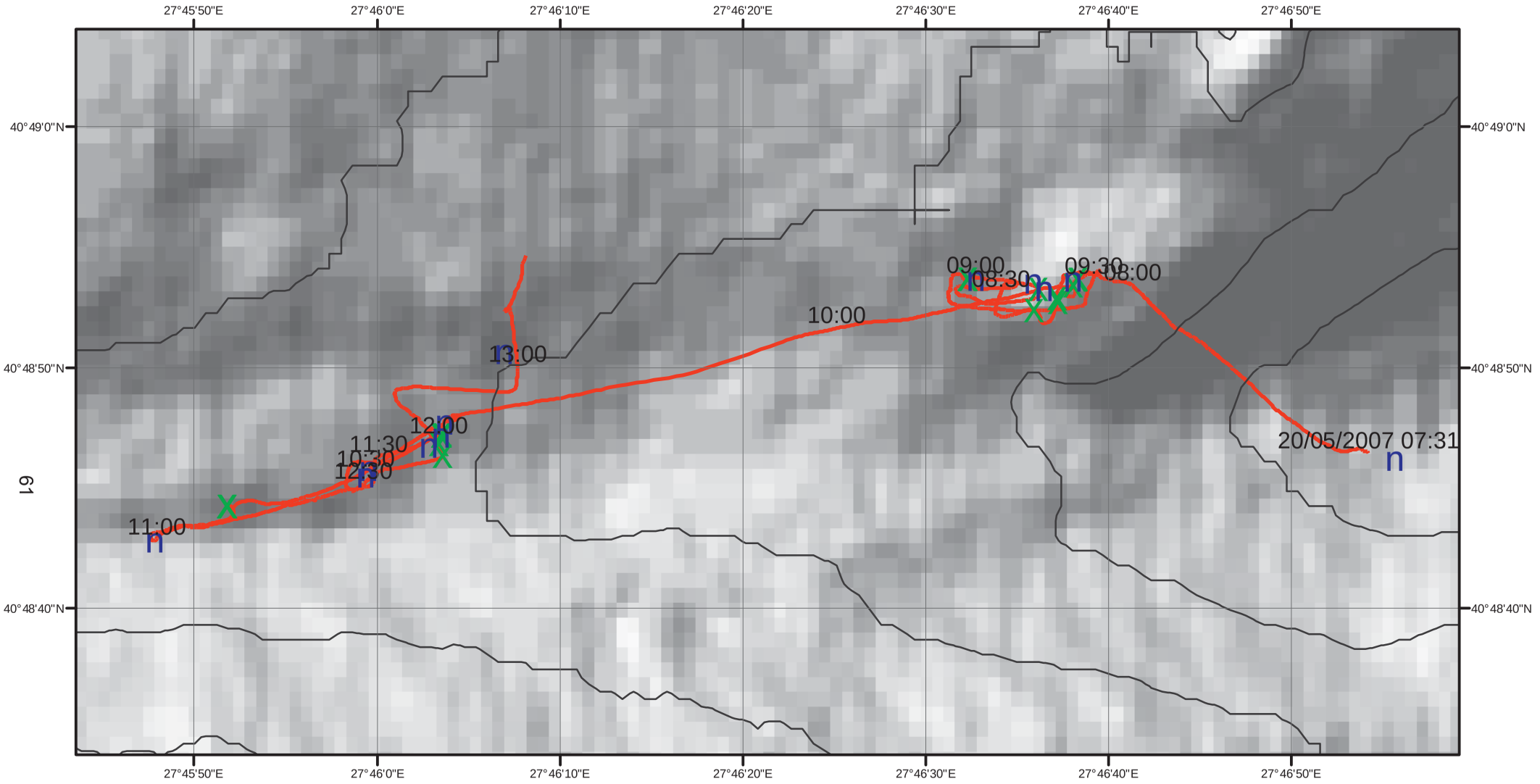



Fig. 6 : Nautile filtered navigation during Dive 1648.

| MARNAUT Cruise - NAUTILE DIVE 1648 – MAY 20, 2007 | | | | | | |
|---|---|---|---|---|---|---|
| | Time | Long. | Lat | Imm. | Observation | Figure |
| | 07:23:00 | 27,7822666 | 40,8126166 | 707 | ON BOTTOM | |
| Begin | 08:11:00 | 27,7771000 | 40,8149500 | 661 | Black patches with white material mats | |
| End | 08:13:30 | 27,7769333 | 40,8148833 | | Black patches with white material mats | |
| Begin | 09:01:00 | 27,7756833 | 40,8149167 | 668 | black patch with white bacterial mat close to carbonate mound | Fig. 1 |
| End | 09:04:00 | 27,7756000 | 40,8149000 | | clams on black patches | |
| Begin | 09:21:40 | 27,7768000 | 40,8145500 | 668 | black patch with white bacterial mat | |
| End | 09:21:50 | 27,7768333 | 40,8145500 | | | |
| Center | 09:36:00 | 27,7773167 | 40,8149167 | 663 | Carbonate mounds surrounding black patches with white dots. | Fig. 2 |
| | | | | | Fluids escaping from carbonate crust visible on video | |
| Center | 09:38:00 | 27,7772833 | 40,8148833 | 662 | Pt remarquable : black patches with white bacterial mats and carbonate crusts. Full screen covered | Fig. 3 |
| Begin | 09:39:40 | 27,7772333 | 40,8148667 | 662 | Point remarquable : massive carbonate crust (full screen) | |
| End | 09:43:00 | 27,7771500 | 40,8147500 | | black patches w. white bacterial mat | |
| Punctual | 09:47:00 | 27,7772833 | 40,8148000 | 662 | black patch w white bacterial mat | |
| Punctual | 09:51:00 | 27,7765000 | 40,8147333 | 659 | black patch w white bacterial mat | |
| Punctual | 10:13:00 | 27,7677167 | 40,8132667 | | small black patch, w white bacterial colonies | |
| begin | 10:18:00 | 27,7677000 | 40,8132833 | 660 | black patches with white bacterial mats | |
| end | 10:21:30 | 27,7676167 | 40,8132000 | | | |
| begin | 10:30:10 | 27,7666000 | 40,8127000 | 632 | very bad visibility induced by Nautile | |
| end | 10:36:00 | 27,7653667 | 40,8123500 | | | |
| begin | 10:43:00 | 27,7644000 | 40,8122833 | 646 | little, dispersed black patches w white bacterial mats | Fig. 5 |
| end | 10:46:00 | 27,7643833 | 40,8122833 | | | |
| punctual | 11:36:00 | 27,7675333 | 40,8130833 | 659 | black patch w. white bacterial mat | |
| begin | 11:40:00 | 27,7676333 | 40,8131000 | 660 | Start sampling operation, push cores 7 and 8 in same black patch | |
| | 11:41:00 | 27,7676333 | 40,8131000 | 662 | Bubbles degassing while pushing core # 8 in sediments | |
| | 11:42:00 | 27,7676500 | 40,8131000 | 662 | push core # 7 inserted in same black patch | |
| | 11:45:00 | 27,7676500 | 40,8131167 | 661 | bubbles going out as push core # 8 is pulled out | |
| end | 11:58:00 | 27,7676167 | 40,8130667 | 661 | End of push core (7 & 8) sampling operation | |
| begin | 12:01:00 | 27,7676167 | 40,8130667 | 661 | Start sampling operation, ush cores 4 # 5 in nearby black patch | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 12:02:00 | 27,7676333 | 40,8130667 | | bubbles coming out as push core # 5 is pushed in sediments | |
| | 12:07:00 | 27,7676500 | 40,8131000 | | bubbles coming out as push core # 5 is pulled out of sediments | |
| end | 12:18:00 | 27,7674333 | 40,8130333 | 662 | Start sampling operation, push cores 4 # 5 | |
| begin | 12:39:00 | 27,7674167 | 40,8128000 | 660 | area with dispersed, small black patches w white bateriall mats | |
| end | 12:41:00 | 27,7676833 | 40,8128833 | | | |
| punctual | 13:00:00 | 27,7688167 | 40,8139000 | 659 | black patch with white bacterial mat | |
| punctual | 13:13:00 | 27,7686000 | 40,8145500 | | weight released – Nautile starts pop up | |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11:30
12:00
13:00
10:00
09:00
08:30
08:00
09:30
20/05/2007 07:31

**Campagne MARNAUT**
**Chef de mission : Pierre Henry**
**Travaux réalisés par le Nautile**

| | |
|---|---|
| **N° absolu de plongée** : 1649 | **Date** : 21/05/2007 |
| **Observateur**<br>- Nom : Tiphaine Zitter<br>- Spécialité : Géologie marine<br>- Organisme : CEREGE | **Pilote** : Jean-paul Justiniano<br><br>**Navigateur engin** : Xavier Placaud |

**Objectif(s) de la plongée** :
Exploration de l'escarpement de faille au centre du Bassin Central, et de sa connection avec le haut Occidental
Recherche de sorties de fluides dans une zone ou une anomalie acoustique avait ete détecte avec le SAR

**Coordonnées du point d'arrivée sur le fond**
- Longitude : 27° 57,017 - Latitude : 40°49,861

**Profondeurs explorées pendant la plongée**
- Minimum : 1108m - Maximum : 1228 m

**Durée totale de la plongée** : 7h07 **Durée sur le fond** : 5h46

**Equipements scientifiques**

- installés sur le submersible :
Multipreleveur de fluide
Pegaz
4 carottiers

- transportés dans la navette : non

- mouillés en autonome :non

**Travaux réalisés sur le fond**

- Distance parcourue :
5700m
-Travaux réalisés :
Observation, exploration, échantillonnage fluide et carottes
- Echantillons :

| | | | |
|---|---|---|---|
| Croute 08:39:54 | 40,8270500 | 27,9419000 | 1649-R1 |
| Carotte 11:17:04 | 40,8254833 | 27,9338667 | PC-1649-1 |
| Fluide 11:17:04 | 40,8254833 | 27,9338667 | WS-1649-1 |
| Fluide 11:17:04 | 40,8254833 | 27,9338667 | WS-1649-2 |
| Fluide13:11:24 | 40,8322667 | 27,9340667 | WS-1649-3 |
| Fluide 13:11:24 | 40,8322667 | 27,9340667 | WS-1649-4 |

- Nombre de bandes vidéo :
6 DVD
- Nombre de photos : 56 images + 77 photo pentax

**MARNAUT Dive 1649/18/09**
21/05/2007

**Scientist observer :** Tiphaine ZITTER
**Nautile pilot :** Jean-Paul JUSTINIANO
**Nautile co-pilot :** Xavier PLACAUD

**Dive zone :** Intersection of western edge of Central Basin and of Western High, immersion between 1200 and 1110 m

**Objectives :**
-Explore an area where acoustic anomalies where detected with the SAR
-Explore the northern extension along the en-échelon fault scarp of a zone of crust observed with the ROV dive 199
-Explore the connection with the western High fault

**Tools :**
Four push corers (Nautile basket)
Fluid microsampler (Nautile basket)
One Pegaz device (Nautile basket)

**Dive Summary:**

We landed south of the fault trace outline the northern inner part of the Central Basin on a brown bioturbated bottom. We went towards the scarp which is a subdued gentle slope and explore an area where SAR acoustic anomaly and EK60 acoustic anomaly H2 were observed. Nothing peculiar was observed there, so we continued southward along the basis of the slope. Climbing the slope that was becoming very steep at about 8:30 we saw some crust outcropping the slope and sampled a piece there. It seems this carbonate level was coinciding with waterdepth 1200m and formed inside the sediment and was outcroping because of the slope. We cross this level back and forth at 8:55, 10:00. Then we went over an area that was observed as carbonate crust area with the ROV during MARMARASCARPS but nothing was to be seen there. From this point we climbed directly the very steep slope but it was a very dull sedimented area with few grey patches probably due to the gliding of the oxidised upper blanket of sediment. We went back towards waterdepth 1160m and climbed again the slope. At the top we found interesting active site with dark patches, and we took two water samples and two core samples. Only one out of the two coring attempt succeed, although the device for closing the core broke. We went north crossing lineaments recognised in the multibeam bathymetry. They form small ridges and in the depression between these ridges another active area was found. We made an attempt of push core there, but it borke and stayed in the sediment. We continued northwards and arrived on a plateau. Small grey patches were scattered within a area that appear wider than any previously observed, and sitting within a small depression. Bubbles were observed escaping from the sediments from several places. We wanted to take a Pegas sample there but were running out of time, so we did two water samples and leaved the seafloor.

**Dive report:**

STARTING DVD1

7:37 Arriving on the seafloor, brown and bioturbated

8:31:44 Zone of crust outcropping from place to place out of the slope water-depth 1200m

8:39:50 Sampling 1649-R1 crust that is very fragile and looks much like cemented sediment with relict holes (burrows or gas conduits?)

8:46:58 Big pieces of crusts

8:55 Small pieces of crusts

09:08:23 Crusts outcropping on the slope water-depth 1197 m

9: 35 END OF DVD 1

STARTING DVD 2

09:49:03 Grey patches, may be only the sediment underneath the oxydized upper layer wich is exhumed because of gliding along the steep slope

09:57:47 Very small grey patches

10:01 Small area with black patch, crust and actinians water-depth 1180 m

10:47:22 Small black patch

10:48 Another black patch stop for sampling

10:58 water sampling (bottle number 6 and 7). Bottle 6 from the middle of the black patch and 7 from above the periphery with bacterial mat

11:17 Push core sampling in the same black patch Bubbles are seen while coring PC-1649-1 (tube 1) from middle of the patch succeed, although the device for closing the core broke, PC-1644-2 (tube 4) from the periphery emptied itself when retrieving

11:42 Nice zoom on a bacterial mat with filaments

11:46 END OF DVD 2

STARTING DVD 3

11:49:46 Small area of black patches

11:52:18 Aligned patches of grey sediments with bacterial mat direction of the fixed camera

11:55:05 Few grey patches

11:55:50 Small grey patches at the left of the submarine

12:03 Arrival on a big patch (5 m wide) of black sediment with bacterial mat, crusts and lots of dead urchins on the periphery waterdepth 1120m

12:10:28 Attempt of coring PC-1649- 3 (tube 3) broke

12:30:45 Black patch

12:31:52 Zone of black patches in the middle of the two ridges visible on the multibeam bathymetry

12:32 Crust on the slope

12:57:52 Black patch

12:58:05 Elongated grey patches

12:59:15 Grey patches with crust

12:59: 40 Seeing bubbles coming out of the sediment, the area is a wide zone in a small depression covered by small grey patches, a lot of them are bubbling

13:00:50 Video sequence above a bubbling site

13:11: 26 Water sampling (bottle 5 and 8) above a bubbling site

13:21 END OF THE DIVE

**Best Of**

DVD2 Mob 11:14:10 → 11:15:20 coring with bubbles
DVD3 Mob 12:10:35 →12:11:10 Big patch with urchins
DVD3 Mob 13:00:50 →13:01:50 Travelling above bubbles
DVD3 13:15:20 →13:17:40 Water sampling above bubbles

**Dive Photos**

Fig. 1: Sampling site of water sampling within black patch surrounded by filamentous white bacterial mat- Coring site PC-1649-1 and PC-1649-2- 11:09:19

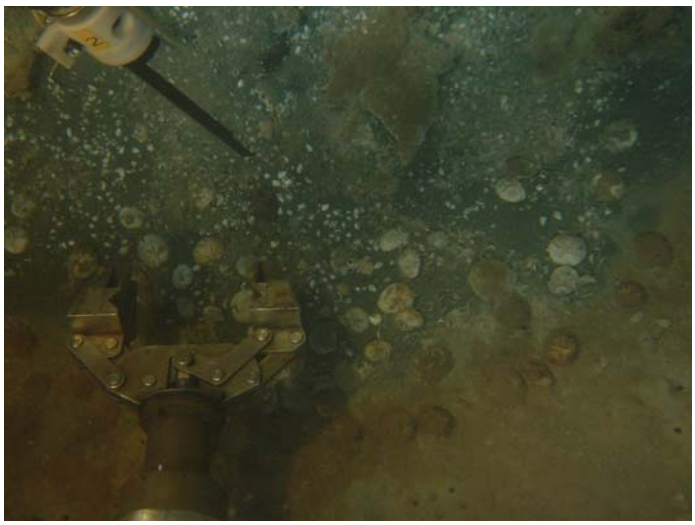
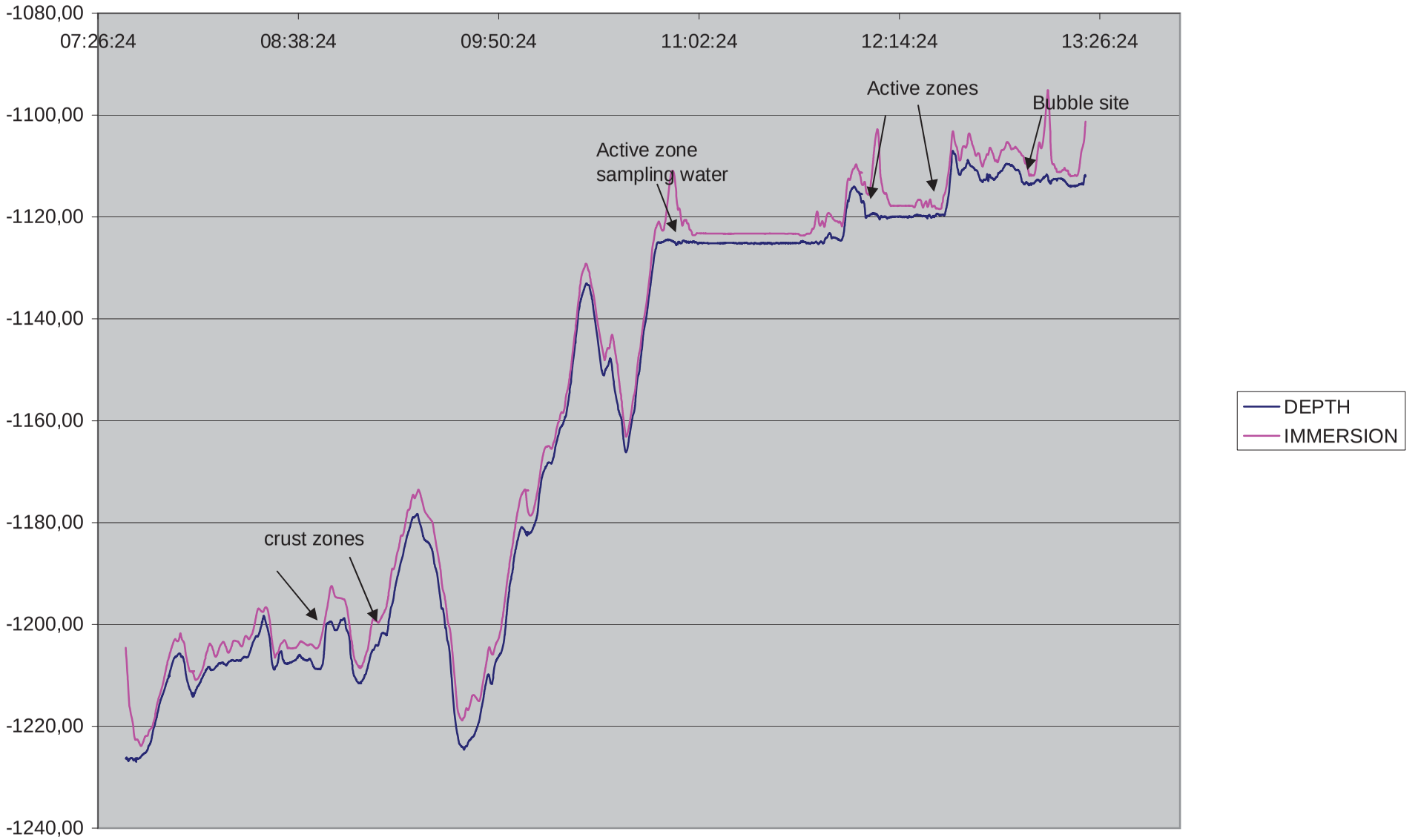


Fig 2.: Coring site PC-1649-3 with dead urchins, mat and crust -12:13:32

Fig. 3: Bubble site and sampling site for water sampling- 13:01:09

**Sample list**

| | Latitude | Longitude | Sample Number | |
|---|---|---|---|---|
| 08:39:54 | 40,8270500 | 27,9419000 | 1649-R1 | |
| 11:17:04 | 40,8254833 | 27,9338667 | PC-1649-1 | |
| 11:17:04 | 40,8254833 | 27,9338667 | WS-1649-6 | bottle 6 |
| 11:17:04 | 40,8254833 | 27,9338667 | WS-1649-7 | bottle 7 |
| 13:11:24 | 40,8322667 | 27,9340667 | WS-1649-8 | bottle 8 |
| 13:11:24 | 40,8322667 | 27,9340667 | WS-1649-5 | bottle 5 |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09:50:24
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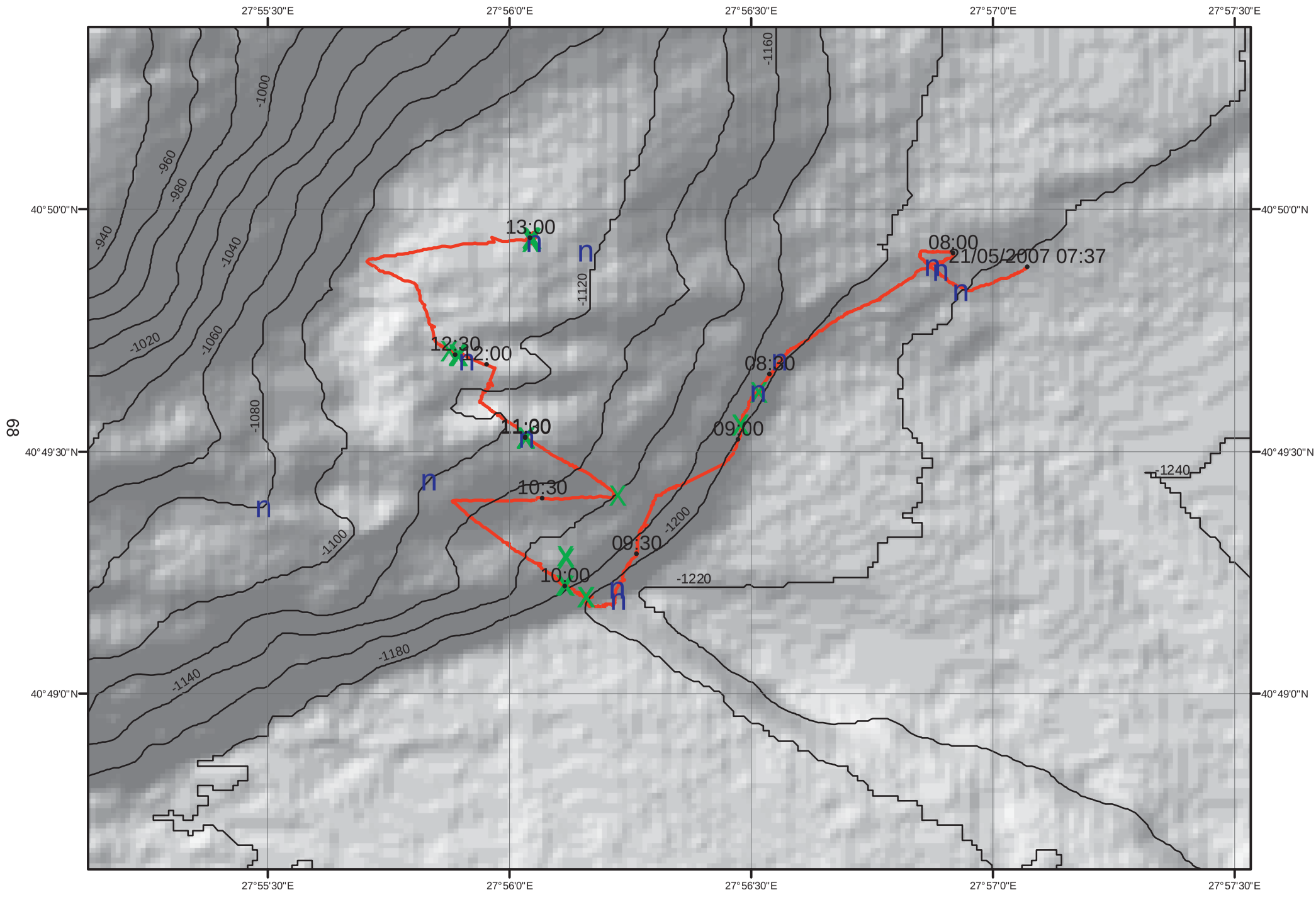
12:14:24
13:26:24
Active zones
Bubble site
Active zone
sampling water
crust zones
DEPTH
IMMERSION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21/05/2007 07:37

**MARNAUT Dive 1650/19/10**
22/05/2007

Scientist observer : Catherine PIERRE
Nautile pilot : Patrick CHEILAN
Nautile co-pilot : Olivier FAUVIN

Dive zone : NE edge of Marmara sea central basin, at the base of the escarpment (subbottom depth :1170 to 1160 m)

Objectives :
- sampling of fluids, gas, authigenic carbonate crusts and organisms at venting sites observed during Marmarascarp dive 211.
- Installation of two modules of microbial colonization (one on a venting site, the other one on the normal sea floor) that will be recovered during leg 3

Tools :
Microcat (Nautile basket)
Two biological boxes containing the colonization modules (Nautile basket)
Four push corers (Nautile basket)

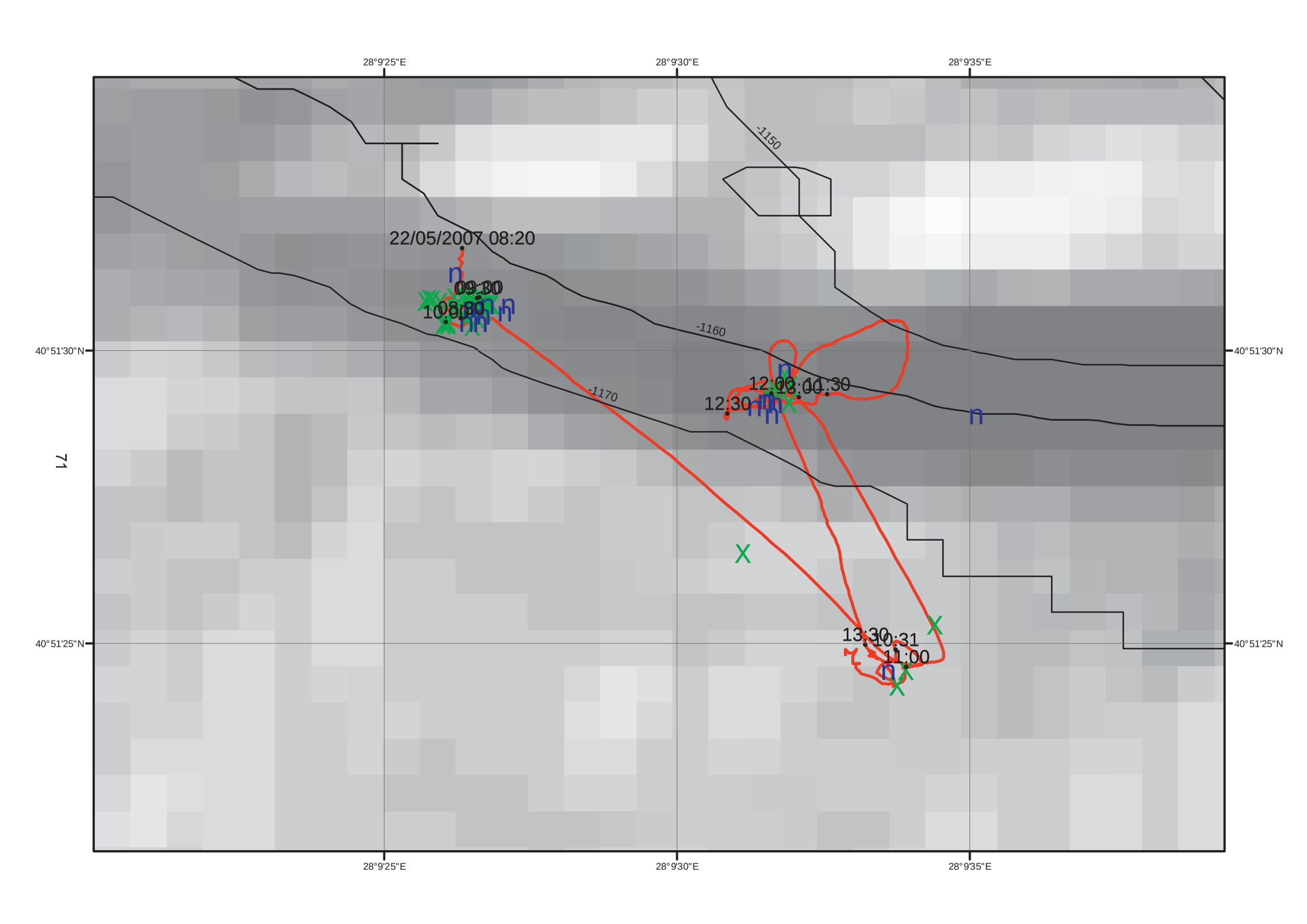
One Pegaz device (in the shuttle)
Two blade corers (in the shuttle)
Fluid microsampler (in the shuttle)

**Dive Report :**
STARTING DVD1
08 :04 - The Nautile arrived at the sea floor that is covered by beige colored pelagic sediment mottled by intense bioturbation. During all the dive, the visibility remained very low due to abundant marine snow, lowering significantly the quality of video pictures .
08 :22 - First occurrence of black patches
08 :23 - First occurrence of carbonate crust. It forms probably an extensive pavement below the cover of bioturbated pelagic sediment.
08 :25 - Extensive black patches covered by filamentous microbial mats, bivalve shells and urchins, and surrounded by carbonate crust pavement.
08 :26 - Detail of the edge of the carbonate crust pavement with microbial filaments. Black patches are visible on the non-encrusted sea floor where fragments of carbonate crust are disseminated. The black patches are roughly oriented in the N110 direction.
08 :30 :30 - Two small black active chimneys are observed in a large black patch area surrounded by carbonate crust pavement. We decided to install the first module of colonization at this site.
08 :37 - Close-up view on the two chimneys that are capped with white and orange microbial mats.
08 :39 - Close-up view of fluid venting from the top of chimneys.
08 :39 :20 to 08 :41 :29 - Close-up view of the black patch covered with white filamentous and ribbon-like microbial mats, bivalve shells and urchins.
08 :47 - Installation of the module of colonization mc2.
09 :00 - The chimneys have been accidentaly destroyed by water turbulence during the movement of Nautile.
09 :02 - Sampling of the black sediment , stored in the biological box 1.

09 :06 to 09 :15 - Microcat measurements within the stream of the venting fluid.
09 :22 to 09 :27- We tried to sample sediment with push-corer but the sediment was too soft and there was an indurated layer at a few centimeters depth.
09 :37- Installation of the module of colonization mc1 on the pelagic sediment, a few meter away from the zone of black patches where mc2 was deposited.
09 :44 to 09 :58 - Sampling of a layered carbonate crust that is colonized by sea anemonae and sponges.
10 :06- Repositioning of mc2 closer to the fluid stream.
END OF DVD 1 (10 :06)

STARTING DVD 2
10 :08 to 10 :16 - Various views of the sampling site.
10 :16 - Starting to go to the shuttle.
10 :33 - Arrival to the shuttle. Deposit of the biological boxes in the shuttle. Taking off from the shuttle : the pegaz device in the Nautile basket, the fluid multisampler and the blade corers in the Nautile claws.
11 :00 - Leaving the shuttle and going back to the profile.
11 :10 to 11 :11 - Broken fragments of carbonate crusts and black fish-eggs accumulations.
11 :26 - Broken fragments of carbonate crusts.
11 :36 - Numerous accumulations of black fish-eggs.
11 :34 to 11 :37 - Isolated black chimney surrounded by black fish-eggs accumulations.
11 :40 - Black chimney capped with orange bacterial mats.
11 :48 - We deposited the blade corer rack on the sea floor.
11 :55- The sea floor is covered with broken carbonate crust pavement (very bad visibility).
11 :59 :44 - Come back to the black chimney.
12 :02 to 12 :06 :50 - Fluid sampling (bottle 2) and close-up views of the filamentous microbial mats and of the stream of venting fluids.
12 :10 - Fluid sampling (bottle 3) at the same site.
END OF DVD 2 (12 :10 :30)

STARTING DVD 3
12 :18 - We put the fluid microsampler in the Nautile basket.
12 :34 - Recovery of the blade corer rack.
12 :44 - Blade corer L7 = Sampling of the sediment of the black patch surrounding the chimneys.
12 :55 - We arrived on a site with accumulation of black fish-eggs.
13 :02 - Blade corer L8 = Sampling of black fish-eggs.
Leaving the site to go to the shuttle.
13 :30 - We arrived to the shuttle.
13 :48 - We put the rack of push corers within the shuttle.
14 :04 - Starting the uplift of the Nautile.
END OF THE DIVE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**MARNAUT Leg 2**
**Nautile Dive 1651 / 23.05.2007**

**Pilots:** Jean-Paul Justiniano , Frank Rosazzo
**Scientist:** Gülsen Ucarkus

**Location:**

East of Kumburgaz basin in the Central High

**Objectives:**

1. Reconnaissance/exploration of the fault scarps in the Central High
2. Investigate and sample outcrops
3. Check if there are black patches, cold seeps and bubble sources around the fault scarps; collect push cores, fluid samples, microcat data

**Equipment:**

4 push cores
4 titanium syringe fluid samplers
microcat CTD

**Dive Observations:**

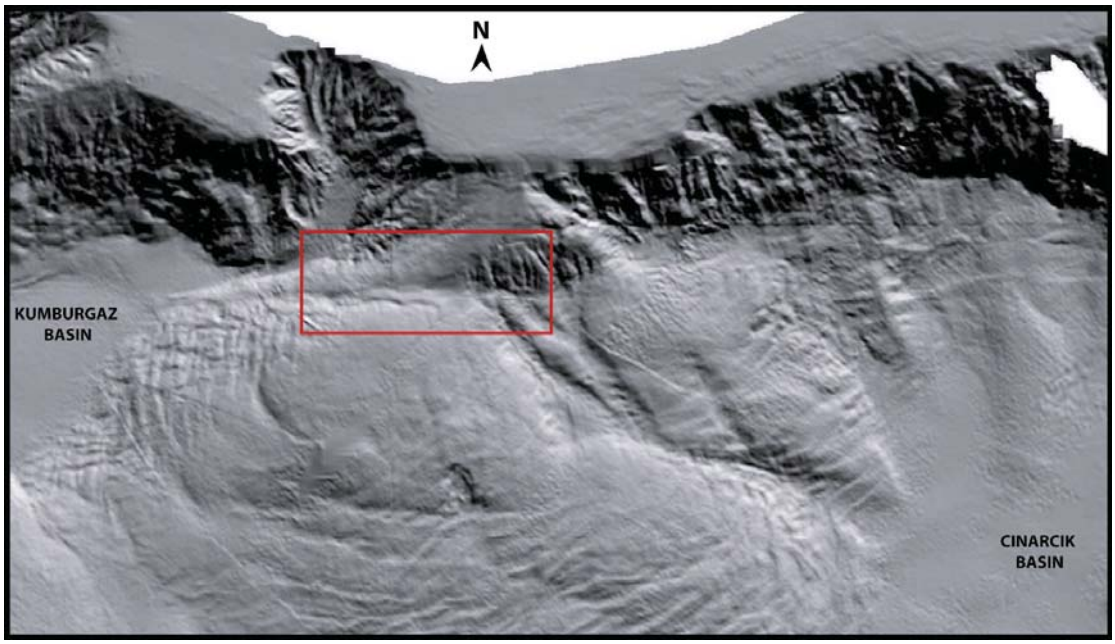



**Figure 1.** Coverage of the Dive 1651 site, indicated in the red box.

Dive 1651 focuses on the area east of Kumburgaz basin, at eastern Central High. This is the place where we observe a right-lateral offset of 3.5 km on the ridge at the Central High. Two fault strands are distinguished in that area from the bathymetry. Therefore, main target of this dive is to explore the escarpments of these faults.

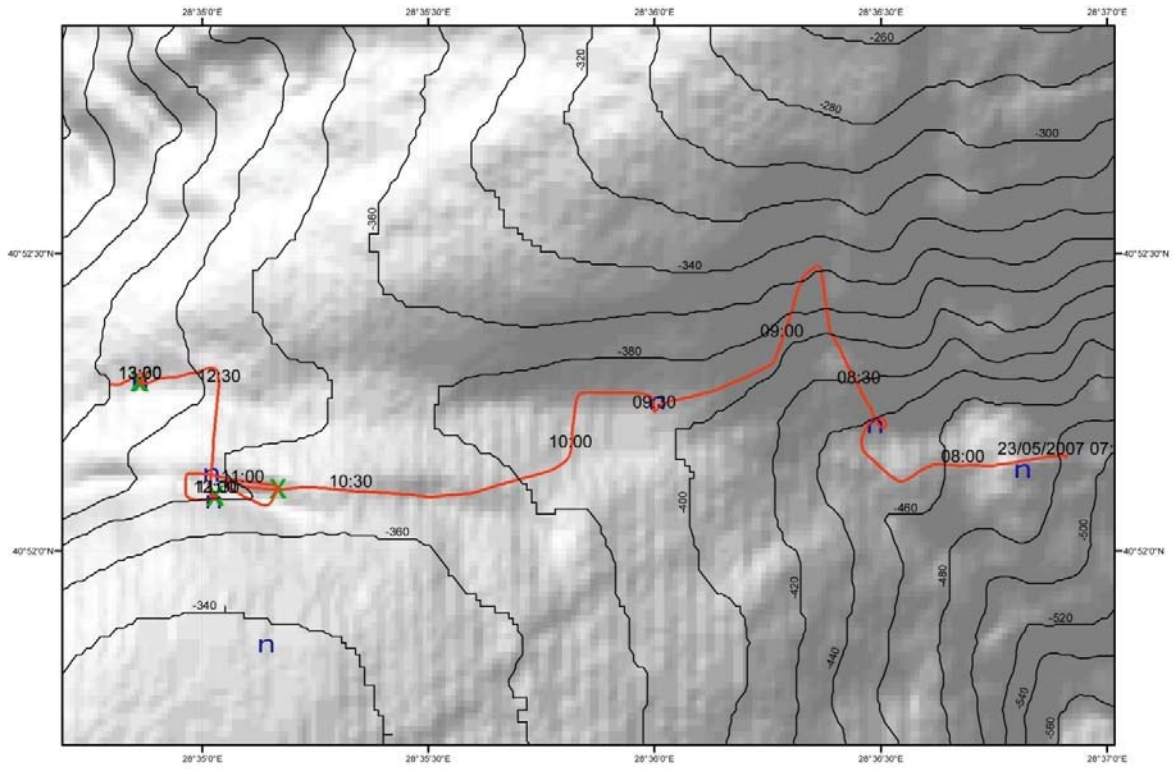



**Figure 2.** Navigation of the dive 1651

The points given below are located in the figure 3 which is a 3D view of the dive area.

**From point 1 to 2:** The dive starts at 07:43. The route covers the E-W trending scarp. No significant scarp morphology observed. Everything was blanketed by the hemipelagic sediments with abundant bioturbation.

**From point 2 to 3- 4:** We climbed the slope to the north to explore for the outcrops (08:25). No outcrops recognized other than the usual blanket of sediments. We exceeded the planned route more to the north in order to create the chance of finding outcrops. No blocks or fallen rocks. We went down the slope. The incline of the slope was recognizable. We reached the bottom of the slope at 09:30. Changing the planned route, I decided to follow an E-W direction parallel to the slope front where the fault passes. Unfortunately nothing observed but everything was covered by the yellow hemipelagic sediments. Another info is that the continuous marine snow which decreased the visibility also in the video record. We headed to the south to follow the southern scarp, at 09:46.

**From point 5-6:** We go along the southern scarp (10:13-10:46). I detected nothing regarding to the scarp morphology or black patches. Usual hemipelagic sediment covers everything. At 10:38,

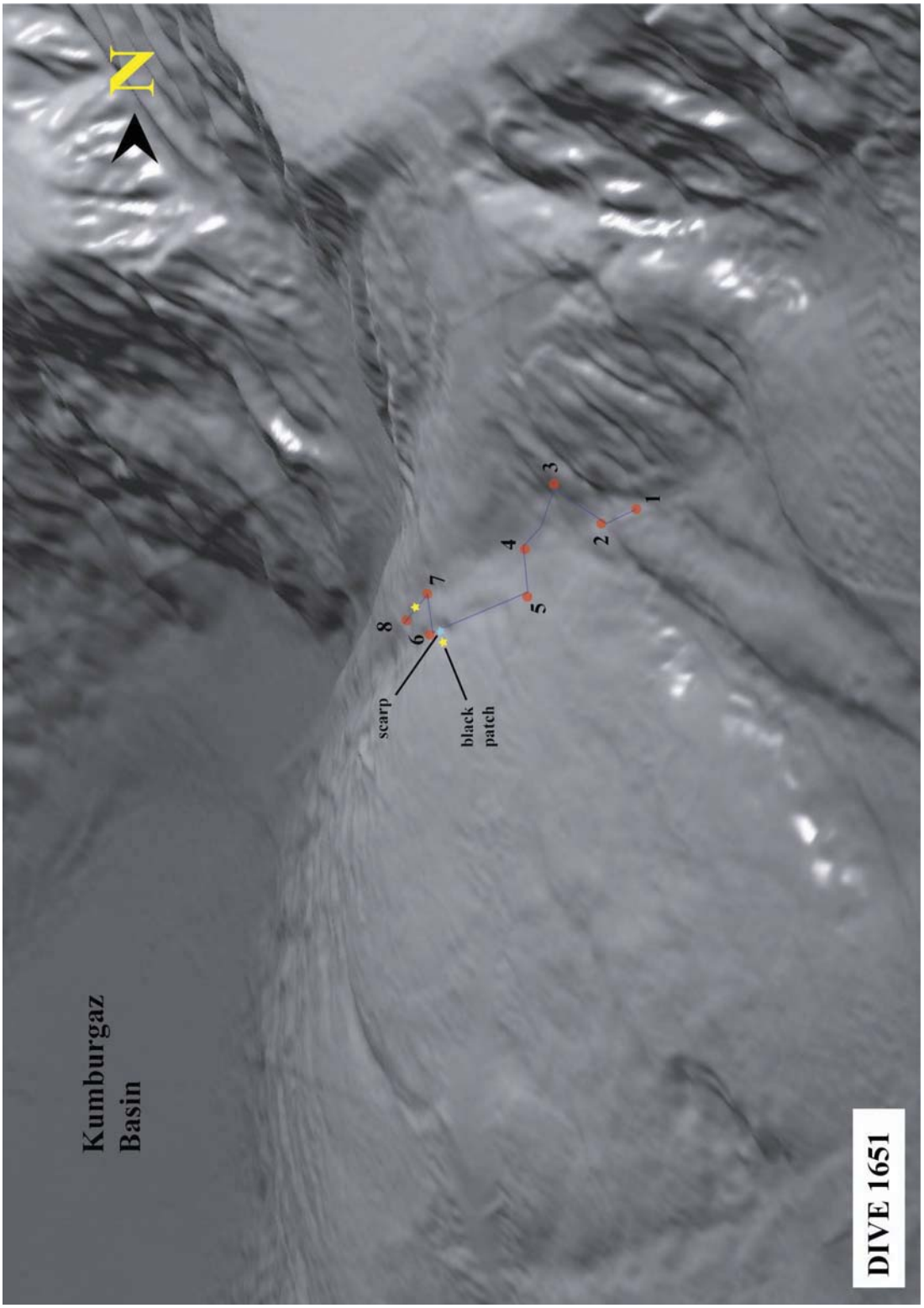



**Figure 3.** 3D view of the area covering dive 1651

we changed the planned route and turned SW (at 10:46) and kind of rotated around the final 200 m in order to cover more area and look for the scarp morphology. Further west, we made a square route and finally I recognized a small black patch covered with bacterial mat (at 11:36). Indeed it seemed as if it was small because it was draped by the sediments. But it was not that small as I first recognized (Figure 4) . We, first, took the water column sample (bouteille no.#1) and then two push cores. Core #8 from is taken from the center of the patch and core #7 from the edge of the patch.

**Figure 4.** Black patch which is observed in the south of the southern fault strand.

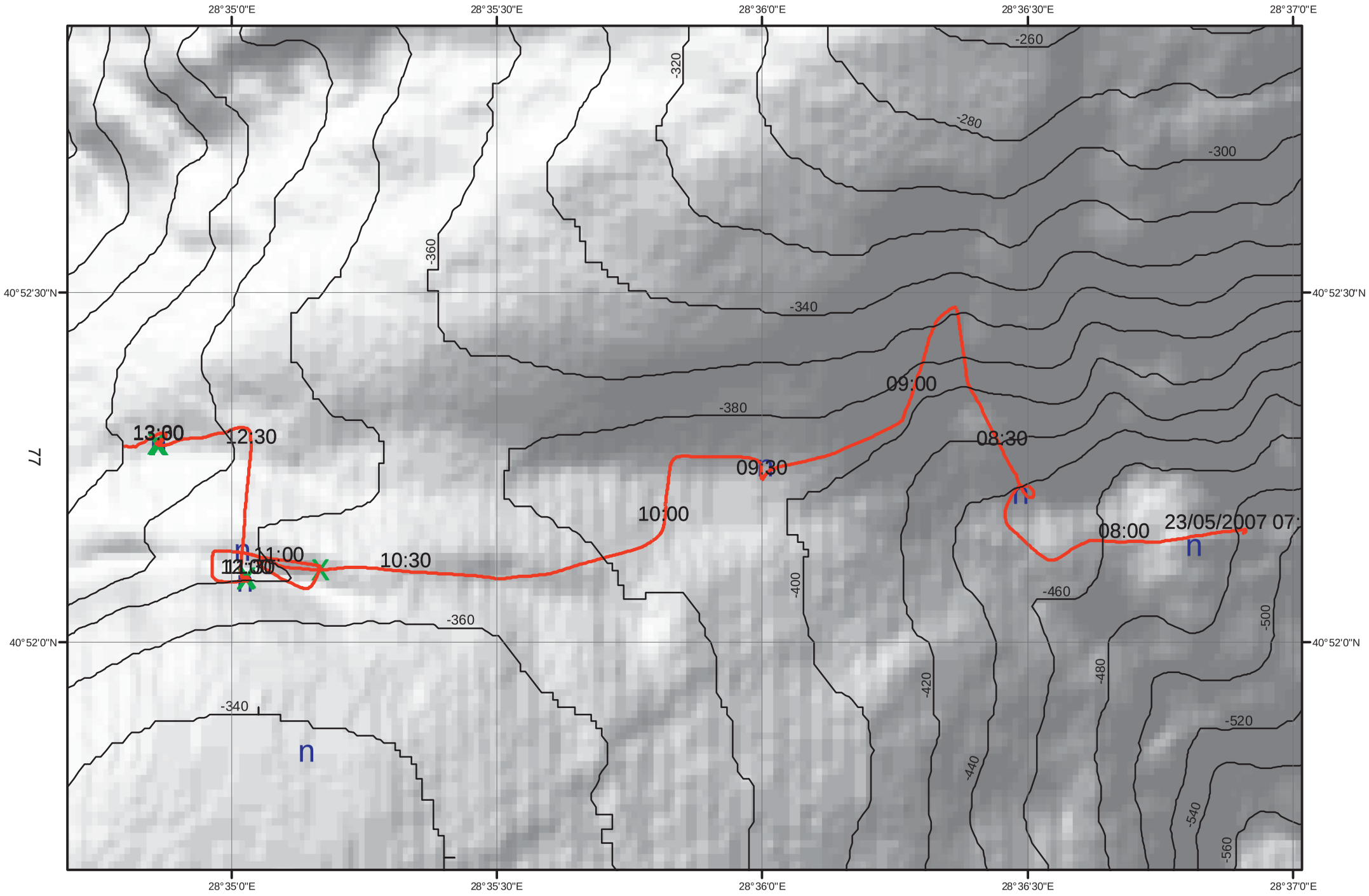
At 12:14, we headed north to go to the northern strand. As soon as we crossed the fault line on the route map, I recognized a ~1-2 m high scarp-like slope, at 12:19. It was fully covered by the sediments. We continued to the north. From **point 7 to 8** , we followed the northern fault strand but again we were not able distinguish anything other than the bioturbated pale yellow hemipelagic sediments. At 12:46 we recognized a black patch-like feature which had a kind of mountain-like relief. We sampled this feature (after it is interpreted by Mike as a dead animal). Water column sample bouteille n°2, two push cores core #5 and core #6. Our time for the dive was over after sampling in this site.

Dive 1651 ended at 13:48.

**Conclusion:**

This fault segment has long been thought to be the prime candidate for the localization of the large Marmara earthquake on account of its nearly complete seismic quiescence. During our survey, I observed that all the possible morphological features was draped by the hemipelagic sediments, which suggests that this area has long been not ruptured and thus it is still the potential site of the next earthquake.

| DATE | HEURE | LATITUDE | LONGITUDE | IMMERSION | CODE | LIBELLE |
|---|---|---|---|---|---|---|
| 23/05/2007 | 04:39:59 | 40.8640830 | 28.5856920 | 0.00 | MARQ | acoustic anomalie |
| 23/05/2007 | 04:40:50 | 40.8630670 | 28.5232500 | 0.00 | MARQ | acoustic end |
| 23/05/2007 | 04:41:30 | 40.8702180 | 28.6081070 | 0.00 | MARQ | fault1 |
| 23/05/2007 | 04:42:26 | 40.8708820 | 28.6000990 | 0.00 | MARQ | fault2 |
| 23/05/2007 | 04:45:03 | 40.8689830 | 28.6135670 | 0.00 | DEPA | MAL |
| 23/05/2007 | 11:36:55 | 40.8681330 | 28.5837500 | 384.00 | SITE | patch gulsen |
| 23/05/2007 | 12:19:00 | 40.8688670 | 28.5836670 | 380.00 | AUTT | ride |
| 23/05/2007 | 12:46:37 | 40.8713830 | 28.5810330 | 413.00 | DEPA | Patch-like feature |
| 23/05/2007 | 11:58 | 40.8682167 | 28.5838000 | 381.00 | | Bouteille no.1 |
| 23/05/2007 | 12:01 | 40.8682000 | 28.5838000 | 381.00 | | Core n°8 |
| 23/05/2007 | 12:14 | 40.8681500 | 28.5837500 | 373.00 | | Core n°7 |
| 23/05/2007 | 13:02 | 40.8713833 | 28.5810000 | 404.00 | | Bouteille no.2 |
| 23/05/2007 | 13:15 | 40.8715167 | 28.5811000 | 402.00 | | Core n°5 |
| 23/05/2007 | 13:30 | 40.8714167 | 28.5810333 | 407.00 | | Core n°6 |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REPORT OF THE DIVE 1652/21/12

Date: 24/05/2007

Pilots:
Patrick Cheilan
Séverine Cipriani (co-pilot)

Scientist:
A.M. Celal Sengör, geologist

Dive objectives:

To study the ridge at the foot and the western breakaway wall of the major late Pleistocene landslide at roughly between 40 degrees 46 minutes and 40 degrees 45 minutes N latitude and 29 degrees 11 degrees and 29 degrees 13 degrees E longitude. It was expected to collect rock samples from the breakaway wall with a view to establish the shear resistance of the rocks making up the breakaway wall. In addition an attempt was made to see whether any black patches or any fluid emissions could be seen.

Dive summary:

The dive was a great success from the viewpoint of outcrop geology and a complete failure from the viewpoint of finding black patches or fluid emissions. A total of 12 samples were collected, the majority of which being foliated shales with consistent southerly and southeasterly dips. The breakaway wall seems to have been defined by joint sets in the rock. The region was predestined for a major ladslide form the viewpoint of its rock type and structure. This dive led to a major change of plan and dive 1653 (Pierre Henry) was directed to another outcrop area to the west-northwest with a view to seeing whether that area was under a similar threat.

Course of the dive:

At 07:35:01 GMT, *Nautile* arrived at a depth of 1188,00 m at long. 29,1762833 and lat. 40,7496833. Where we arrivd the ground looked like a stone pavement covered with numerous irregular stones. This was however deceptive. What we were seeing was a buff-coloured hemipelagic sediment blanket patchily covered by a brown fluffy material.
07:37:56. This is when we have poked the ground and saw that it was all soft sediment. An enormous amount of bioturbation holes perforate the ground. They are conical depressions of 10 cm scale with holes at their bottoms of about 3 cm diameter. They are very frequent. Their frequency is about one every ten cm.
At 07:42:57 A very small black patch was seen. Tiny. Had an elongation 315 degrees. No more than 15-20 cm in diameter.
At 07:45:42 We have reached the first escarpment, but there was no change in the nature of the ground.

At 07:46:42 Individual pieces of rocks that have slid or fallen into their present locations have started.
At 07:47:42 A breccia cobble was seen.
Until 07:50 lots of individual cobbles look imbedded in sediment.
At 07:52:50 We obtained the first sample: It is a breccia:

**Shape of sample:**
Sample consists of four pieces:

a)Parallel-sided irregular prism
Length: 15 cm
Maximum width 9 cm
Average thickness 5 cm

b)Parallel-sided irregular prism
Length: 11 cm
Maximum width: 7 cm
Average thickness: 5 cm

c) and d) Two broken pieces of the same

**Colour:**
Mouse-grey to darkish grey coloured on the fresh surface. One flat surface is encrusted with a greenish buff-coloured travertine-like material. The opposing surface is covered with iron and sulfide crust of dark brown to black colour.

**Composition:**
Clayey limestone with coarse clasts of the same material. In the 'upper' and 'lower' surface of the specimen, there is a travertine-like crust with generally a millimeter-thickness. In places where this crust encrust also other material that happened to be on the surface of the rock, its total thickness may be more (cm-scale). The 'lower' surface seems to be also coated with a thin film of iron sulfide.

**Structure:**
*a)Sedimentary:*
The tabular shape is probably parallel with bedding if not the bedding itself. The 'clasts' may be diagenetic and their diameters may reach up to 2 cm.

*b)Secondary:*
The rock shows a Rauwacke-style cavernous fabric. This fabric seems preferentially localized along a stylolitic fabric parallel with 'bedding.'

The travertine-like coating has fine laminar structure and many organisms attached to it and coated by it. One conspicuous organism is a twisted tube.

At 08:00 we saw another piece of 'breccia'.
At 08:02a light coloured small pebble. We also reached the top of the escarpment. The same boiturbated sedimentary blanket continuing.
At 08:03 a few pebbles below us. They all look as if they are buried in the sediment.
At 08:10: 03 a small pebble beneath us.
At 08:13:38 we began descending again
08:15: 13 still descending. Much bioturbation.
08:16:42 One piece of buried looking stone. But the rest the same sediment-blanketed stuff.
08:22:31 Bioturbation holes every 5-6 cm. Here Patrick tried to penetrate the sediment and reported that we have at least 30 cm. sediment cover. Very easy to penetrate, almost like snow.

08:27:53 A very dark grayish-blackish patch about 10 cm across. Entirely solitary.
08:28:01 To the right topography begins climbing vey gently with still the same sedimentary cover and bioturbation.
08:34:17 Big piece of rock that seems to have tumbled down. I thought it resembled the Siluro-Devonian limestones of Istanbul.
08:36:14 Another small piece of stone about 10X10. We began gradually climbing.
08:37:41 Seems a carbonat covered piece of rock. Here every 10 to 20 cm a bioturbation hole. The 'rock' turned out to be a plastic bag!!
09:01:07 Patric announces that we are near the principal escarpment
09:01:42 The ground changes character. Numerous stones strewn on the surface. But some of these stones may actually turn out to be sediment on the basis of our later experience.
09:02:45 We saw a small group of tiny black patches. These make up a patch in themselves.
09:43:57 Samples 2 and 3 from the sedimentars surface where these rocks are strewn:

Sample 2: **Shape of sample:**
V-shaped sample
Maximum width 14 cm (wing-span)
Width of the wings 5 cm
Thickness of the wings 6 cm.

**Colour:**
Outer surface is covered with an iron rich brick red alteration halo.
On fresh surface the rock has a salt-and-pepper appearance. The matrix is grey and the small clasts have colours of black, white, red and grey. Towards the outside of the sample an alteration halo of ligher colour develops. It has an average width of 1 cm.

**Composition:**
It is a carbonate cemented breccia with very badly sorted angular clasts with abundant shell material including pectens and other bivalves.

**Fossil content:**
Abundant shell fragments including pecten and other bivalve fragments. Probably Pleistocene in age.

**Structure:**
No particular structure is observed.

**Note:**
The sample was broken by a hammer for identification.

9:06:08 Locally derived large pieces of rock at the foot of the cliff. This is one of our remarkable points because it is the beginning of the principal escarpment.
9:07:01 Ground still sediment covered, bioturbated but strewn with stones. Sample 3 here:

Sample 3: **Shape of sample:**
Thickness of specimen: 3.5 cm
Length of specimen: 14.5 cm
Maximum width: 11 cm

**Colour:**
Very dark grey on fresh surface

**Composition:**

Black pyrite-bearing Rauhwacke breccia with probably dolomitic (very slow fizzing with 10% HCl) angular clasts, also shell fragments and quartz grains up to 3 mm in diameter.

**Structure:**
No structures other than Rauhwacke-type cavernousness.

**Note:**
One edge of the specimen was broken by a hammer for identification.

09:10:25 Patrick says there is 100 metres to the Principal Escarpment
09:11:27 Increasingly more frequent rock pieces slide blocks on the surface. We are gradually climbing up a slope. There are rocks with a tabular aspect dipping towards us, but we are unsure whether they are outcrop.
09:13:10 Small piece of rock.
09:14:07 Still the same sedimet-covered ground. No significant pieces of rocks.
09:14: 56 Piece of slid rock. They are far in between.
09:16:22 Still no major pieces of rock
09:17:15 Still the same sedimented ground with no fallen blocks.
09:09:18:20 Considerable pieces of rocks. Breccia-like things dipping towards us.
09:19:18:57 Reached the escarpment.
09:32:59 We collected the fourth specimen from what seems a real outcrop.

Sample 4: **Shape:**
Irregular angular specimen of about 6 cm in diameter.

**Colour:**
Brick red on altered surface. Milky-pinkish white on fresh surface.

**Composition:**
Orthoquartzite with a grainsize of o.3 to o.5 mm. Rare grains of dark minerals.

**Structure:**
Homogeneous. It has one red vein of submillimetric width.

**Note:**
The sample was found loose on the hemipelagic sediment cover. One corner of it was broken for identification.

09:34:05 The slope is covered with rocks.
09:43:50 Bedded rocks. Strike E-W to NW-SE dipping S.
09:44:26 Nicely bedded rocks. Dark coloured. Could be Upper Devonian.
09:46:19 Beds dipping 30 degrees to S.
09:47:14 Good outcrop. Bedded.
09:48:35 Dips now steeper 35 to 40 degrees in the same direction.
09:52:12 Large sample not in place but clearly belongs to this outcrop. The reason we could not collect fresh samples was thatthey ar difficult to break. Dip is towards us so it is to the S, 35 to 40 degrees.
09:53: 38 Outcrop.
09:54:56 A slope full of fallen blocks and outcrops.
09:55:35 Dip has become gentler. Strike still E-W. We are climbing up the stairs defined by beds about 15-20 cm thickness.
09:57: 28 Dip to S strike E-W.
10:03:55 Sample definitely collected from an outcrop:

Sample 6:**Shape of sample:**

Irregular, lens-shaped specimen. Diagonal diameter 11 cm. Maximum width, 5 cm.

**Colour:**
Mose gray

**Composition:**
Calcareous shale.

**Structure:**
S-C fabric. There is a milky white calcite vein in the specimen, part of it crossing the tectonic fabric at high angles, the other parallel with the S-fabric and has a syntaxial growth fabric in it.

10:05:54 107 striking surfaces possibly a spaced cleavage. Very pervasive in the oucrop, with 10-20 cm spacing. It is not penetrative. It and the strike determine outcrop outlines.
10:07:34 Dip may have changed to NW? But this might have been a fallen block. Outcrops are sparser now than before.
10:08:37 50 degrees north dip here.
10:09:38 Slope very steep. 45 to 50 degrees. Strike has become about 45 degrees. Dip steeply to NW. Regularly bedded rock. 10-15 cm bed thickness.
10:10:58 Another jointing direction: strike N-S very steeply E dipping (85 degrees). 170 direction less visible here.
10:12:22 Strike 45-40. Dipping strongly to NW.
10:12:55 Dip changed again dipping towards us. Strike N-S dipping eastward (30 degrees).
10:13:43 Abundant outcrop.
10:18:39 Attempts at collecting sample from the bedded sequence. It is very hard, because the rocks are hard.

Sample 7: **Shape of specimen:**
Irregular with a rough diameter of 6 cm

**Colour:**
Gray

**Composition:**
Calcareous shale

**Structure:**
S-C fabric with possible millimetric floating hinges.

**Note:**
Another sample of the same rock, Specimen irregularly-shaped with a diameter of 4 cm.

10:21:21: Magnificent outcrop. Strike almost N-S. Gentle dip towards E. Formed from bedded sedimentary rocks. Bed thickness 10-20 cm. This outcrop has a fold! Fold axial plane strikes N-S and dips E. Closed fold, nose towards the E. Another fold cut by a fault striking N30 W almost vertical. Fold axis plunges N 70 degrees. Fold closes northward.
10:25:54 Joint 345-350 strike dipping steeply SW.
10.28:33 Jointing E-W. Folding.
10:29:49 Strike NS- dips E.
10:31: 06 Huge outcrops dipping gently to E and SE.

10:32:14 We encountered a whole wall. Collected a sample. Just above the 1000 m line (997 m.)

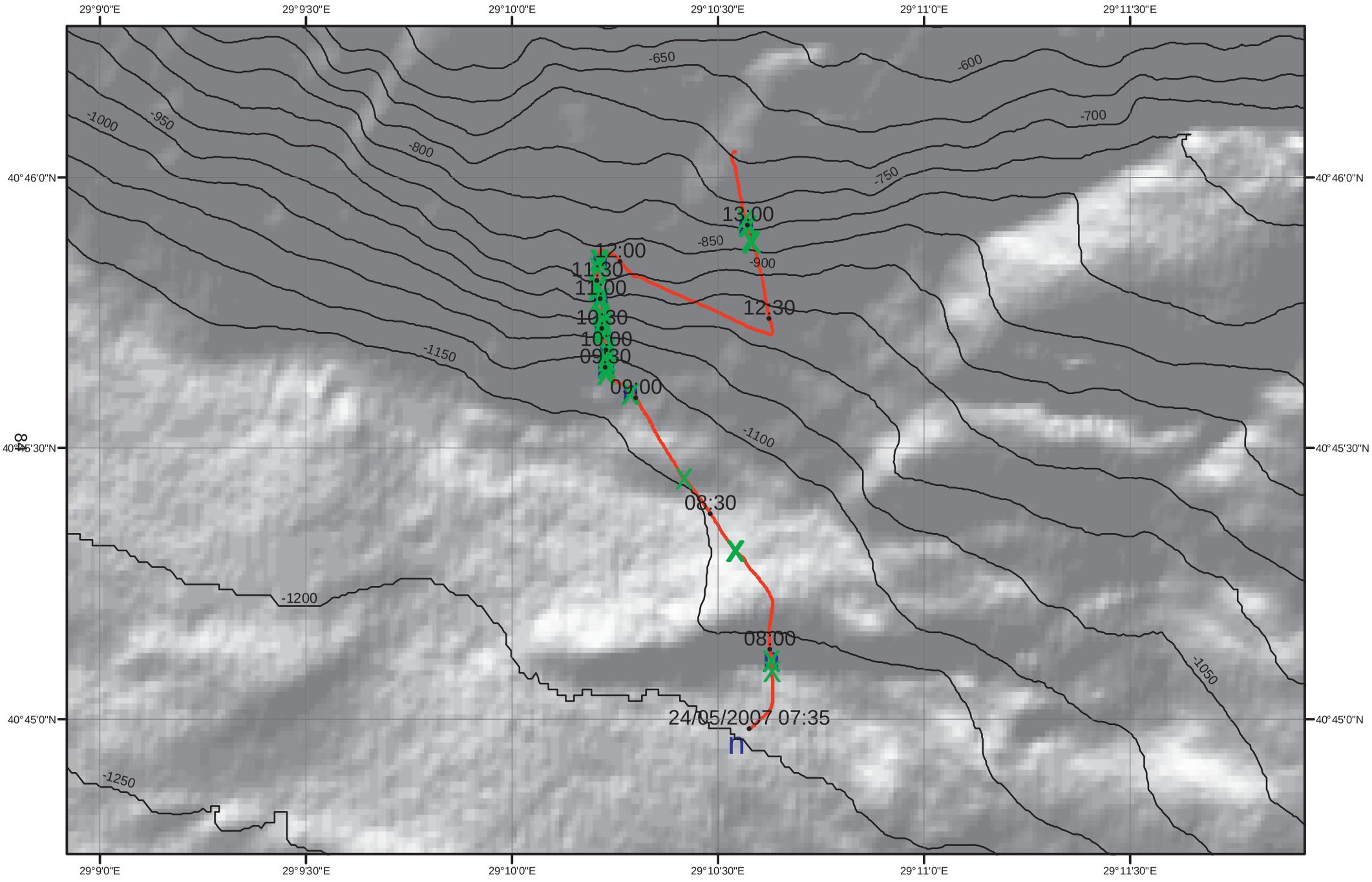
Sample 8: **Shape of sample:**
Iregular with dimensions roughly 5 x 5 x 3 cm

**Colour:**
Dark gray

**Composition:**
Calcareous shale

**Structure:**
S-C fabric and a possible crenulation cleavage at high angles to the S.

10:36:41 Bedding dipping to E. But there are surfaces in the bedding that dip more steeply eastward. Hard to tell the nature of these surfaces. 150 degree joint sets.
10:39:57 Another joint set 60 degrees very steep dip to SE.
10:40:54 Bedding strikes N-S dipping about 30 to 45 degrees W.
10:42:55 We have been climbing across a pure outcrop.
10:43:58 20 degree axial direction on a gentle fold. Dips are still gently to the E.
10:45:14 Steep slope but outcrop si sparse, but shortly afterwards outcrop appears again. Dips are to the E.
10:47:04 Large blocks and immediately afterwards another huge outcrop. Strike 20 degrees, dip 20 to SE. A lot of detached blocks on the surface of the outcrop.
10: 48:26 Now gentle NW dips.
10:49:15 Huge beds with dips to SE.
10:50:56 Dips to the E. Easterly rather than southeasterly. Thick beds. A very steep cliff of more than 60 degrees. Almost vertical. Continuous outcrop.
10:53:13 Beds dipping steeply W.
11:08:38 Fold axis plunging N opening to the E closed fold.
11:09:40 Sample 9: Numerous samples of mouse gray calcareous shales with possible Neptunian dykes parallel with tectonic foliation.
Jointing 330: vertical. A whole population of corals and bivalves.
11:14: 10 Same place as the previous locality. Everything here dips E and SE 15 to 20 degrees. All edges of the beds are truncated along joint sufaces and all beds generally dip towards the landslide. Patrcik collected corals.
11:15:40 Still the bedded sequence. The outcrop gives the impression of being Upper Devonian. It is amazing how the beds are truncated against the landslide.
11:19:52: Still the same rocks with easterly dips.
11:21:42 Medium to thickly-bedded sequence.
11:32:29 Back to sediment-covered slopes with bioturbation.
11:33:41 Steps indicating very gentle SE dips. Joint direction is about 40 degrees. Hard to tell dips.
11:38:24 The first appearance of castle-like structures, which we thought to be rocks and turned out to be entirely fine clastic sediment. It seemed to have a fabric striking 6 degrees and dipping very steepls W-NW. We collected a sample:
Sample 11: Recent gray mudstone breccias. In one sample travertine-like calcareous deposit. In adition numeros balls of semi-consolidated gray mud.
12:04:56 Thinly-bedded sequence dipping SSE with angles 30 35 degrees.
12:59:00 Sample of unconsolidated but solid-looking objects: Sample 12: Dominantly light brown to yellowish rown mud. Where we collected it, it builds rectangular castle-like structures giving the appearance of solid rock outcrops.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**MARNAUT Dive 1653**
**25/05/2007**

**Scientist observer :** Sinan OZEREN
**Nautile pilot :** Franck ROSAZZA
**Nautile co-pilot :** Xavier PLACAUD

**Dive zone :**
Dive at the southern slope of Cinarcik Basin
Dive duration: 05:44 hours on bottom - Immersion max: 1240 m

**Objectives :**
The mission's aim was to explore the nature of the two SAR anomaly spots, one on the Cinarcik Basin, near the toe of the slope that forms the southern bound of the Basin and the second on the toe of the basin. In addition to that, we wanted to make assessments on the morphology of the lower part of the slope in relation to the landslide activity.

**Tools :**
-Four push corers (Nautile basket)
-Pgas (Nautile basket, never used)
-Fluid sampler (Nautile basket)

**Dive report:**
The slope that bounds the Cinarcik Basin from the south is much less steep than the northern slope. The dive started to the north of the sothern slope (the point zero). When we reached the bottom, it was flat and covered by soft sediments, light brown-yellow coloured and an additional patchy, thin layer of brown coloured sediment. We then headed towards the point-1 where the anomaly data indicated that we might have either fluid seepage or bubble emission. When we arrived to this location we did not notice any feature that might relate to the anomaly, the sedimentary cover looked identical to the previous. This being the case, I decided to make zig-zags in the region with the hope of finding any black patches or any other visual evidence of the anomaly but at the end we did not find anything so we decided to head towards the toe of the slope.
After passing point 1, we headed to the toe of the southern slope bounding the basin, we noticed a black patch of the size 2-3 times that of the submersible. The black patch was irregular in its shape and there was a small carbonate block in the middle of the patchy region. Height of the carbonate block was around a meter or so. I decided to do a push-core on the black patch. We attempted twice and both failed due to the softness of the black material. The pilot said that under the very soft black material there was a very hard layer, presumably carbonate. The thickness of the soft material was around 10 cm and may be greater than that at places. We tried very hard to cut off a sample from the carbonate platform, it proved very difficult for the rock was very hard. After having failed to do push-cores, we did a fluid sampling on the central part of the black patch. After that, we started to proceed towards south, towards the toe of the slope.
At around 10:30, we encountered a large rock, very steep, almost like a wall. On its flanks there were broken bits and one could see white strata at places. This is probably a very large carbonate platform, almost 15 metres high. The cracks on the rock are not spatially systematic. The top of the platform is relatively flat and there are black patches on the top. Some black patches are on the flanks of the cracks that we observe. No fluid seepage or gas emission has been observed in this exceptionally high and large, turtle-shell shaped carbonate

platform. There are corals on it. We sampled some pieces from this platform and it proved very difficult as the rock was very hard. After we passed this large outcrop, we encountered another one, smaller in size but with similar chromatic and morphological characteristics. By now, we were on the lower extremity of the slope already. On the landslide there were several boulders, some of them were quite large (size of around one half of a medium-size car). One interesting feature that we consistently observed were aligned black patches that elongated down the slope, as to this day I have no explanation why should they trend in down slope direction. Some of these elongated patches were as long as 3-4 meters. In this part of the slope there were also several small-sized rock debris, not covered with sediments that may indicate that the landslide is active. On top of any carbonate platform we observed black patches on the flat tops.

In general, the black patches were observed both on the slope and on the flat basin, but those on the flat basin were much larger than those on the slope. Basically, when we were moving along the toe of the slope, we kept seeing blocks of various sizes with occasionally black patches on top.

After having spent a long duration trying to sample parts from the carbonate platforms on the slope, we had little time left so we headed towards the second anomaly region on the toe of the slope. There we spotted a large black patch region, but not exceptionally large compared to the others we have been observing. We did push-cores and fluid sampling on this black patch site and returned to the surface.

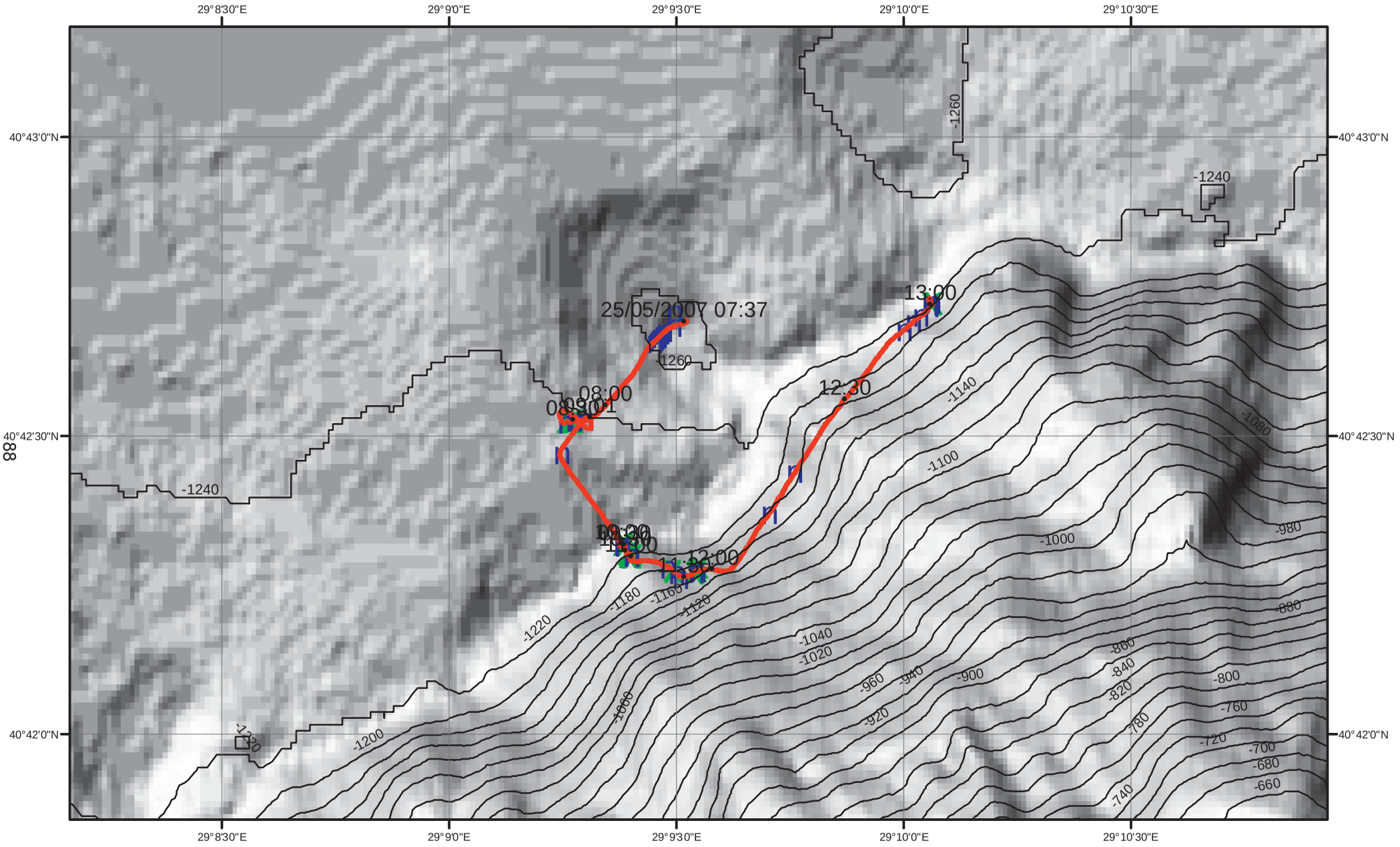
**Dive highlights:**

| TIME | DEPTH (m) | LAT | LONG | EVENT |
|---|---|---|---|---|
| 07:38:05 | 1258 | 40,712 | 29,159 | arrival to the bottom |
| 07:41:15 | 1263 | 40,711 | 29,158 | starting to see the brown, monotonous sediment |
| 08:11:25 | 1240 | 40,709 | 29,155 | push core attempt on a grey-organic-like object |
| 08:15:00 | 1240 | 40,709 | 29,155 | push core effort continues with insertion and sucking difficulties |
| 08:20:18 | 1240 | 40,709 | 29,155 | push core effort continues with insertion and sucking difficulties |
| 08:29:00 | 1240 | 40,709 | 29,155 | push core failed due to soft sediment-we start to zigzag the area |
| 08:33:10 | 1233 | 40,709 | 29,155 | we observe some light grey cover on the sediments |
| 09:17:16 | 1234 | 40,705 | 29,156 | we observe a large black patch, 2-3 size of the submersible and several other patches |
| 09:27:53 | 1233 | 40,705 | 29,156 | we see a tiny carbonate crust, maybe 60-70 cm high, black patches around |
| 09:33:42 | 1235 | 40,705 | 29,156 | push core attempt (no 3) on the black patch next to the carb. crust, cannot be inserted completely due to a hard layer underneath |
| 09:45:00 | 1235 | 40,705 | 29,156 | push core no 3 fails due to the fluidity of the black patch material |
| 09:47:00 | 1235 | 40,705 | 29,156 | fluid sampled in the same location bottle no 5 |
| 10:00:15 | 1233 | 40,705 | 29,156 | efforts start to rock sampling (no 1) from the carbonate crust, takes several minutes |
| 10:17:55 | 1232 | 40,705 | 29,156 | efforts to sample rock (no 2) continue and prove extremely difficult due to the hardness of the rock, finally we took a free rock (greyish colour) from the side |

| | | | | |
|---|---|---|---|---|
| 10:24:29 | 1226 | | | we see more black patches and mostly rectangular pieces of rocks |
| 10:27:29 | 1220 | | | we follow the isobaths and we see a very large platform, like a wall, black patches on it |
| 10:30:00 | 1218 | 40,705 | 29,157 | we climb up the wall, tiny black patches, corals, the wall is very steep, around 20 metres up to now |
| 10:38:00 | 1214 | 40,705 | 29,157 | dome-shaped top of the platform is visible, aligned black patches on the top |
| 10:49:35 | 1215 | 40,705 | 29,157 | other platforms, more flat topped, we start rock sampling from the flank of a platform, cracks, black patches on the tip of cracks |
| 11:12:30 | 1213 | 40,705 | 29,157 | finished rock sampling, we see black patches of very irregular shapes |
| 11:19:19 | 1209 | 40,705 | 29,158 | many rock fragments on the ramp, we follow the isobaths on the ramp, more aligned black patches, along the ramp |
| 11:28:00 | 1198 | 40,705 | 29,158 | we sampled another rock and we observed a boulder of large proportions (half the size of a car), more black patches, we also encounter a very large black patch |
| 11:31:45 | 1192 | 40,704 | 29,159 | a huge black patch site and a platform, flat with some black patches on it, white sedimentary stratification on the platform |
| 11:39:19 | 1192 | 40,705 | 29,159 | rock sampling from the flank of the platform |
| 11:51:00 | 1191 | | | failure to sample from the flank of platform, the rock is very hard |
| 11:55:48 | 1179 | | | flat topped platform with very sharp edges, staircase-like video-3 may be an important structural feature, we are heading towards point 4 |
| 12:20:23 | 1201 | 40,708 | 29,163 | large black patches aligned along the slope, lots of boulders around |
| 12:56:25 | 1244 | 40,712 | 29,168 | push core sampling on a black patch , push core no:1, largest black patch site, several times the size of the Nautile |
| 13:02:05 | 1245 | 40,712 | 29,168 | push core sampling on the same site, push core no:2 |
| 13:07:53 | 1245 | 40,712 | 29,168 | fluid sampling on the black patch site bottle no:6-7-8 (multi-preleveur) |

**Sample list:**

| TIME | DEPTH (m) | LAT | LONG | SAMPLE | OBSERVATIONS |
|---|---|---|---|---|---|
| 09:47:00 | 1235 | 40,705 | 29,156 | fluid sample FS-1653-5 | |
| 12:56:25 | 1244 | 40,712 | 29,168 | push core PC-1653-1 | largest black patch site, several times the size of the nautile |
| 13:02:05 | 1245 | 40,712 | 29,168 | push core PC-1653-2 | same site than PC1 |
| 13:07:53 | 1245 | 40,712 | 29,168 | FS-1653-6, -7 and-8 | black patch site |
| 10:02 | 1233 | 40,705 | 29,156 | R-1653-1 | |
| 10:21 | 1232 | 40,705 | 29,156 | R-1653-2 | |
| 11:11 | 1213 | 40,705 | 29,156 | R-1653-3 | |
| 11:27 | 1198 | 40,705 | 29,158 | R-1653-4 | |
| 11:45 | 1192 | 40,705 | 29,159 | R-1653-5 | |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**Campagne**
**Chef de mission : Pierre Henry / Celal Şengör**
**Travaux réalisés par le Nautile**

| | |
|---|---|
| **N° absolu de plongée** : 1654 | **Date** : 26/05/2007 |
| **Observateur**<br>- Nom : Pierre HENRY<br>- Spécialité : Géophysique<br>- Organisme : CNRS | **Pilote** : Jean-Paul JUSTINIANO<br><br>**Navigateur engin** : Patrick CHEILAN |

**Objectif(s) de la plongée** :
Repérage de sorties de fluide et détermination de leur contexte structural
Exploration of cold seeps and of their structural context

**Coordonnées du point d'arrivée sur le fond**
- Longitude : 29,104 - Latitude : 40,7756

**Profondeurs explorées pendant la plongée**
- Minimum : 964 m - Maximum : 1224 m

**Durée totale de la plongée** : 6:52 **Durée sur le fond** : 5:31

**Equipements scientifiques**

- installés sur le submersible : Microcat – Water samplers (4) – Push corers (4) - Pegaz

- transportés dans la navette :

- mouillés en autonome :

**Travaux réalisés sur le fond**

- Distance parcourue : 3900 m

-Travaux réalisés : Observation and sampling – Temperature and Salinity measurements

- Echantillons : 3 rock samples (R1,R2,R3) – 2 water samples (bottles 3 and 4)

- Nombre de bandes vidéo : 6 DVD

- Nombre de photos : 65 pan and tilt + 110 pentax

**Dive objectives:** Dive 1641 confirmed the presence of very active cold seeps at the base of the Cinarcik northern scarp. However, no evidence for active seepage was found during dive 1652 located at the eastern end of this scarp slope.
The purpose of this dive was (1) to assess the extent and importance of the active outflow zone associated with the cinarcik N scarp by exploring a site located halfway between dive site 1641 and 1652 and presenting SAR acoustic anomalies. (2) to determine the relationships between seeps and structural framework. Hypothetically, fluid may flow along the main fault and/or along N330 oblique fractures affecting the paleozoic basement.

**Site survey data:** EM300, ROV microbathymetry and observations, 3.5 kHz, MCS.

**Dive course and operations:** Two observation transects about 350 m apart were performed from the talus slope at the base of the Cinarcik scarp to the first outcrop found at the location of SAR acoustic anomalies. Rock sampling was performed at the end of the first transect. Af ter the second transect, the submersible returned to an active seepage zone found on the first transect for sampling and microcat measurements. Two water samples were taken within a black patch. Push coring failed because of a hard substrate at just a few cm depth.
After sampling, a course of 310 N was taken, along the trend of the active seepage zone toward the outcrops. Then the submersible ascended obliquely a steep slope cut by erosional gullies, following a N330 structurally controlled large scale trend until reaching a steep slope at the intersection with a N 80 structure. However, it was impossible to keep a N330 course because of the complex seafloor morphology. Structural observations were done on outcrops up to 12:15 TU, when it was decided to reach the planned end of dive point at maximum speed in water. Outcrops of shale were sampled at this point.

**Main results:** The eastern transect crossed a very active zone of emission between 1200 and 1177 m depth, but the western transect found only one small black patch. The three exploration tracks define a zone of high activity about 100 m wide and 200 m long along a N310 direction. It is not known whether this zone extends further eastward.
This zone is characterized by large surfaces of black reduced sediment, extending over several meters to several tens of meters, with complex shapes. These black patches are, as elsewhere covered by a carpet of polychetes (tube length about 2,5 cm) and are associated with two types of bacterial colonies. White colonies form flakes and have a powdery aspect when viewed from a distance, although they appear to form filaments on close up. They are found around the rim of the black patches, attached on polychete tubes and sometime extend over zones of otherwise normal sediments. Yellow colonies are make of thicker filaments, forming reticulated mats or isolated hairy lumps. They are usually found on the rim of black patches but can sometimes extend over the black reduced sediment surfaces. It may be suspected that these two types of colonies host different bacterial species and have different optimal growth conditions.
The active seepage area spreads out over a scree slope with rocks ranging in size from 10 cm blocks to meter size boulders and slabs. In this context, cementation by authigenic carbonates may not be needed to explain the failure of push coring. Although visual observations suggest the presence of carbonate cemented crusts, these could not be sampled, unlike at 1641 dive site. Although the scree is mixed with pelagic mud it could represent a high permeability zone and extend to sufficient depth along the base of the cliff to provide a conduit for lateral

drainage from the Cinarcik basin.
During the dive, the microcat recorded several spikes of increasing temperature and decreasing salinity, which could result from the expulsion of pore water from the sediment. However, only a very weak anomaly was found when doing systematic measurement over the surface of a black patch an over its rim. Photo shows the location on the edge of the black patch where this very small (+0.003°C, -0,003 per mil) disturbance was observed.
There is no evidence for active seepage on the slope. The fractures in the Paleozoïc formation thus do not seem to channel fluids and no evidence of recent tectonic activity was found along the N330 slope break. Recovered samples were shale. However, layered formations, likely turbidite series, as well as massive jointed sandstone or quartzite outcrops, were also seen. The stratification has a southward dipping monoclinal component, on which is superimposed folding with roughly N-S axis. This results in strikes ranging from N040 to N110 and dips from 10° to 30°. Outcrops host solitary corals and small pedunculate animals with small shells. These animals look like inarticulate brachiopods, with a retractable lophophore extending outside of the shell when it is open (is that correct ?).
Two orthogonal joint families were observed. One is regional, N000/N090 ± 10°. The other joint system is less consistent in orientation, ranging from N310 to N330 and is not systematically associated with the orthogonal direction (N030 to N060). This second family may be related to the orientation of the cliff, which is dominantly N310, but rotates to N330. A few minor faults were observed but not systematically recorded on video. Their strikes are N320-N330 and N070-N080, which is consistent with the assumption that the N330 and N080 directions observed at the km scale in the cliff morphology are structurally controlled. It follows from these observations that the structural directions observed at the km scale in the cliff morphology are controlled by fault directions, rather than by joints directions. However, the current activity of these faults cannot be assessed.

**Video :**
Complete observation report (with seeps and structural observations) is available as an XL spread sheet in the cruise data folder.

**Sample report :**

| Sample Nb | Depth (m) | LAT | LON | DESCRIPTION |
|---|---|---|---|---|
| R1 | 1112 | N 40°46,945' | E 29°06,220' | Cubic block of black shale, split samples ITU/CEREGE |
| R2 | 1197 | N 40°46,804' | E 29°06,236' | Round Pebble, Quartzite, not split, ITU. |
| R3 | 984 | N 40°47,549' | E 29°05,621' | Irregular block of shale, split samples ITU/CEREGE |
| WS1 | 1197 | N 40°46,803' | E 29°06,231' | Water sample taken above a black patch within the polychete carpet (bottle 4) |
| WS2 | 1197 | N 40°46,803' | E 29°06,231' | 1 m apart from WS1 within same black patch (bottle 3) |

**Photo selection: full resolution photos and larger selection is found in the data folder**

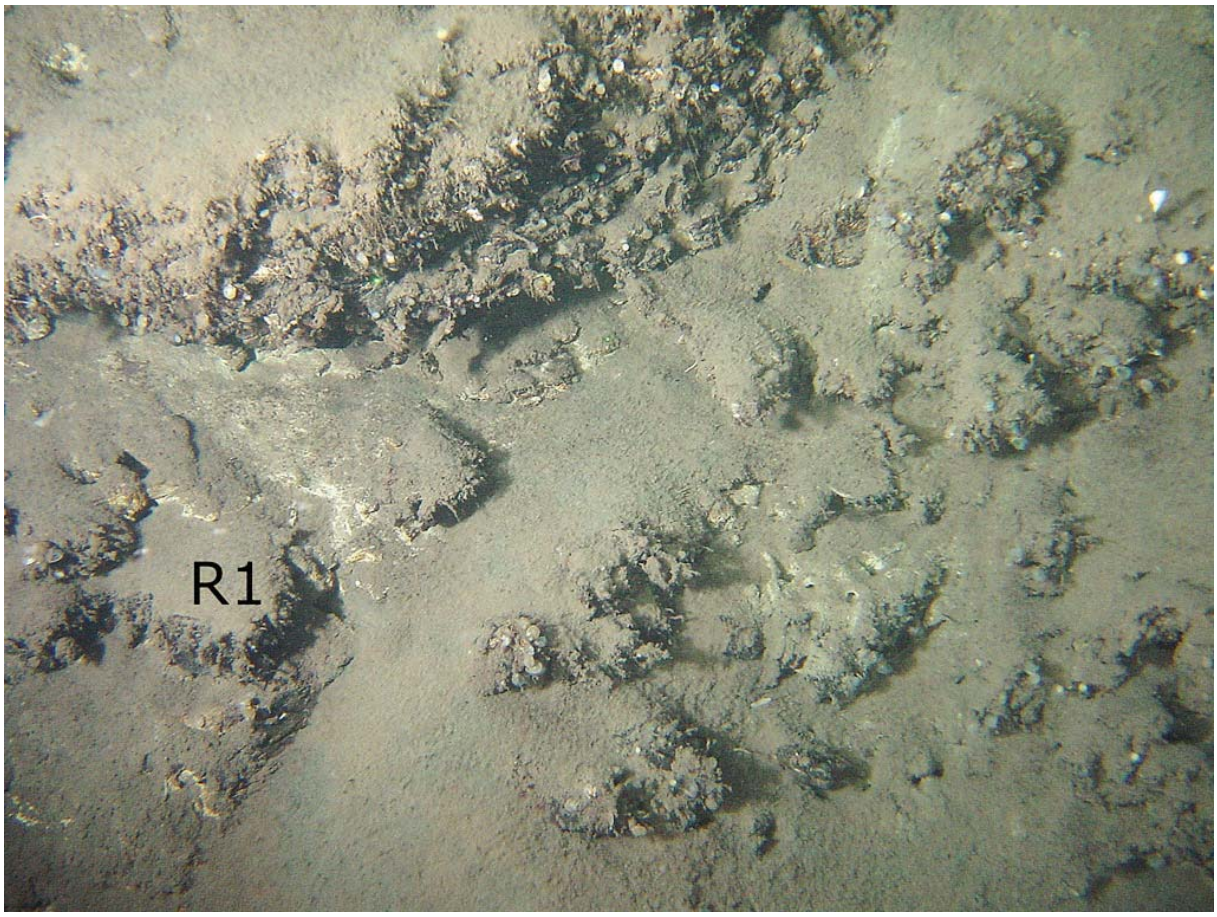


Photo 1: Rock sample R1 in place

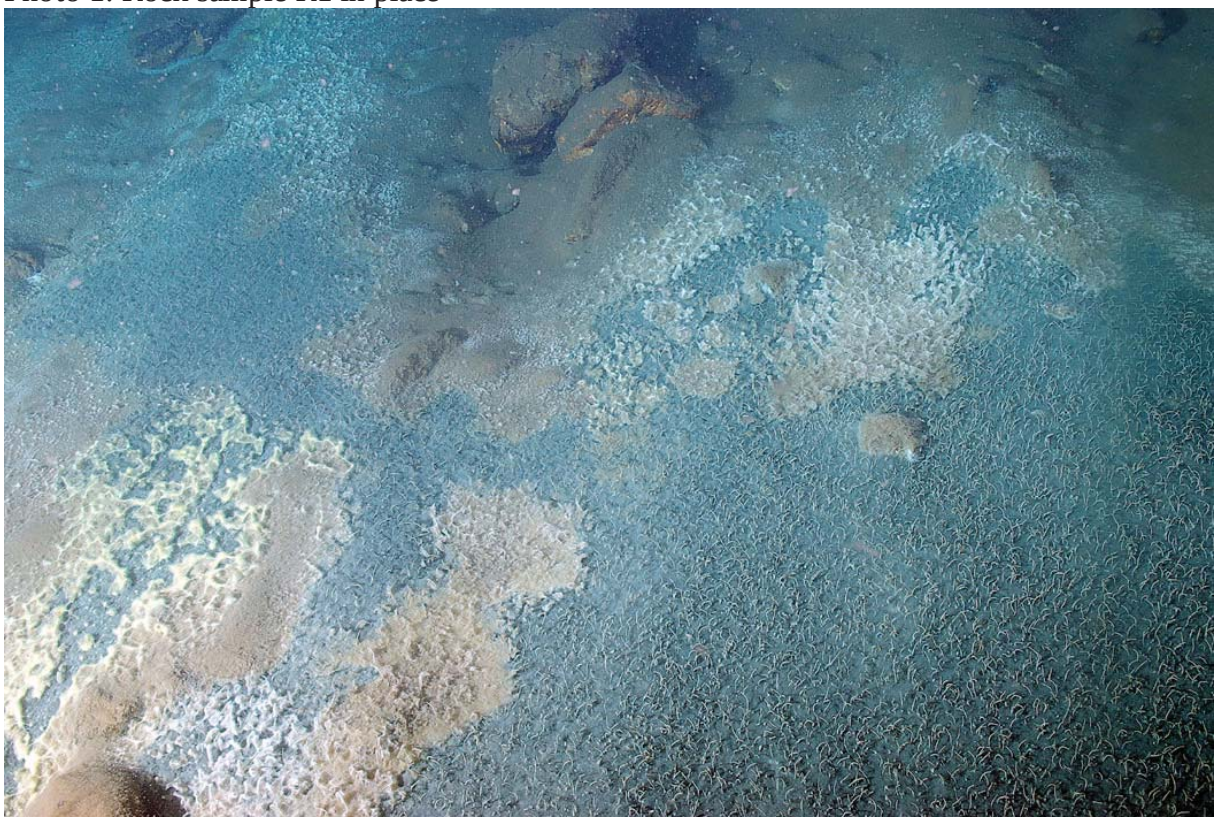


Photo 2: Stop site – see black patch with polychete carpet and two types of bacterial colonies (yellow and white).

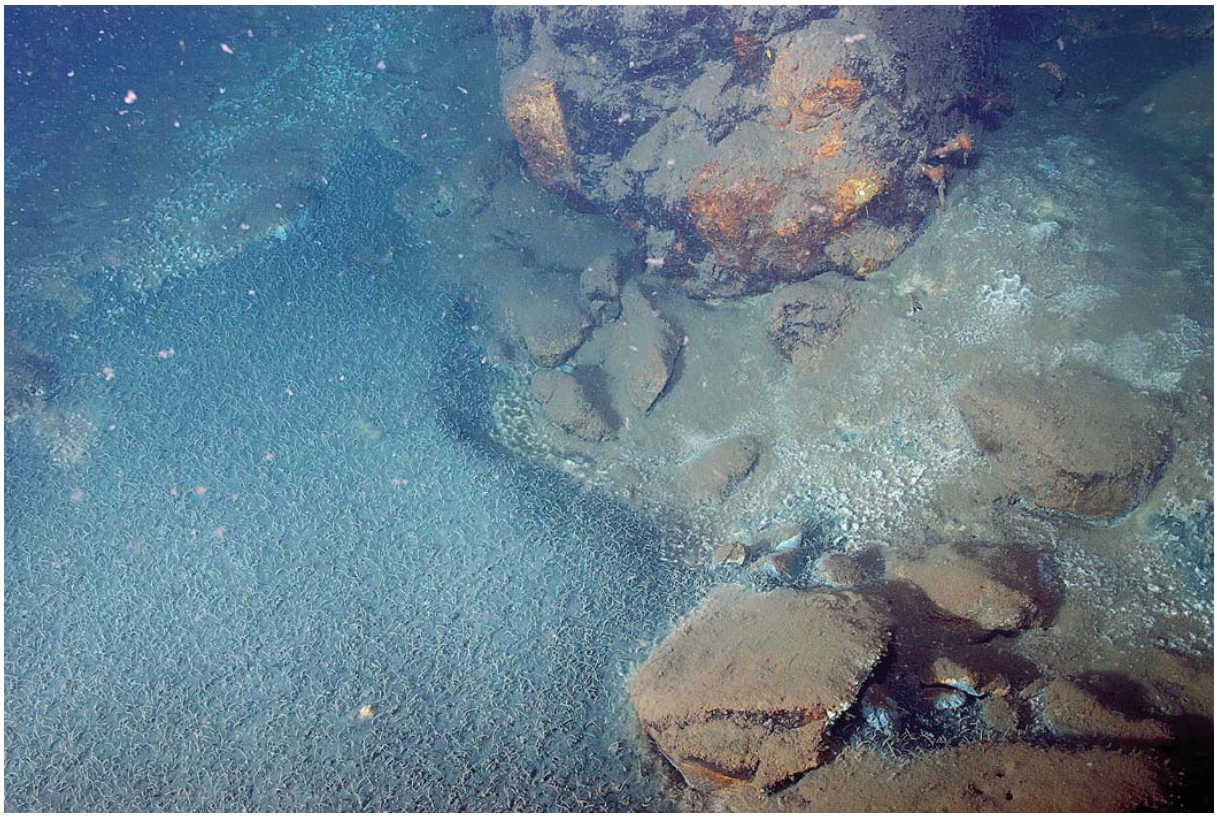


Photo 3: Stop site – meter size boulder near same black patch. Bacterial colonies (white and black)

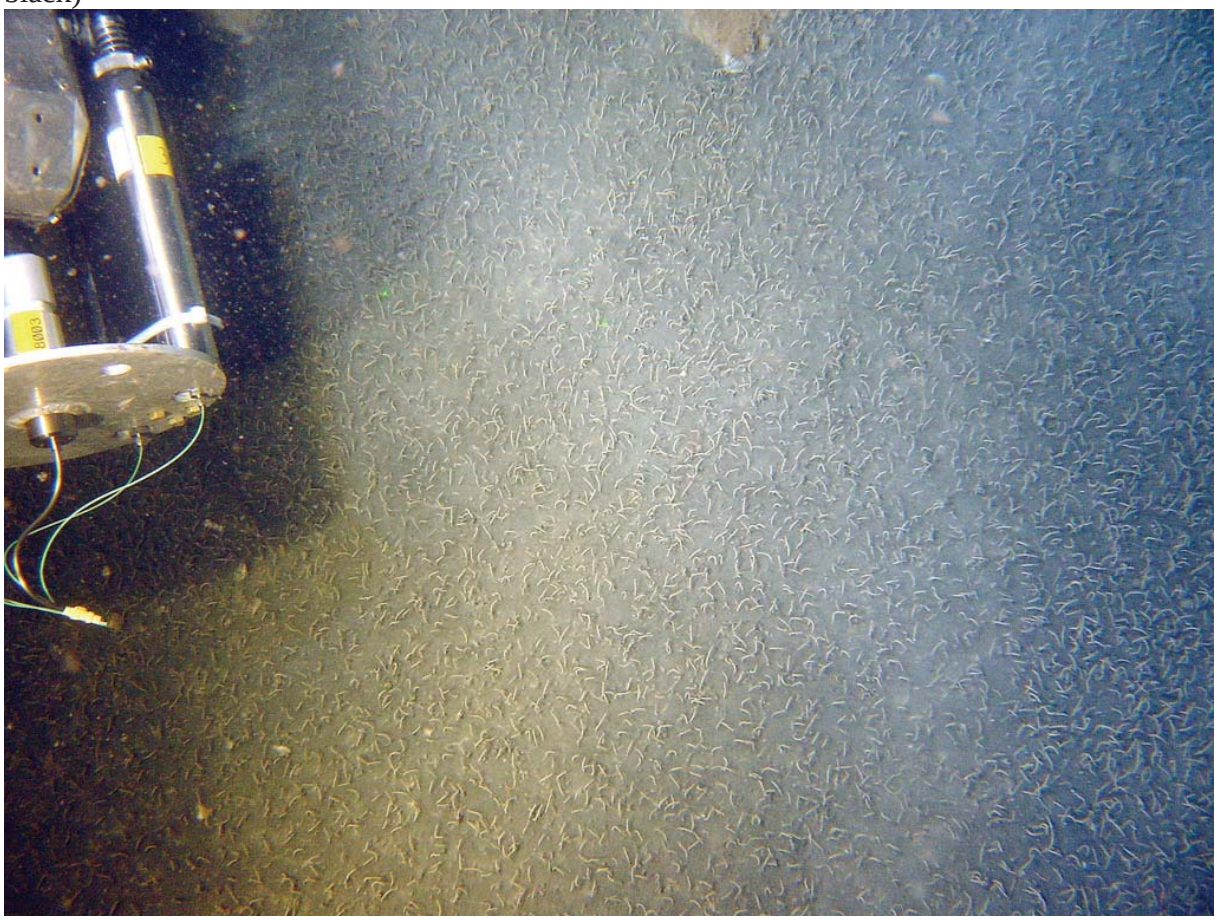


Photo 4: Water sampling 1

Photo 5: Water sampling 2

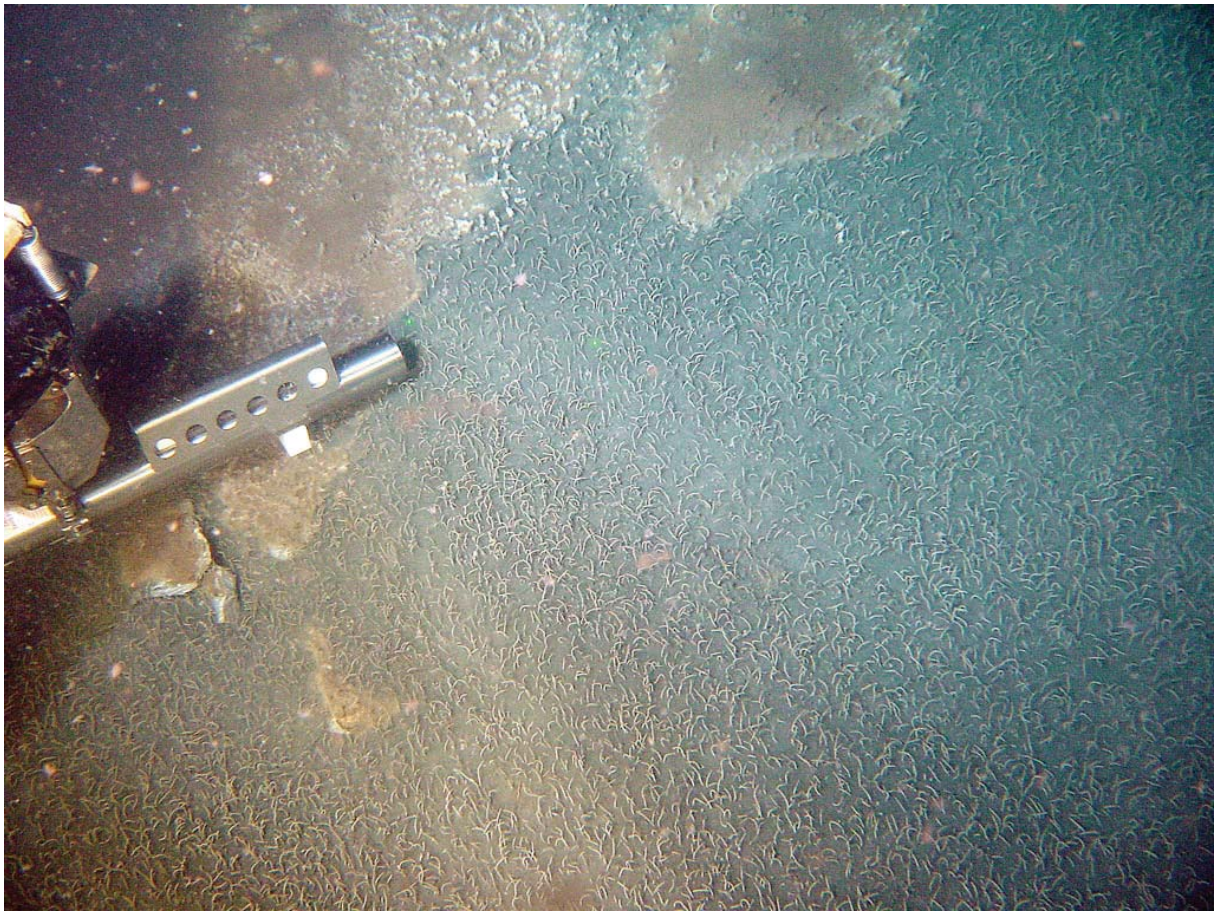


Photo 6: microcat measurement with very small (+0.003°C,-0.003 per mil) T,S anomaly

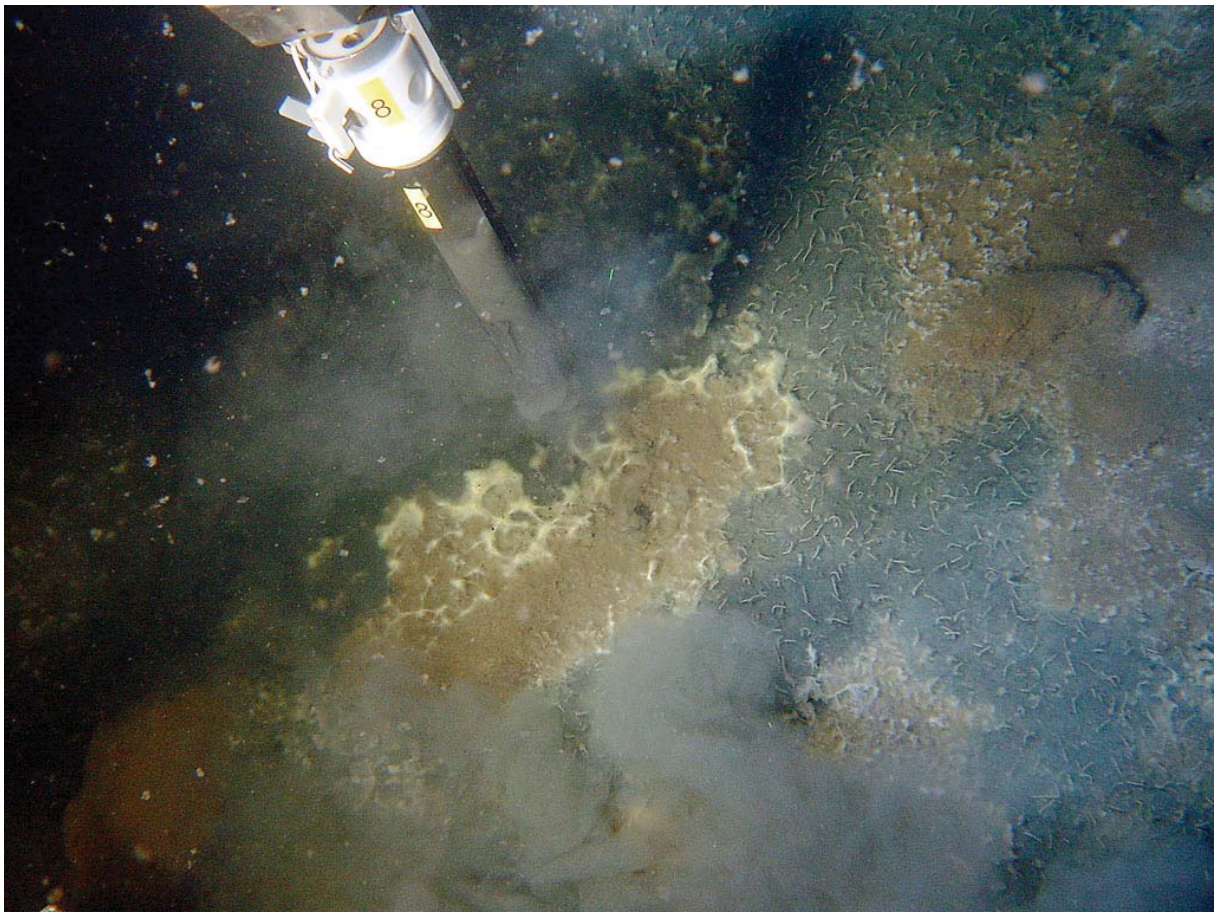


Photo 7: push core attempt in yellow reticulated bacterial mat

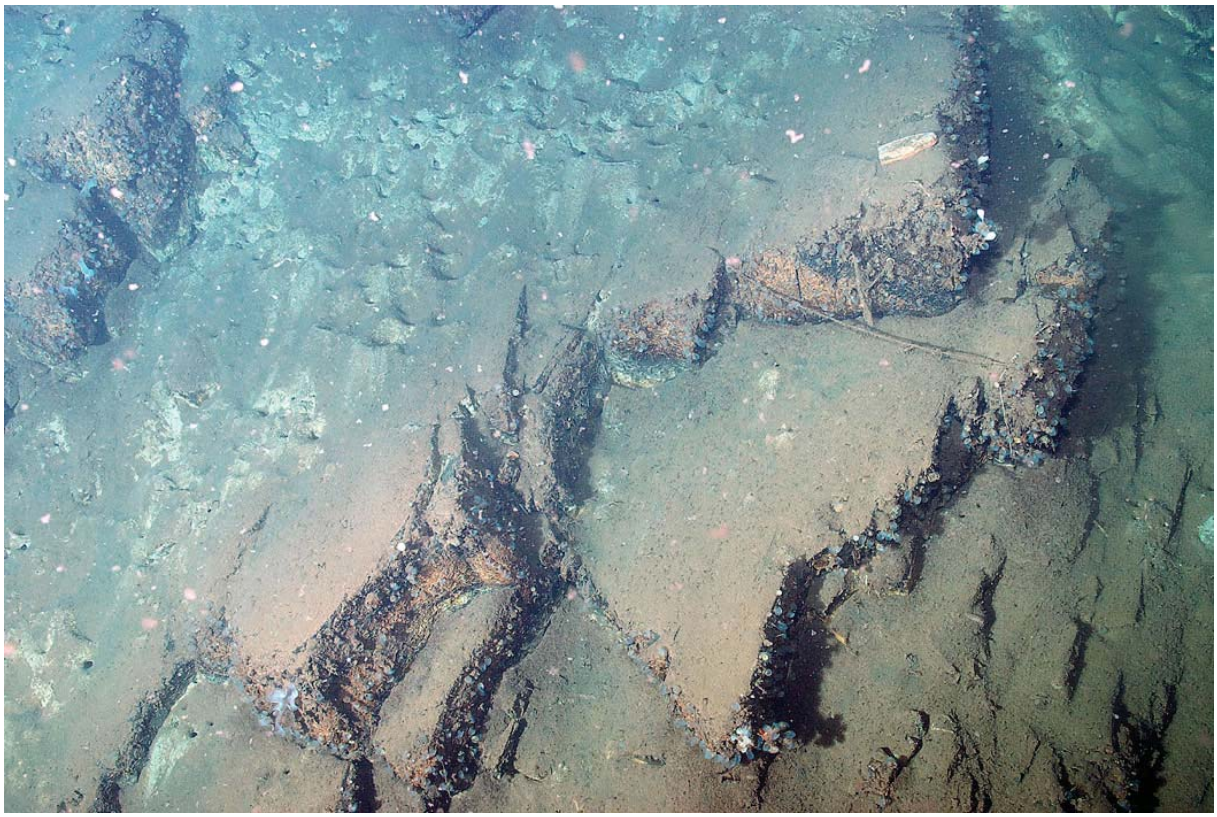


Photo 8: layered ourcrop (11:45:35) with N000, N090 and N310 joints

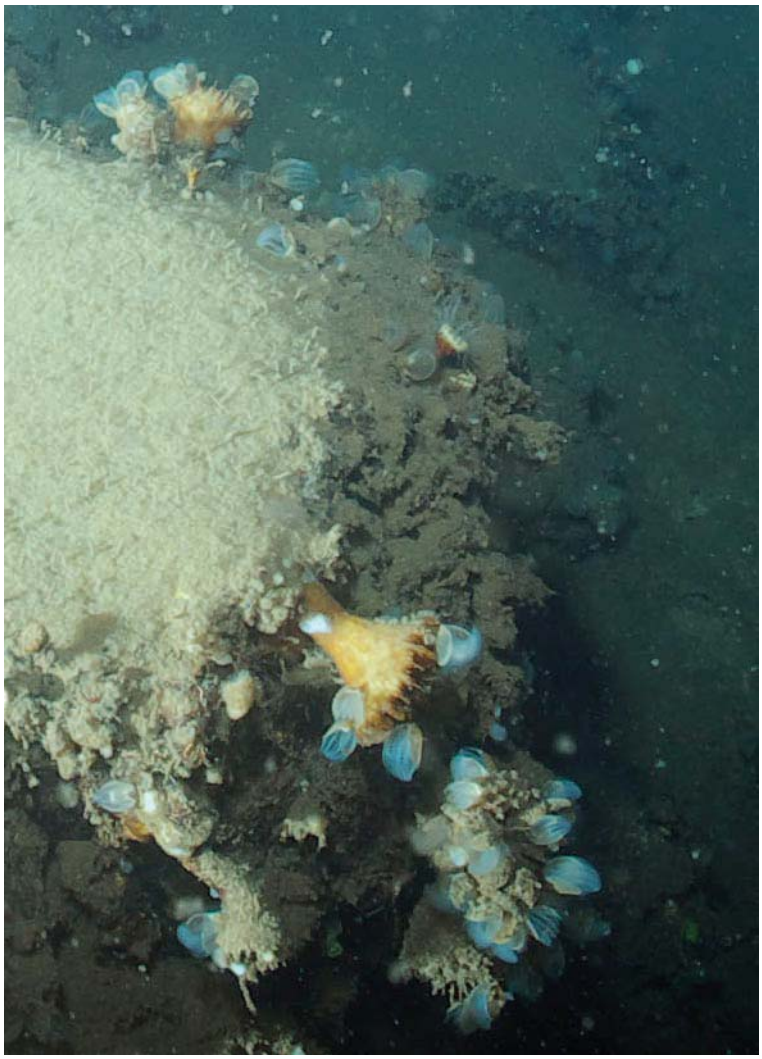
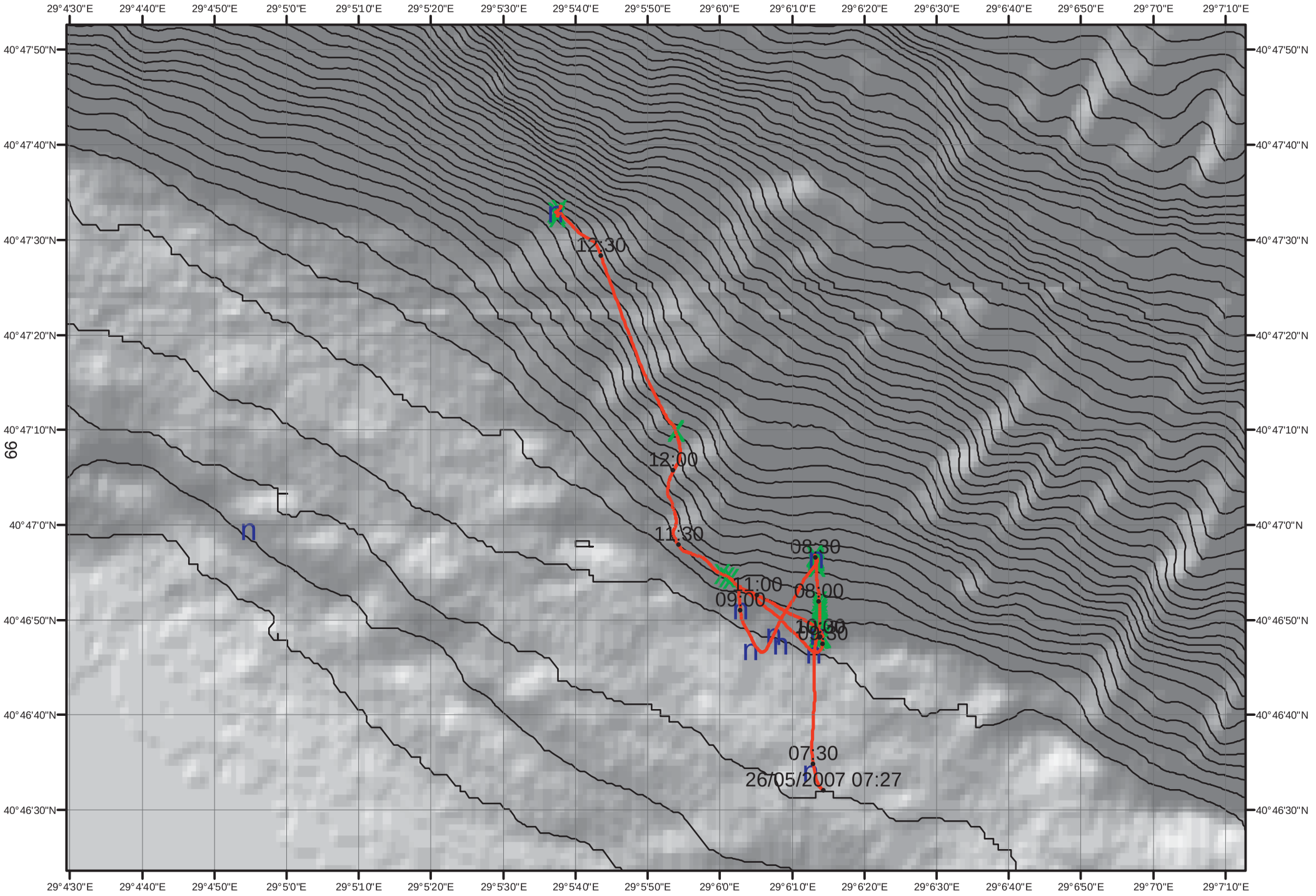


Photo 9: corals and, possibly, brachipods.

| Table 1: 1654 highlights | | | | | | |
|---|---|---|---|---|---|---|
| time | depth (m) | latitude | | longitude | | |
| 7:31:00 | 1220 | 40° | 46,572' | 029° | 06,213' | beginning of observations on S-N transect |
| 7:42:15 | 1206 | 40° | 46,771' | 029° | 06,218' | first cold seep occurrence |
| 7:45:36 | 1200 | 40° | 46,803' | 029° | 06,223' | beginning of zone with large black patches. Polychetes and two types of bacterial colonies: white powdery flakes and thicker yellow hairy filaments and lumps |
| 7:57:53 | 1177 | 40° | 46,856' | 029° | 06,231' | end of zone with large black patches |
| 8:01:14 | 1166 | 40° | 46,872' | 029° | 06,229' | last cold seep occurrence |
| 8:11:57 | 1133 | 40° | 46,928' | 029° | 06,223' | reaching paleozoic outcrop on edge of gully. subhorizontal strata N010, N040 and N330 joints |
| 8:24:25 | 1112 | 40° | 46,945' | 029° | 06,220' | Sample R1 - end S-N observation transect |
| 8:48:30 | 1207 | 40° | 46,780' | 029° | 06,106' | Start 2nd observation transect |
| 9:00:16 | 1193 | 40° | 46,850' | 029° | 06,048' | location of only black patch found on this transect |
| 9:08:27 | 1176 | 40° | 46,887' | 029° | 06,040' | outcrop at base of cliff, SE dipping strata (10°) N330 joints |
| 9:10:50 | 1168 | 40° | 46,894' | 029° | 06,039' | End 2nd transect - turning point |
| 9:21:40 | 1198 | 40° | 46,813' | 029° | 06,165' | Visual contact with seafloor: meter size black patches |
| 9:26:45 | 1207 | 40° | 46,773' | 029° | 06,223' | limit of active zone and turning point |
| 9:33:45 | 1197 | 40° | 46,803' | 029° | 06,231' | Stop site |
| 9:58:00 | 1197 | 40° | 46,803' | 029° | 06,231' | Water sample - Bottle 4 |
| 10:00:00 | 1197 | 40° | 46,803' | 029° | 06,231' | Water sample - Bottle 3 |
| 10:07:35 | 1197 | 40° | 46,803' | 029° | 06,231' | begin microcat measurements on the seafloor |
| 10:15:40 | 1197 | 40° | 46,803' | 029° | 06,231' | end microcat measurements on the seafloor |
| 10:22:45 | 1197 | 40° | 46,803' | 029° | 06,231' | 2 push core attempts in black patch - no penetration |
| 10:30:40 | 1197 | 40° | 46,803' | 029° | 06,231' | push core attempt in yellow bacterial mat, sample did not stay in tube |
| 10:35:35 | 1197 | 40° | 46,804' | 029° | 06,236' | attempt to sample carbonate crust, pebble recovered (sample R2) |
| 10:42:00 | 1197 | 40° | 46,806' | 029° | 06,237' | Start N310 observation transect |
| 10:48:29 | 1182 | 40° | 46,834' | 029° | 06,196' | large black patches, trending N300 |
| 10:57:00 | 1182 | 40° | 46,870' | 029° | 06,114' | leaving active zone |
| 11:07:50 | 1177 | 40° | 46,892' | 029° | 06,043' | Beginning of outcrops with N300-310 and N000-010 and N270-280 joints. Strata 135 S 15° |
| 11:37:04 | 1150 | 40° | 46,998' | 029° | 05,899' | following gully upslope (N030) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11:45:25 | 1139 | 40° | 47,036' | 029° | 05,891' | thinly layered (5-15 cm strata) outcrops with clear joint directions N000, N270 and N310 |
| 11:57:28 | 1099 | 40° | 47,088' | 029° | 05,888' | zone of outcrops on eastern slope of N030 gully. Strata dipping N040 SE 10, N010 and N100 joints, N320-330 small faults |
| 12:08:00 | 1059 | 40° | 47,159' | 029° | 05,900' | thinly layered (5-15 cm) strata dipping SSW 20°. Clear joint directions N005 dominant joints, N0315 and N045 |
| 12:09:00 | 1055 | 40° | 47,161' | 029° | 05,899' | thicker strata, dipping N110 SW 30. dominant joint direction N000. Other fracture directions: N030, N330, N300 (with NE 70 dip), N070. |
| 12:10:42 | 1049 | 40° | 47,165' | 029° | 05,898' | N070 small fault |
| 12:15:52 | 1023 | 40° | 47,188' | 029° | 05,878' | leaving bottom, going strait to end of dive point |
| 12:40:00 | 991 | 40° | 47,547' | 029° | 05,629' | Mudstone outcrop, poor layering, foliated aspect, N090, N050 and N350 fractures. |
| 12:50:00 | 984 | 40° | 47,549' | 029° | 05,621' | Sample R3 |
| 12:55:10 | 974 | 40° | 47,554' | 029° | 05,629' | Layered formation suggesting turbidites, strata dipping SSW 20°. N000, N120 and N060 fractures |
| 12:58:45 | | | | | | weight dropped, coming up |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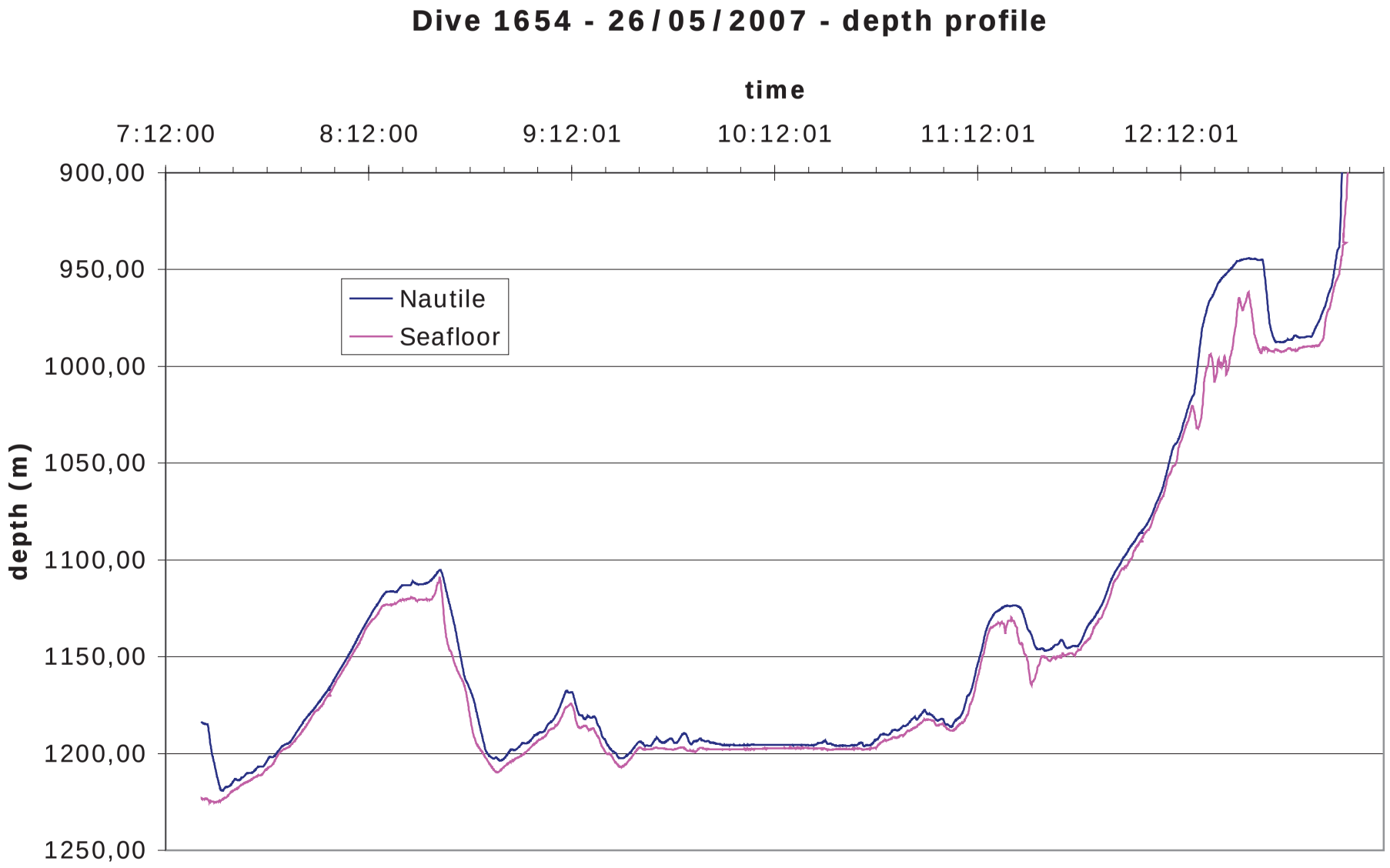
Dive 1654 - 26/05/2007 - depth profile
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8:12:00
9:12:01
10:12:01
11:12:01
12:12:01
depth (m)
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Nautile
Seafloor

# MARNAUT 2007
# Dive 1655
# Cinarcik North, south of Istanbul

**Date:** Sunday 27 May, 2007
**Immersion point:** N40º47.948 E28º49.117

**Scientist:** Sylvain BOURLANGE
**Pilots:** Xavier PLACAUD and Severine CIPRIANI
**Localisation:** On the North Cinarcik margin. Where the North Anatolian Fault presents a change of direction

**Objectives:**

Observation
Collect fluid samples
Collect push cores
Collect microcat data

**Equipment:**

4 titanium syringe fluid samplers
4 push cores
microcat CTD

**Dive summary:**

The objective of this dive was to investigate the trace of two segments of the North Anatolian Fault, South of Istanbul, where the fault presents a drastic change of direction. Westward, the fault presents an approximative 130º strike. Eastward, the fault strikes nearly East-West. In the same time, we wanted to explore SAR anomaly that have been located in this region, and that we supposed related to the presence of the fault bent.

We encountered very poor visibility conditions. So poor that we nearly abandoned the dive after reaching the seafllor because the security could nearly be insured in these conditions. In fact, we spent most of the dive jumping from one point to another, hoping to find better visibility conditions. During a large part of the dive, we encountered a “giant” turbid cloud, that we have had to cross. We spent about 2 hours struggling with these turbid conditions, with no visibility.

We finally reached the crest of the North-South ridge at the point 10, where a SAR anomalies had been mapped. We didn’t find any structure or seepage that could explain this anomaly. We finally went North, following the ridge crest, with slightly better conditions than anything that we had encountered before. We reached and climbed the slope and finally discovered several black bacterial patches laying approximately East-West at the Isobath 930 m. The position of these patches was about 50 m North compared to the foot of the slope that is recognized as the trace of th East-West branch of the fault. Northward, we found some more patches, and then no patches. These patches seem to indicate precisely the localization of the fault.

At the first set of patches, we managed to sample fluids above the patch, and took two push cores.

**DVD structure:**
DVD Number 1: 7:27 – 9:32
DVD Number 2: 9:36- 11:42
DVD Number 3: 11:43-13:17

**Dive Report:**
7:24 Arrival at the seafloor
7:24-7:34 Bioturbated pelagic sediment. Very poor visibility conditions
7:34 Facing the slope.
7:38 small outcrop. Dip toward the South.
7:46-8:08 We decide to move frankly in order to find a place with a better visibility
8:08 We reach the bottom. Bioturbated pelagic sediment. Very bad visibility.
8:10 New transit
8:24 We reach the floor at Point 1. Visibility is better
Same bioturbated pelagic sediments. We head westward, following the profile.
8:31 We meet a "roussette" and a plastic bag
8:34 Two "roussettes on the seagfloor"
8:42 Entering a large turbide cloud.
8:45 The copilote noticed that the cloud has pushed us backward.
8:46 We meet the front of the cloud again. The particle charge is very heavy. Navigation was very difficult in this cloud. The pilot noticed difficulties in keeping the altitude, presumably due to change in density, and or current.
8:49 Outside of the cloud.
8:51-9:12 Around (and sometimes in) the cloud at about 30 m above seafloor. We leave the cloud at about 72 m above seafloor.
9:50 Point 6 (SAR anomaly). In the cloud.
9:51 We meet the cloud at 50 m above seafloor.
9:54 We feel the water sampler number 6 in the cloud, 3 masf.
10:06 We leave the cloud at 29 m
10:13 In the cloud again, ~30m above seafllor
10:25 Leaving the cloud ~22 masf
10:47 We reach the seafloor at point 10 (SAR anomaly). Bad visibility again. Bioturbated pelagic sediments. We advance in direction of the point 9.
11:06 We meet better visibility condition
11:34 Point 9 (summit of a hill).
11:43 We fill a water sampler to be used as a backgrouns (bottle 7)
11:54 After a jump northward, we reach the seafloor.
11:57 Point 8.
12:00 We modify our route to climb the slope no the North-East.
12:06 Set of 5 Black patches. Aligned along the slope, approximately along the 930 m isobath, about East-West strike. Size about half a meter each. The two patches at the West are dark with a white outline presumably a bacterial film. On the right is a grey one, showing some polychetes.
12:07 General view of three patches
12:08 Close up of the bacterial mat with white outline (left patch).
12:12 Sampling water (bottle 8)
12:13 Close up of the patch in the middle
12:25 Push core number 4 on the same black patch (westward)

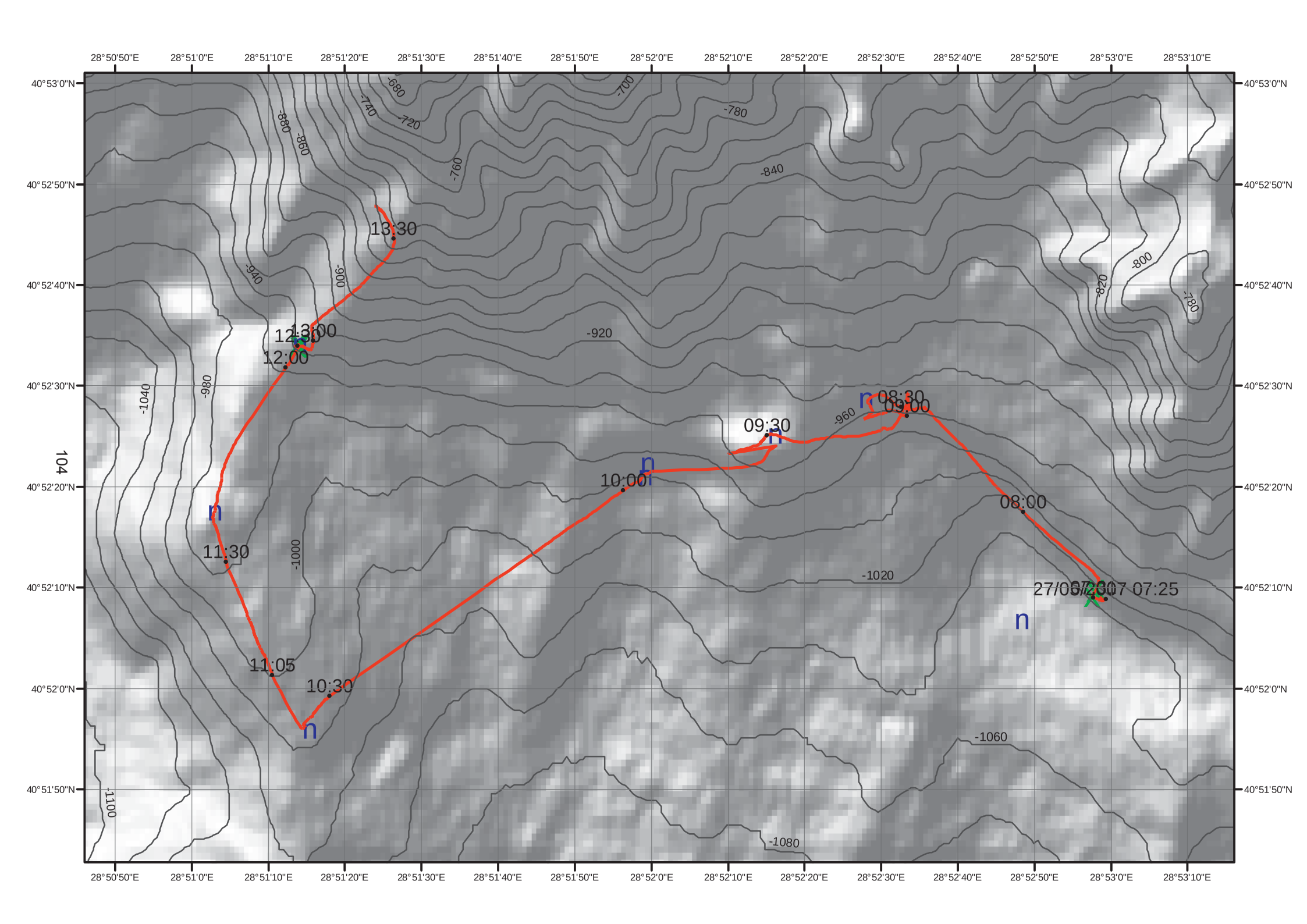
12:39 Push core number 3 on the grey patch (eastward). Gaz bubbles release during the push.
12:55-57 Following the isobathe 930 toward the East, we meet two other black patches. Black patch.
12:59 Heading North, we find a new grey patch
13:00 Three black patches aligned East-West
13:05 We climb the slope toward the North-East

**Samples**

| Time | name | acronym | lat | lon | immersion (m) |
|---|---|---|---|---|---|
| 9:54 | Water sample 6 | FS-1655-6 | 40º52.355 | 28º51.988 | 990 |
| 11:43 | Water sample 7 | FS-1655-7 | 40º52.347 | 28º51.066 | 949 |
| 12:12 | Water sample 8 | FS-1655-8 | 40º52.566 | 28º51.229 | 927 |
| 12:25 | push core 4 | PC-1655-4 | 40º52.567 | 28º51.230 | 927 |
| 12:39 | push core 3 | PC-1655-3 | 40º52.565 | 28º51.232 | 927 |

**Pictures**

One of the black patches observed at the emplacement of the East-West fault.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# MARNAUT 2007
# Dive report

## LEG3
**28/05/2007-08/06/2007**

**Nautile Dive 1656 – N. Cinarcik basin**
**28 May, 2007**

**Pilots:**
Justiniano
Rosazza

**Scientist:**
Tryon

**Location:**
N. Cinarcik basin – same site at dive 1641

**Objectives:**
Deploy 3 flow meters
Collect fluid samples
Collect push cores
Collect carbonate crusts

**Equipment:**
3 flow meters (deployed by wire before dive)
4 titanium syringe fluid samplers
4 push cores
microcat CTD

**Dive narrative:**

After arriving at the bottom the instruments were quickly found within 20 m of the drop site. We headed toward target 1 with meter M and encountered a large area of sulfidic sediment with microbial mats well before reaching the target. The meter was deployed here and a core was taken. We returned to retrieve the second meter but had difficulties with it. The anchor came off when the instrument was lifted and we had to let it float up to the surface for retrieval. We picked up meter J and headed to target 2. We encountered the large area of seepage near the target and deployed meter J on sulfidic sediment with thick patches of yellow microbial mat. An area of what appeared to be white bacteria was seen that was not on sulfidic sediment and we took a core there. During this period we did not encounter any carbonate crusts, although the cores did not go in too deep. We then headed ESE to follow the zone of activity to see what its extent might be. We soon were out of the seep area and had not encountered the escarpment. We continued onward but never found either the scarp nor seeps. I thought we were too far south and turned us more northerly upslope but continued to find nothing but a steady slope and no seeps. I decided to head back toward the seeps, passing to the north of the previous track but did not find seeps or scarp all the way back. In hindsight, we may have been above the scarp (or at least the zone of activity) but we never encountered anything remotely resembling a scarp since arriving on the bottom. We continued through the area of seeps, taking a core along the way at a thick mat. After leaving the seep area we headed north looking for the scarp and eventually find it, but do not find seeps nearby. After following the scarp WNW for a while we again look south for seeps and encounter them again and take the final core at the edge of a seep.

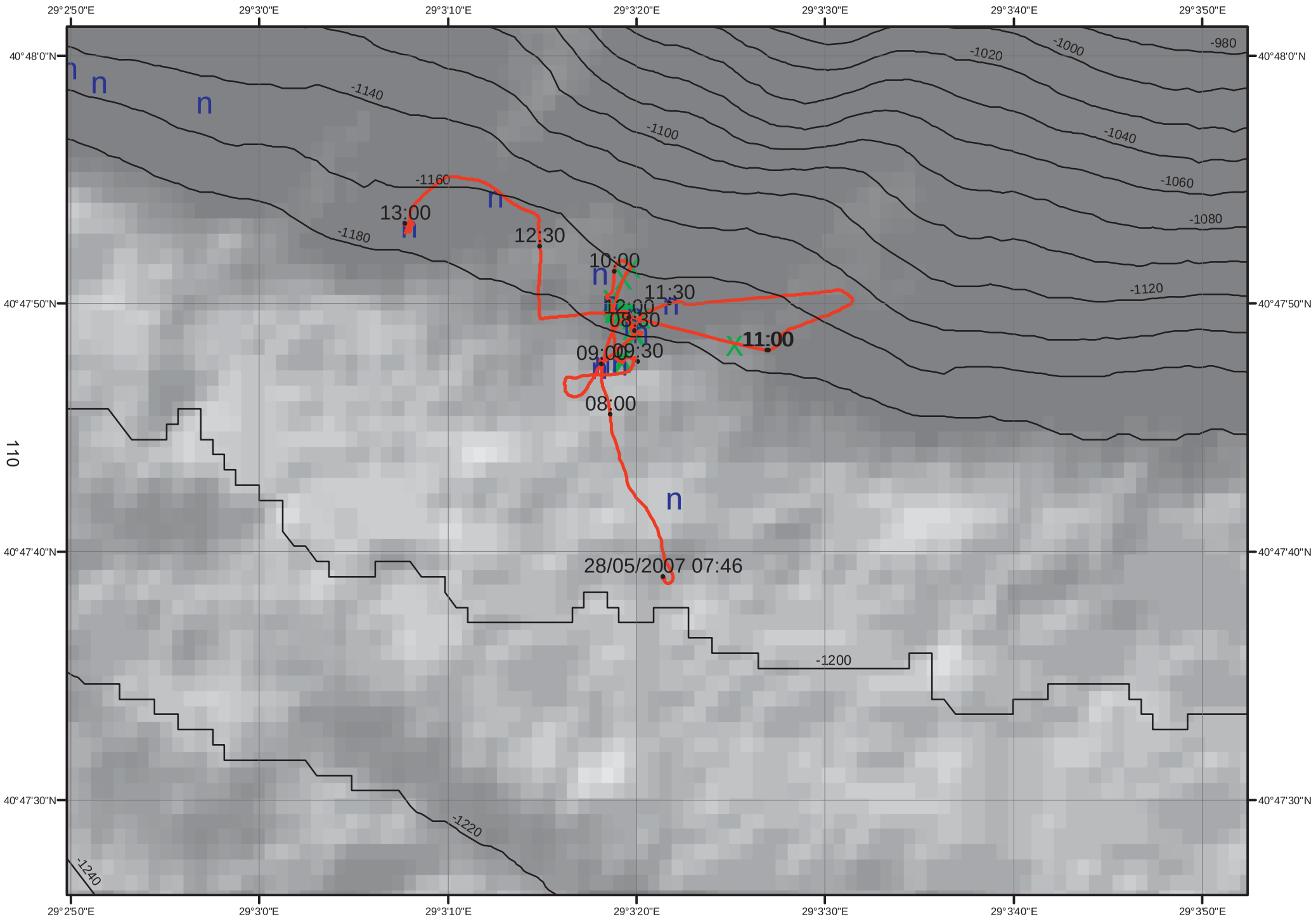
While we certainly did not completely map out the extent of the seep area, I think we have a good idea of its minimum extent. The seep area appears to be exclusively below the

scarp and, in many cases, is well below the scarp. It is appriximately 100 m perpendicular to the slope and extends at least 200 meters along strike. The area explored covers a rough trapezoid with an area of 6000 $m^2$. At least half of this area is covered with black sulfidic sediment and much of that has white and yellow microbial mat on it. Most of the areas where no black sediment is seen are those that have exposed boulders that are diverting the flow. It is likely that the remaining areas without seepage have boulders buried just below the sediment surface. In my experience, areas of sulfidic sediment with microbial mat such as we see here typically have fluid flow rates on the order of at least 5-10 cm/yr. If we assume the minimum rate from 50% of the surface of this area then approximately 400 liters of pore fluid are emited from this area per day. This is appriximetely 10% of what Jack-the-smoker emits assuming a rate of 1 cm/s through an 8 cm orifice.

**Dive events:**

| TIME | LAT | LONG | DEPTH (m) | EVENT |
|---|---|---|---|---|
| 07:46 | 40° 47,649 | 29° 3,358 | 1186 | arrive on bottom - begin DVD 1 - heading to flow meter drop site |
| 08:04 | 40° 47,792 | 29° 3,303 | 1175 | arrive at flow meter M |
| 08:10 | 40° 47,796 | 29° 3,300 | 1183 | meter M picked up |
| 08:11 | 40° 47,795 | 29° 3,303 | 1182 | heading toward target 1 |
| 08:15 | 40° 47,808 | 29° 3,335 | 1176 | arrive at seep site - still 60m to target 1 |
| 08:16 | 40° 47,815 | 29° 3,331 | 1173 | looking over the site |
| 08:23 | 40° 47,807 | 29° 3,331 | 1150 | settin meter down on the site |
| 08:26 | 40° 47,814 | 29° 3,329 | 1169 | maneuvering the submarine |
| 08:32 | 40° 47,816 | 29° 3,331 | 1175 | beginning to deploy meter |
| 08:40 | 40° 47,815 | 29° 3,332 | 1159 | flow meter M deployed |
| 08:42 | 40° 47,816 | 29° 3,330 | 1170 | getting ready to core |
| 08:44 | 40° 47,816 | 29° 3,328 | 1171 | moving away from meter |
| 08:51 | 40° 47,818 | 29° 3,329 | 1173 | core #1 taken in sulfidic sediment w/ microbial mat - but not where I thought it was |
| 08:55 | 40° 47,824 | 29° 3,323 | 1169 | heading back to drop site for next meter |
| 09:05 | 40° 47,771 | 29° 3,283 | 1184 | sonar not working so starting a search pattern |
| 09:17 | 40° 47,791 | 29° 3,329 | 1179 | flow meter R found |
| 09:20 | 40° 47,797 | 29° 3,330 | 1181 | picking up meter |
| 09:25 | 40° 47,797 | 29° 3,331 | 1181 | encounter difficulties with flow meter R |
| 09:29 | 40° 47,797 | 29° 3,331 | 1179 | anchor fell off and meter returned to surface |
| 09:38 | 40° 47,795 | 29° 3,322 | 1183 | picking up meter |
| 09:43 | 40° 47,794 | 29° 3,322 | 1180 | DVD 2 begins |
| 09:44 | 40° 47,794 | 29° 3,318 | 1180 | heading to target 2 |
| 09:54 | 40° 47,853 | 29° 3,324 | 1155 | arrive at seep site |
| 09:56 | 40° 47,857 | 29° 3,328 | 1151 | looking over the site for a good deployment spot |
| 09:57 | 40° 47,859 | 29° 3,329 | 1149 | lots of large boulders |
| 10:07 | 40° 47,835 | 29° 3,310 | 1171 | white bacteria covering sediment but sediment not black |
| 10:11 | 40° 47,834 | 29° 3,310 | 1168 | moving to right to black sediment with thick patches of yellow mat |
| 10:16 | 40° 47,828 | 29° 3,314 | 1170 | instrument set down |
| 10:26 | 40° 47,825 | 29° 3,314 | 1173 | flow meter J deployed at seep with thick yellow microbial mat |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10:37 | 40° | 47,824 | 29° | 3,320 | 1173 | core #2 taken in white mat w/o sulfidic sediment |
| 10:46 | 40° | 47,823 | 29° | 3,325 | 1170 | starting to explore to the east - heading 100 deg |
| 10:48 | 40° | 47,815 | 29° | 3,332 | 1159 | observe flow meter to left |
| 10:49 | 40° | 47,814 | 29° | 3,338 | 1176 | passing out of seep area |
| 10:58 | 40° | 47,795 | 29° | 3,425 | 1178 | I think we've passed south of scarp and turn to 70 deg |
| 11:00 | 40° | 47,800 | 29° | 3,444 | 1172 | |
| 11:06 | 40° | 47,816 | 29° | 3,467 | 1161 | continuing up slope and not seeing anything |
| 11:15 | 40° | 47,834 | 29° | 3,524 | 1139 | turn back to seep area - heading 260 deg |
| 11:28 | 40° | 47,833 | 29° | 3,382 | 1166 | entering seep area |
| 11:29 | 40° | 47,835 | 29° | 3,372 | 1164 | leaving seep area - heading 240 deg |
| 11:32 | 40° | 47,829 | 29° | 3,347 | 1168 | entering seep area - decide its time to core |
| 11:34 | 40° | 47,826 | 29° | 3,337 | 1168 | swapping around the core rack |
| 11:37 | 40° | 47,822 | 29° | 3,338 | 1161 | having some problems seating the core rack |
| 11:39 | 40° | 47,825 | 29° | 3,336 | 1172 | looking for a good site |
| 11:46 | 40° | 47,819 | 29° | 3,329 | 1174 | having some difficulties |
| 11:53 | 40° | 47,818 | 29° | 3,326 | 1174 | DVD 3 begins |
| 11:56 | 40° | 47,822 | 29° | 3,324 | 1171 | still having difficulties coring |
| 12:00 | 40° | 47,823 | 29° | 3,327 | 1171 | taking push core #3 at thick yellow microbial mat |
| 12:07 | 40° | 47,824 | 29° | 3,327 | 1171 | finally have the core - not sure how disturbed it is |
| 12:11 | 40° | 47,824 | 29° | 3,328 | 1169 | heading 270 deg to map extent of seeps |
| 12:20 | 40° | 47,824 | 29° | 3,258 | 1178 | leaving seep area - turning to 0 deg |
| 12:24 | 40° | 47,836 | 29° | 3,246 | 1178 | starting to climb more |
| 12:26 | 40° | 47,849 | 29° | 3,248 | 1175 | boulder encounter |
| 12:31 | 40° | 47,881 | 29° | 3,246 | 1163 | no seeps - still heading upslope |
| 12:32 | 40° | 47,888 | 29° | 3,246 | 1161 | we encounter the escarpment and turn left to follow it |
| 12:36 | 40° | 47,897 | 29° | 3,234 | 1155 | we've come up too much, scarp seems to be 290 deg |
| 12:38 | 40° | 47,903 | 29° | 3,217 | 1149 | still up too much - we keep drifting onto a more northerly heading |
| 12:44 | 40° | 47,920 | 29° | 3,168 | 1150 | turning left - not seeing any seeps |
| 12:47 | 40° | 47,904 | 29° | 3,141 | 1156 | turning left to 180 deg |
| 12:48 | 40° | 47,894 | 29° | 3,133 | 1158 | entering seep area |
| 12:50 | 40° | 47,886 | 29° | 3,133 | 1163 | we're going to try to core one more time |
| 12:56 | 40° | 47,885 | 29° | 3,131 | 1158 | trying for the rim of a black patch with white bacteria rim |
| 13:00 | 40° | 47,887 | 29° | 3,128 | 1164 | beginning attempt to take push core #4 |
| 13:01 | 40° | 47,887 | 29° | 3,128 | 1164 | no penetration |
| 13:03 | 40° | 47,888 | 29° | 3,127 | 1164 | second try - no good |
| 13:10 | 40° | 47,884 | 29° | 3,130 | 1165 | third try |
| 13:14 | 40° | 47,773 | 29° | 3,234 | 1269 | no good again |
| 13:16 | 40° | 47,884 | 29° | 3,130 | 1165 | final success at taking push core #4 at edge of seep |
| 13:22 | 40° | 47,883 | 29° | 3,132 | 1162 | core back in rack and heading up |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MARNAUT Cruise by Luca Gasperini

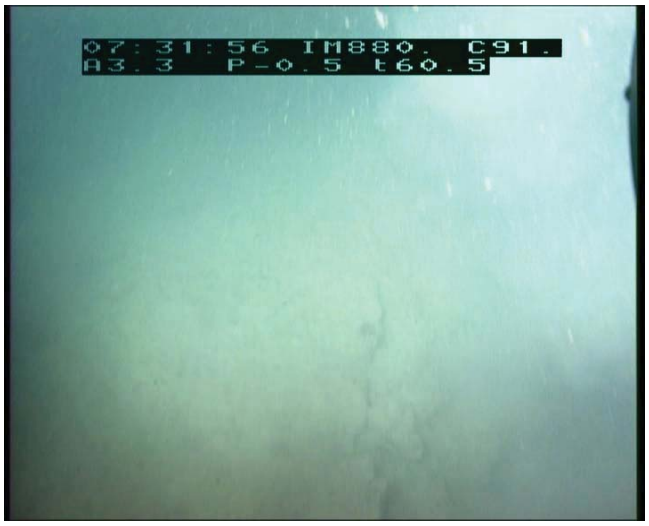
REPORT ON DIVE 1657

**Location and purpose of the dive**

This dive was carried along the canyon that connect the Cinarcik basin with the Izmit Gulf to find evidence of recent faulting at the surface, as suggested by analysis of micro-topography data collected during MARMARASCARPS cruise.

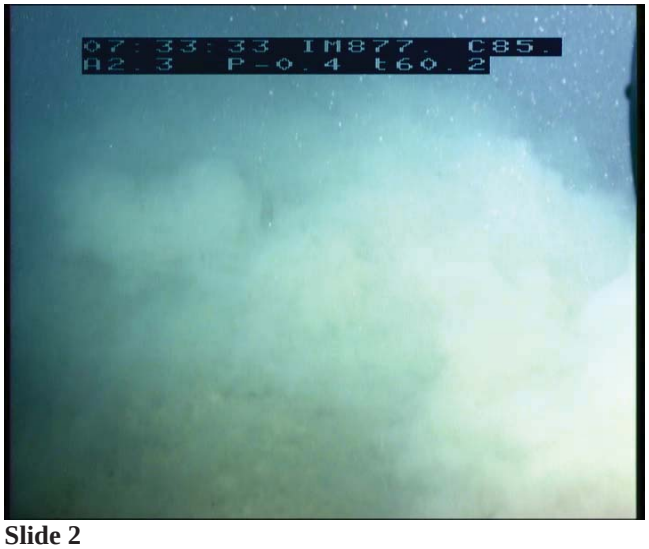
**Time sequence**
7:08 Start (depth 850 m)

7:31:56 first occurrence of a ruptured crust outcropping the bottom of the canyon (Slide 1); small scarps (10-20 cm high) facing toward S; they appear to consist of poorly cemented grey mud; fractures are covered by a thin veneer of fine grained sediments and strike E-W; no samples were collected.



**Slide 1**

7:33:33 First occurrence of "white clouds" probably made of whitish organic matter floating close to the sea-bottom (Slide 2); the presence of these clouds and of a greenish "leopard skin" carpet at the sea-bottom was frequent during the dive and created some difficulties in the observation of geological features affecting the sediments; no samples;



**Slide 2**

7:48:11 First approach with the canyon N wall; brownish nodules probably made of carbonates emerge from a grey mud that flow along the steep slope (Slide 3); no samples collected;

**Slide 3**

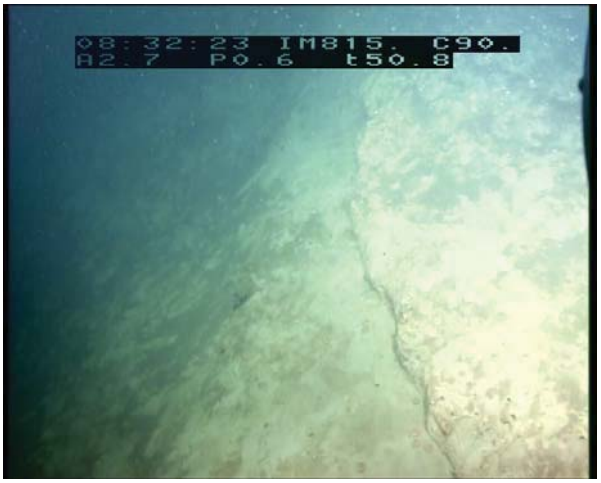
7:52:56 Pink Layers outcropping the deepest pa N-wall of the Canyon (Slide 4); 1 GRAB sample collected (ECH1, see Table 1).

**Slide 4**

8:12:05 Sub-horizontal sedimentary layers outcropping the S-facing wall of the canyon (Slide 5); no samples collected;


**Slide 5**

8:32:23 S-facing scarp of semi-consolidated sediment emerging from the canyon bottom (Side 6); orientation of this feature is E-W

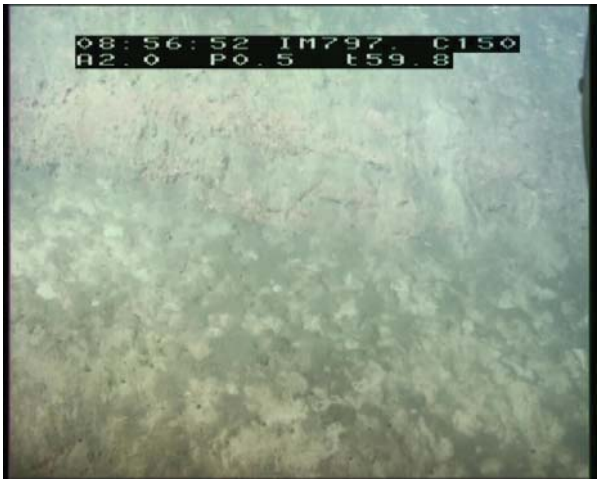



**Slide 6**

8:38:23 S-facing wall of the canyon; angular unconformity between a brownish-pink unit at the base and a grey sub-horizontal, well layered unit at the top (Slide 7); collection of a GRAB sample from the upper unit (ECH2, see Table1);

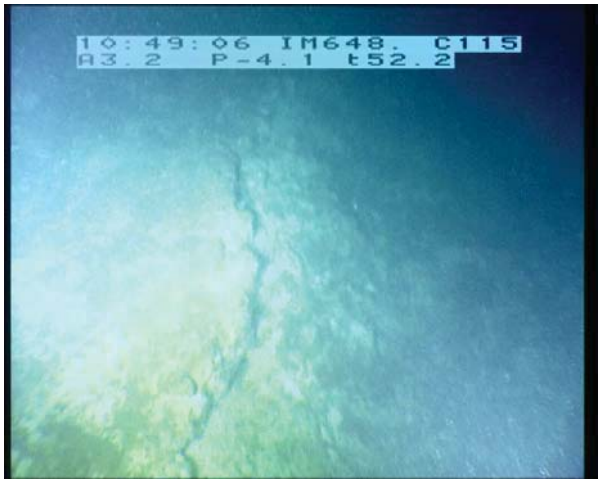

**Slide 7**

8:56:52 Pink unit outcropping the N-wall of the canyon; no samples collected;



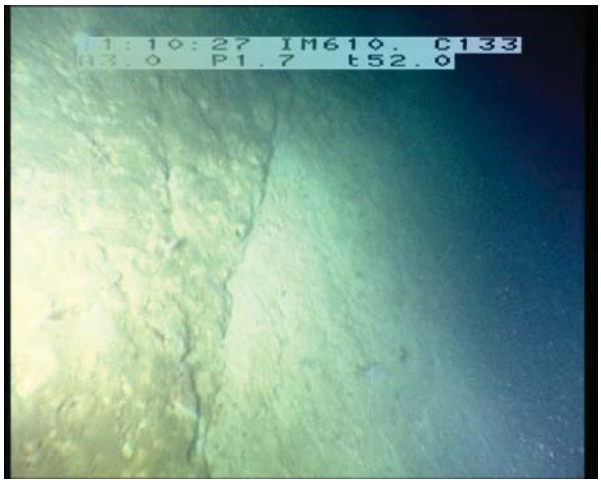

**Slide 8**

10:49:06 center of the canyon; following en-echelon scarps outcropping the bottom of the canyon (Slide 9); an approximate orientation of the scarps measured on-the-fly is 110, that in the context of NAF strike-slip domain means transtension. A push core has been collected from the top of a scarp footwall (PC1 in Table 1)




**Slide 9**

11:10:27 “thin-skinned” gravity failure at the base of the canyon N-wall (Slide 10); no samples collected;




**Slide 10**

11:27:00 N-wall of the canyon; coring the base of the sedimentary sequence exposed by erosion and gravity collapse (Slide 11); samples PC-2;


**Slide 11**

12:30:27 contact with a telephone cable (Slide 11); no sample collected;


**Slide 12**

12:51:48 last core; the base of the canyon N-wall (PC-3);


**Slide 13**

| DATE_ | HEURE | LATITUDE | LONGITUDE | IMMERSION | CODE | LIBELLE |
|---|---|---|---|---|---|---|
| 29/05/2007 | 06:54:54 | 40,7295830 | 29,2602170 | 702,00 | MARQ | 0 |
| 29/05/2007 | 06:56:18 | 40,7294670 | 29,2680170 | 748,00 | MARQ | 1 |
| 29/05/2007 | 06:57:05 | 40,7293000 | 29,2712000 | 774,00 | MARQ | 2 |
| 29/05/2007 | 06:57:19 | 40,7288830 | 29,2741830 | 781,00 | MARQ | 3 |
| 29/05/2007 | 06:57:32 | 40,7282170 | 29,2762500 | 789,00 | MARQ | 4 |
| 29/05/2007 | 06:58:05 | 40,7282670 | 29,2833330 | 808,00 | MARQ | 5 |
| 29/05/2007 | 06:58:19 | 40,7275500 | 29,2878330 | 815,00 | MARQ | 6 |
| 29/05/2007 | 06:58:41 | 40,7264330 | 29,2952170 | 829,00 | MARQ | 7 |
| 29/05/2007 | 06:58:53 | 40,7269670 | 29,3011330 | 836,00 | MARQ | 8 |
| 29/05/2007 | 06:59:29 | 40,7271170 | 29,3064170 | 857,00 | MARQ | 9 |
| 29/05/2007 | 07:19:44 | 40,7294833 | 29,2613400 | 907,00 | DIV3 | |
| 29/05/2007 | 07:56:39 | 40,7297150 | 29,2665184 | 844,00 | AUTT | ECH1 |
| 29/05/2007 | 08:42:37 | 40,7293350 | 29,2735100 | 804,00 | AUTT | ECH2 |
| 29/05/2007 | 10:36:18 | 40,7267300 | 29,2910533 | 655,92 | AUTT | PC1 (16 cm) |
| 29/05/2007 | 11:57:11 | 40,7269517 | 29,2989000 | 564,00 | AUTT | ECH4 |
| 29/05/2007 | 11:57:59 | 40,7269500 | 29,2989150 | 658,00 | AUTT | PC2 (8cm) |
| 29/05/2007 | 12:31:59 | 40,7274316 | 29,3042000 | 511,00 | MARQ | CABLE |
| 29/05/2007 | 12:46:20 | 40,7275750 | 29,3047916 | 513,00 | AUTT | PC3 (27cm) |

Table 1. Positioning and timing of DIVE 1657

| DATE_ | HEURE | LATITUDE | LONGITUDE | SOURCE | FILE | |
|---|---|---|---|---|---|---|
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| 29/05/2007 | 07:46:33 | 40,7296517 | 29,2661133 | HYTEC-A | JPG_FILE | 070529074633A |
| 29/05/2007 | 07:46:41 | 40,7296150 | 29,2660750 | HYTEC-A | JPG_FILE | 070529074641A |
| 29/05/2007 | 07:47:04 | 40,7296833 | 29,2661000 | HYTEC-A | JPG_FILE | 070529074704A |
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| 29/05/2007 | 07:47:26 | 40,7296867 | 29,2660800 | HYTEC-A | JPG_FILE | 070529074726A |
| 29/05/2007 | 07:48:09 | 40,7297000 | 29,2661333 | HYTEC-A | JPG_FILE | 070529074809A |
| 29/05/2007 | 07:48:36 | 40,7296800 | 29,2661333 | HYTEC-A | JPG_FILE | 070529074836A |
| 29/05/2007 | 07:52:42 | 40,7297266 | 29,2665134 | HYTEC-A | JPG_FILE | 070529075242A |
| 29/05/2007 | 07:52:50 | 40,7297000 | 29,2665000 | HYTEC-A | JPG_FILE | 070529075250A |
| 29/05/2007 | 07:53:06 | 40,7297167 | 29,2665000 | HYTEC-A | JPG_FILE | 070529075306A |
| 29/05/2007 | 07:53:21 | 40,7297200 | 29,2665167 | HYTEC-A | JPG_FILE | 070529075321A |
| 29/05/2007 | 07:58:59 | 40,7297333 | 29,2665650 | HYTEC-A | JPG_FILE | 070529075859A |
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| 29/05/2007 | 08:38:54 | 40,7293100 | 29,2735067 | HYTEC-A | JPG_FILE | 070529083854A |
| 29/05/2007 | 08:39:05 | 40,7293083 | 29,2735250 | HYTEC-A | JPG_FILE | 070529083905A |
| 29/05/2007 | 08:39:12 | 40,7293167 | 29,2735266 | HYTEC-A | JPG_FILE | 070529083912A |
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| 29/05/2007 | 08:40:36 | 40,7293533 | 29,2735067 | HYTEC-A | JPG_FILE | 070529084036A |
| 29/05/2007 | 08:40:59 | 40,7293283 | 29,2735425 | HYTEC-A | JPG_FILE | 070529084059A |
| 29/05/2007 | 10:29:52 | 40,7266200 | 29,2910000 | HYTEC-A | JPG_FILE | 070529102952A |
| 29/05/2007 | 10:30:08 | 40,7266333 | 29,2910134 | HYTEC-A | JPG_FILE | 070529103008A |
| 29/05/2007 | 10:36:00 | 40,7267167 | 29,2910500 | HYTEC-A | JPG_FILE | 070529103600A |

| | | | | | | |
|---|---|---|---|---|---|---|
| 29/05/2007 | 10:36:18 | 40,7267300 | 29,2910533 | HYTEC-A | JPG_FILE | 070529103618A |
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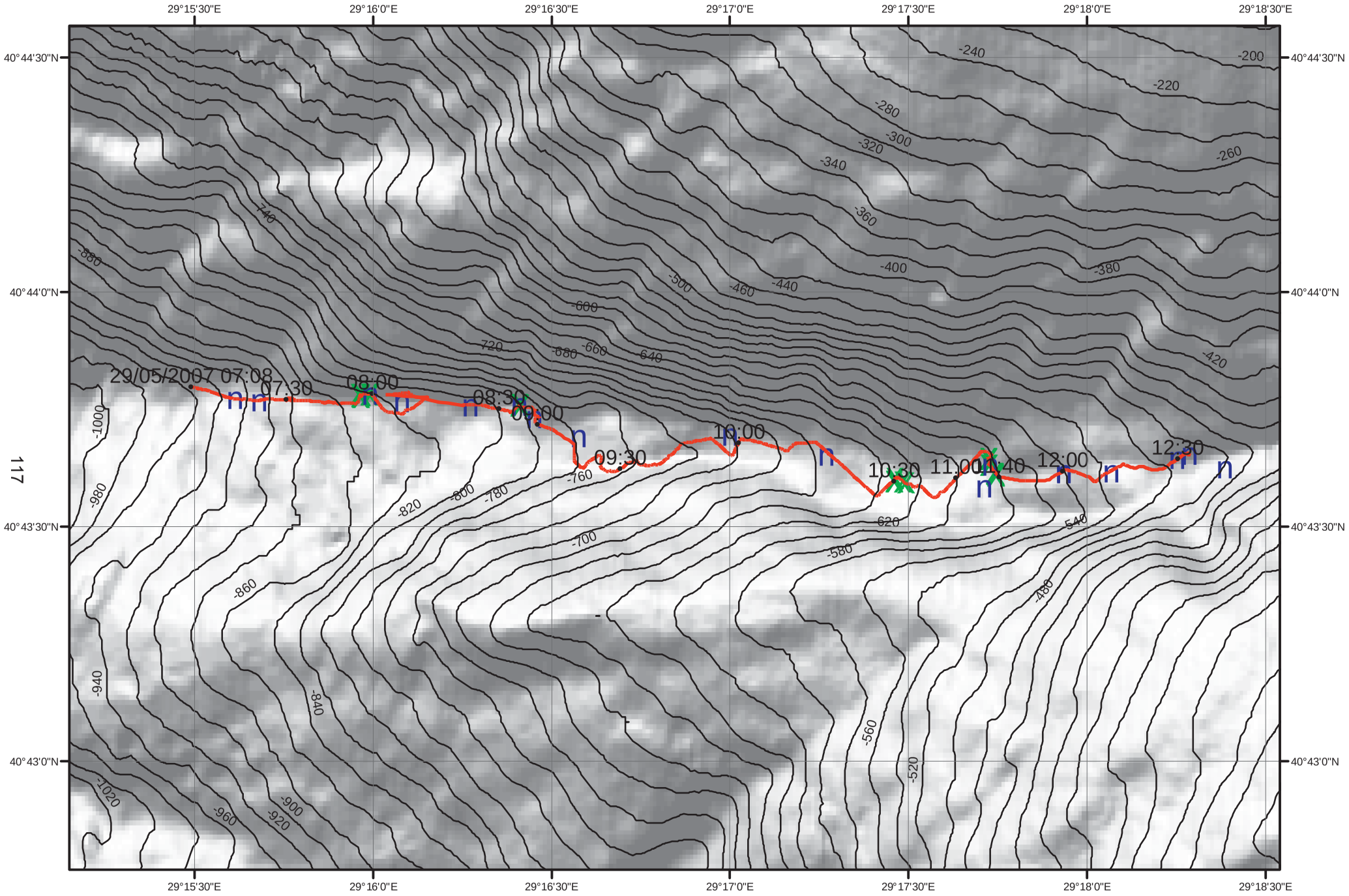
| 29/05/2007 | 10:48:51 | 40,7265650 | 29,2915366 | HYTEC-A | JPG_FILE | 070529104851A |
| 29/05/2007 | 11:10:20 | 40,7274333 | 29,2953833 | HYTEC-A | JPG_FILE | 070529111020A |
| 29/05/2007 | 11:10:26 | 40,7274333 | 29,2953933 | HYTEC-A | JPG_FILE | 070529111026A |
| 29/05/2007 | 11:10:37 | 40,7274217 | 29,2954117 | HYTEC-A | JPG_FILE | 070529111037A |
| 29/05/2007 | 11:10:50 | 40,7274167 | 29,2954000 | HYTEC-A | JPG_FILE | 070529111050A |
| 29/05/2007 | 11:11:12 | 40,7274000 | 29,2954033 | HYTEC-A | JPG_FILE | 070529111112A |
| 29/05/2007 | 11:14:21 | 40,7272000 | 29,2954500 | HYTEC-A | JPG_FILE | 070529111421A |
| 29/05/2007 | 11:15:28 | 40,7272167 | 29,2954200 | HYTEC-A | JPG_FILE | 070529111528A |
| 29/05/2007 | 11:35:00 | 40,7268990 | 29,2956924 | HYTEC-A | JPG_FILE | 070529113500A |
| 29/05/2007 | 11:35:05 | 40,7268972 | 29,2956938 | HYTEC-A | JPG_FILE | 070529113505A |
| 29/05/2007 | 11:35:17 | 40,7268927 | 29,2956974 | HYTEC-A | JPG_FILE | 070529113517A |
| 29/05/2007 | 11:35:56 | 40,7268781 | 29,2957088 | HYTEC-A | JPG_FILE | 070529113556A |
| 29/05/2007 | 11:36:10 | 40,7268729 | 29,2957129 | HYTEC-A | JPG_FILE | 070529113610A |
| 29/05/2007 | 11:36:27 | 40,7268666 | 29,2957179 | HYTEC-A | JPG_FILE | 070529113627A |
| 29/05/2007 | 11:36:39 | 40,7268621 | 29,2957214 | HYTEC-A | JPG_FILE | 070529113639A |
| 29/05/2007 | 11:37:58 | 40,7268326 | 29,2957446 | HYTEC-A | JPG_FILE | 070529113758A |
| 29/05/2007 | 11:38:05 | 40,7268300 | 29,2957466 | HYTEC-A | JPG_FILE | 070529113805A |

Table 2. Photographic record

Achronim List

NAF : North Anatolian Fault
PC: Push Core
ECH: samples collected using Nautile arm grab
JPG: graphic file format


29°15'30"E
29°16'0"E
29°16'30"E
29°17'0"E
29°17'30"E
29°18'0"E
29°18'30"E
40°44'30"N
40°44'0"N
40°43'30"N
40°43'0"N
29/05/2007 07:08
07:30
08:00
08:30
09:00
09:30
10:00
10:30
11:00
11:40
12:00
12:30
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-380
-440
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-500
-600
-720
-680
-660
640
-420
-740
-880
-1000
-980
-820
-800
-780
-760
-700
620
540
-580
-860
-480
-940
-840
-560
-520
-1020
-960
-900
-920
117

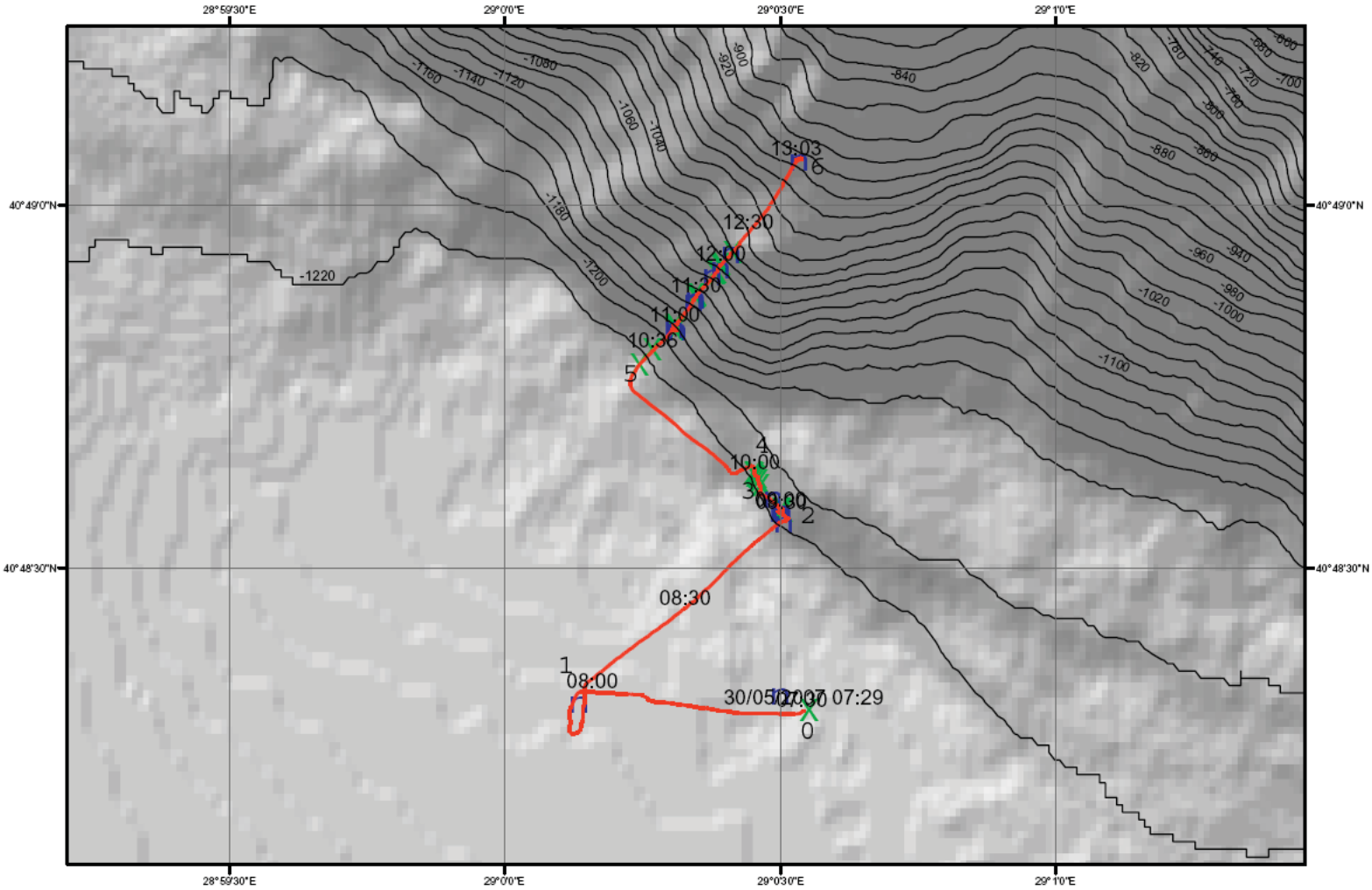
**VEMO+NAUTILE-PLONGEE NO=1658-MARNAUT (18) / (27)**

**DIVING REPORT**

**Date : 30/05/2007**
**Latitude : N40  46.347**
**Longitude : E28  57.121**
**Scientist : Naci Gorur**

## NAVIGATION ROUTE

Navigation route is shown in Fig.1.



## OBJECTIVE

The objectives of the dive are as follows :

- To search for black spots and seepages
- Follow any active fault escarpment that may be encountered along the route
- Study Palaeozoic sediments cropping out on the scarp along the northern part of the route

## DESCRIPTION

After touching down the sea-floor at location 0, we headed to the Location 1 to look for a black spot reported there before (Table-1) . Our investigation has not proved it and we saw no black spot in this area. In our travel from Location 1 to Location 2 we observed a remarkable sea-floor characterized by extensive bioturbation. Burrows are very dense and appearent with their white infill or stain (Fig. 1). They are formed mainly by benthonic organisms, such as annelids, polychaetes, bivalves, crinoids, etc .

**Table-1**

| DATE_ | HEURE | LATITUDE | LONGITUDE | IMMERSION | CODE | LIBELLE |
|---|---|---|---|---|---|---|
| 30/05/2007 | 05:20:21 | 40,8054330 | 29,0083330 | 0,00 | DEPA | MAL |
| 30/05/2007 | 07:02:57 | 40,8052500 | 29,0022170 | 0,00 | MARQ | popmark |
| 30/05/2007 | 08:51:12 | 40,8094000 | 29,0084170 | 1211,00 | MARQ | tache noire |
| 30/05/2007 | 09:02:46 | 40,8096500 | 29,0083500 | 1206,00 | MARQ | TN2 |
| 30/05/2007 | 09:06:24 | 40,8096330 | 29,0083670 | 1208,00 | PANI | core1 |
| 30/05/2007 | 09:38:07 | 40,8096500 | 29,0083000 | 1209,00 | PANI | core2 |
| 30/05/2007 | 09:52:05 | 40,8099670 | 29,0081000 | 1211,00 | MARQ | pt scarp |
| 30/05/2007 | 10:49:07 | 40,8138670 | 29,0051000 | 1174,00 | MARQ | block |
| 30/05/2007 | 11:14:53 | 40,8138000 | 29,0052000 | 1176,00 | MARQ | prelev 1 |
| 30/05/2007 | 11:31:54 | 40,8144830 | 29,0057170 | 1129,00 | MARQ | block |
| 30/05/2007 | 11:39:48 | 40,8145330 | 29,0057500 | 1128,00 | MARQ | prelev 2 |
| 30/05/2007 | 11:53:15 | 40,8150670 | 29,0062830 | 1088,00 | MARQ | prelev3 |
| 30/05/2007 | 12:00:42 | 40,8152500 | 29,0065170 | 1074,00 | MARQ | prelev4 |
| 30/05/2007 | 12:19:22 | 40,8155830 | 29,0068330 | 1040,00 | MARQ | ech5 |
| 30/05/2007 | 13:04:20 | 40,8177170 | 29,0089000 | 918,00 | MARQ | ech6 |

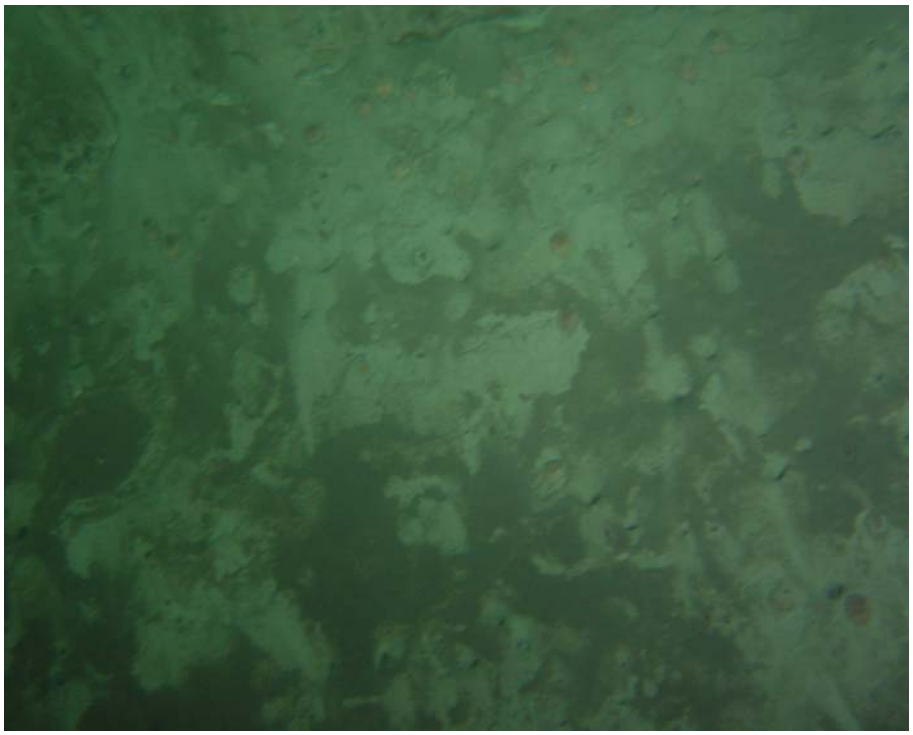


Fig.1 : Burrows on the Marmara sea-floor . Notice the white infill or stains Fig.1 making them appearent

Between Locations 2 and 4, a possible fault scarp was observed and traced for a while hopefully to see seepages along it, but unfortunately there were none (Table-1, Fig.2).

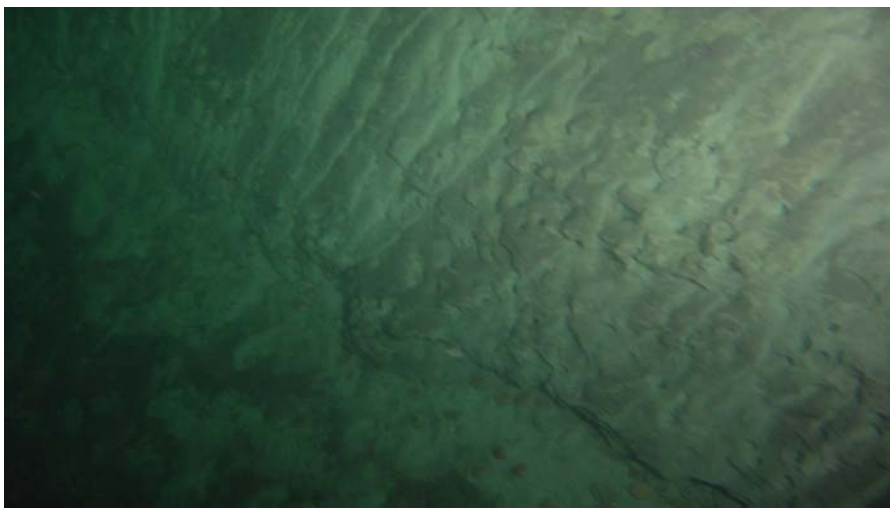


Fig. 2 : Possibly a fault scarp to the northeast of Locations 2 and 4

Between Locations 2 and 4, we also found several black spots. They have rounded shapes with a diameter of one metre or so (Table-1, Fig. 3). At least 4 black spots are counted and two of them were sampled. Samples were taken from the centers of the black spots.

Fig. 3 : One of the black spots between Locations 2 and 4 being sampled

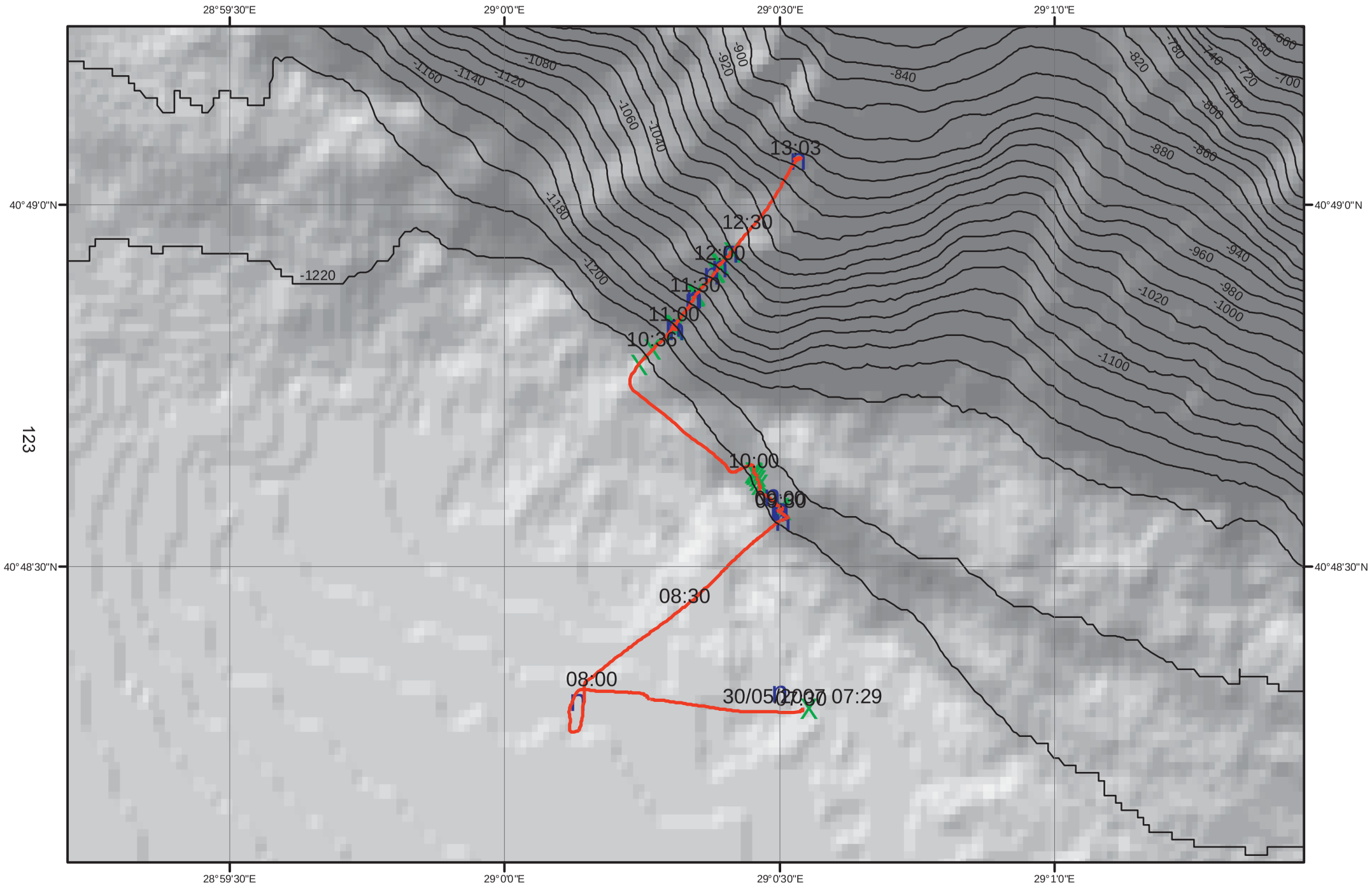
During the transit from Location 4 to Location 5 again the same sea-floor covered by dense bioturbation obnserved. From Location 5 towards Location 6, sequence of the Palaeozoic of Istanbul was encountered (Table-1, Fig.4).

Fig.4 : Black Devonian shales, dipping mainly SE

The Palaeozoic sequence examined form a steep scarp and consists of Lower Devonian shales. They are dark grey to black and thinly- to medium-bedded hard rocks, dipping mainly southeast with an angle of approximately 60 degrees. Six samples were collected from these rocks (Table-1).

## CONCLUSIONS

The diving site is located at the base of the northern margin of the Cinarcik Basin. It is well-known that this margin is a boundary fault and appear to be made up of Palaeozoic sediments in part. During this dive only the Devonian section of this sequence was sampled. In the diving area, a fault scarp can be observed as a steep cliff, running parallel to the main scarp. Several black spots are observable in the area. It seems that they get common towards the foot of the scarp.


28°59'30"E
29°0'0"E
29°0'30"E
29°1'0"E
40°49'0"N
40°48'30"N
123
13:03
12:30
12:00
11:30
11:00
10:36
10:00
09:30
08:30
08:00
07:30
07:29
30/05/2007
-1220
-1180
-1200
-1160
-1140
-1120
-1080
-1060
-1040
-900
-920
-840
-820
-780
-740
-720
-700
-680
-660
-800
-760
-880
-860
-960
-940
-980
-1000
-1020
-1100

**Campagne MarNaut**
**Chef de mission : Pierre Henry / Namik Çagatay**
**Travaux réalisés par le Nautile**

| | |
|---|---|
| **N° absolu de plongée** : 1659 | **Date** : 31/05/2007 |
| **Observateur**<br>- Nom : Pierre HENRY<br>- Spécialité : Géophysique<br>- Organisme : CNRS | **Pilote** : Jean-Paul JUSTINIANO<br><br>**Navigateur engin** : Xavier PLACAUD |

**Objectif(s) de la plongée** :
Exploration d'une anomalie acoustique, échantillonnage du gas et de l'eau.
Ground truthing of an acoustic anomaly, water and gas sampling

**Coordonnées du point d'arrivée sur le fond**
- Longitude : 29,1228 - Latitude : 40,7181

**Profondeurs explorées pendant la plongée**
- Minimum : 1234 m - Maximum : 1248 m

**Durée totale de la plongée** : 6:53 **Durée sur le fond** : 5:27

**Equipements scientifiques**

- installés sur le submersible : Microcat – Water samplers (4) – Push corers (4) - Pegaz

- transportés dans la navette :

- mouillés en autonome :

**Travaux réalisés sur le fond**

- Distance parcourue : 1248 m

-Travaux réalisés : Observation and sampling – Temperature and Salinity measurements

- Echantillons : 1 grab sample (R1) – 4 water samples – 4 push cores – 1 gas sample

- Nombre de bandes vidéo : 6 DVD

- Nombre de photos : 99 pan and tilt + 137 pentax

**Dive objectives:** This dive site is located on a system of normal faults affecting the lower part of the southern slope of the Çinarcik basin. These faults have a weak morphologic expression but are well seen on 3.5 kHz profiles. Seismarmara seismic profiles suggest that a deep strike slip fault is active beneath this system (Carton et al., 2007). In this context, these faults may represent en echelon sediment deformation above a transtensional fault in the prolongation of the Izmit rupture. Acoustic anomalies were found at several locations in the southern Çiarcik area in the Marmara SAR data as well as with the EK60 sounder data acquired duing Marnaut. The purpose of the dive was to ground truth the acoustic anomalies and to sample gas if any was present.

**Site survey data:** EM300, 3.5 kHz, MCS.

**Dive course and operations:** The bubble emission sites could be easily located with the Nautile panoramic sounder (STRAZA), which appeared extremely sensitive to small streams of bubble emitted over relatively wide areas (5 by 5m, typically). Most sampling was performed in the first active site found, a 30 m long swath of black patches trending N090. After a photomosaïc and video coverage of this site, pegas and water sample WS 1 were taken at a small bubble stream at the eastern end of this active zone. The Nautile then went back to a large (5x10 m) black patch at the western end. Water samples WS2 and WS3 were taken at one bubble stream in this site near a yellow bacterial mat. Two push cores (PC1 and PC2) were taken on the other side of the bacterial mat, toward the rim, 20 cm apart. PC2 sampled a lump of bacterial colony. Microcat measurements were performed at the same location at the bubble stream and over the push coring site. Two more push cores (PC3 and PC4 also 20 cm apart) were taken 5 meter further west in the same black patch, in a part covered by a polychete carpet. PC3 sampled a lighter layer in its bottom 5 cm. A grab on a bubble emission point recovered delicate carbonate concretions (sample R1).
After these sampling operations, a loop toward the SE found three more active sites (2, 3, and 4) two of them with strong enough bubble emission to produce sonar echos. A water sample (WS4) was taken at a relatively strong bubble stream at Site 4. This site was selected as Kuellenberg coring and CTD rosette target. A final observation transect connected sites 4 and 3 along a N320 trend.

**Main results:** This dive confirmed that the SAR and EK60 water column echoes observed at this site are gas bubbles, and could be sampled. Bubbles only a few mm diameter are expelled in small streams, sometime continuous, but often sporadic, from the black patches. The bubble emission points are very localized and often marked by a tiny white spot. Grab sampling showed that at least one of these white spots is the exposed part of a small, buried, chimney and that carbonate concretions of complex shapes are forming within the black sediment. One open bivalve shell was observed, but no living individual was seen at the seafloor during the dive. As elsewhere, black patches are covered by a dense polychete carpet. Bacterial colonies only belong to the yellow type, also observed during Dive 1654 on the Northern Çinarcik basin. They form a reticulate 10 cm rim around the black patches and, occasionally, lumps within the black patches.
The microcat recorded several spikes during the dive, with a decrease of salinity of more than 0.01 per mill and a concurrent increase of temperature of more than 0.01°C. The two most prominent spikes occurred at 8:59:21-9:01:02 during the Pegaz sampling and at 9:39:01-

9:44:01 while the Nautile was manipulating instruments above the same site. A small decrease of salinity was also observed while the microcat was held on the surface of the bacterial mat near bubble streams and push coring sites. The maximum salinity decrease during these measurements was 0.012, with no concurrent temperature increase. This last observation suggests slow brackish water seepage occurs through the black patches.
Sites 2, 3, and 4 define a N340 swath of nearly continuous activity over 180 m from the SE end of site 2 to the NW end of site 3. 80+30+20 = 130 m have been actually observed with the submersible. Within this swath, the sonar echos define bubble curtains having the same general orientation. Individual black patches are typically elongated and sinuous, one or two meter wide and 5 to 15 m long and follow the same average trend. Alignment of meter size round black patches are also observed. The N340 direction is consistent with the trend of the fault scarp, it is thus likely that normal faults or tension gashes are channeling the gas escape from the sediment.

**Video :**
Complete observation report (with seeps and structural observations) is available as an XL spread sheet in the cruise data folder.

**Sample report :**

| Sample Nb | Depth (m) | LAT | LON | DESCRIPTION |
|---|---|---|---|---|
| R1 | 1248 | N 40°42,994' | E 29°06,976' | Delicate carbonate concretions of complex shape and small chimneys, sampled with submersible grab at a bubble emission point. |
| Pegaz | 1248 | N 40°42,991' | E 29°06,991' | Taken in intermittent gas stream at the eastern end of active zone 1 |
| WS1 | 1248 | N 40°42,991' | E 29°06,991' | Water sample taken at same bubble stram as Pegaz |
| WS2 | 1248 | N 40°42,994' | E 29°06,976' | Water sample taken next to a continuous bubble stream in large black patch at Site 1 |
| WS3 | 1248 | N 40°42,994' | E 29°06,976' | same as WS2 |
| WS4 | 1243 | N 40°42,937' | E 29°06,846' | Water sample taken in relatively strong bubble stream at Site 4. |
| PC1 | 1248 | N 40°42,994' | E 29°06,976' | next to bacterial mat, 40 cm from WS2 and WS3 toward the rim of the black patch. |
| PC2 | 1248 | N 40°42,994' | E 29°06,976' | 20 cm from PC2, sampled yellow bacterial lump on seafloor. |
| PC3 | 1248 | N 40°42,994' | E 29°06,969' | In polychete carpet, 5 m from PC1 and PC2 in same black patch. Bottom 5cm appear lighter. |
| PC4 | 1248 | N 40°42,994' | E 29°06,969' | 20 cm from PC4. |

**Photo selection: full resolution photos and larger selection is found in the data folder**

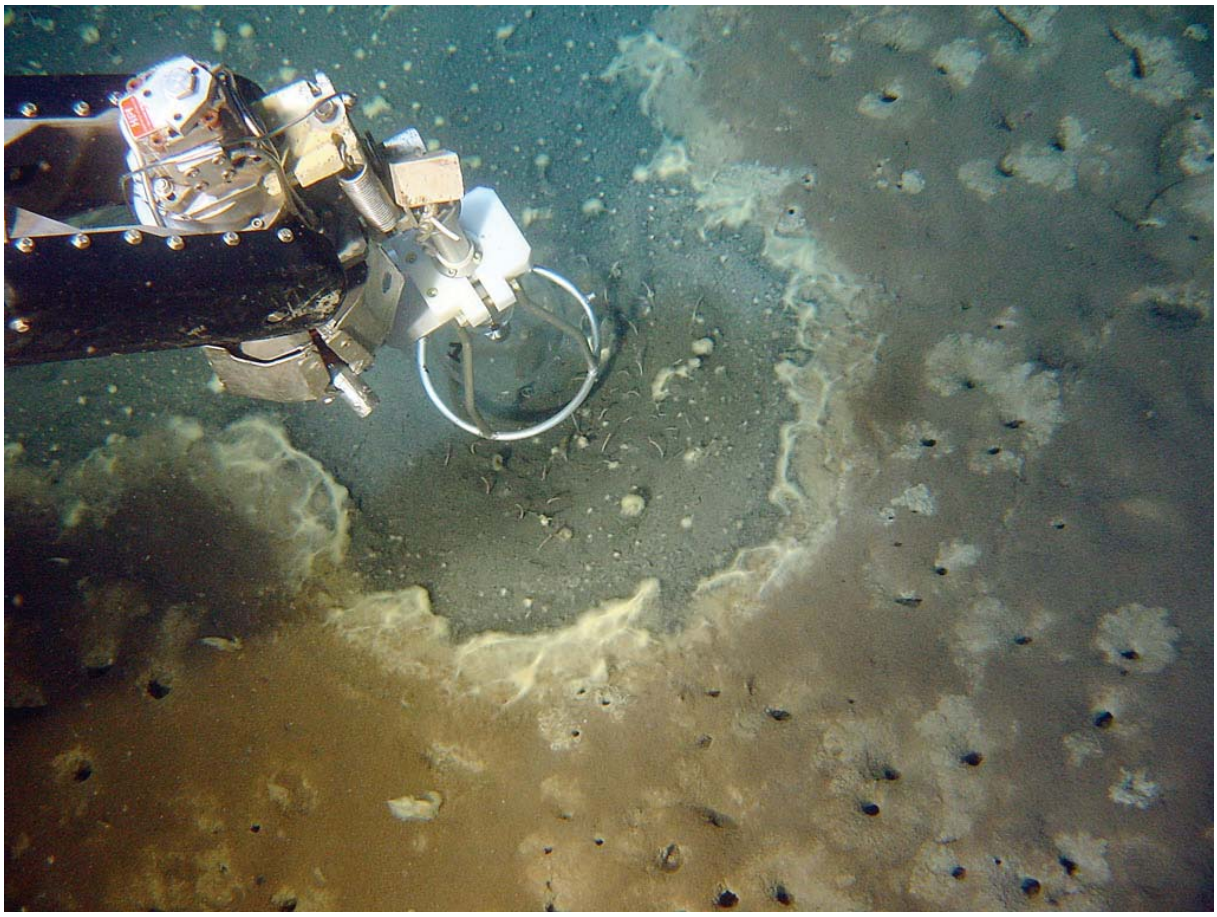


Photo 1: Pegaz sampling, Water Sample was taken at the same location

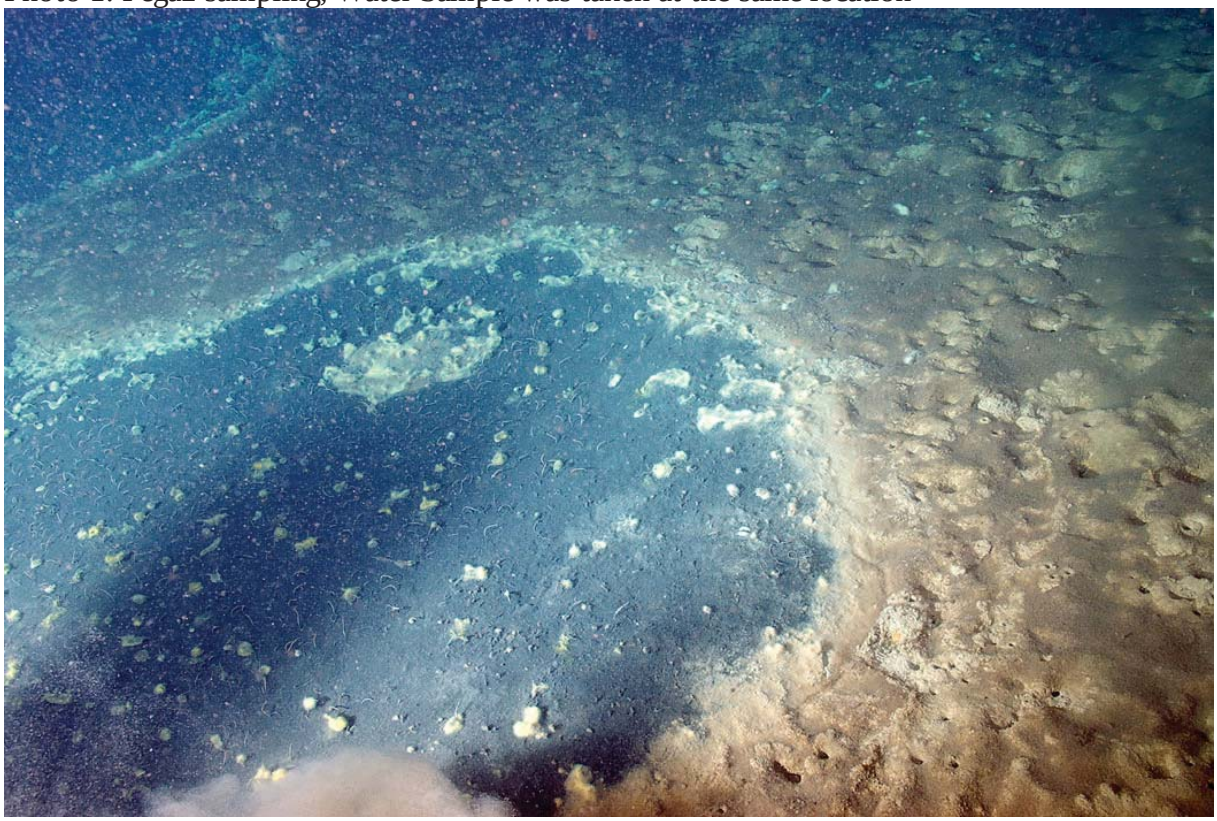


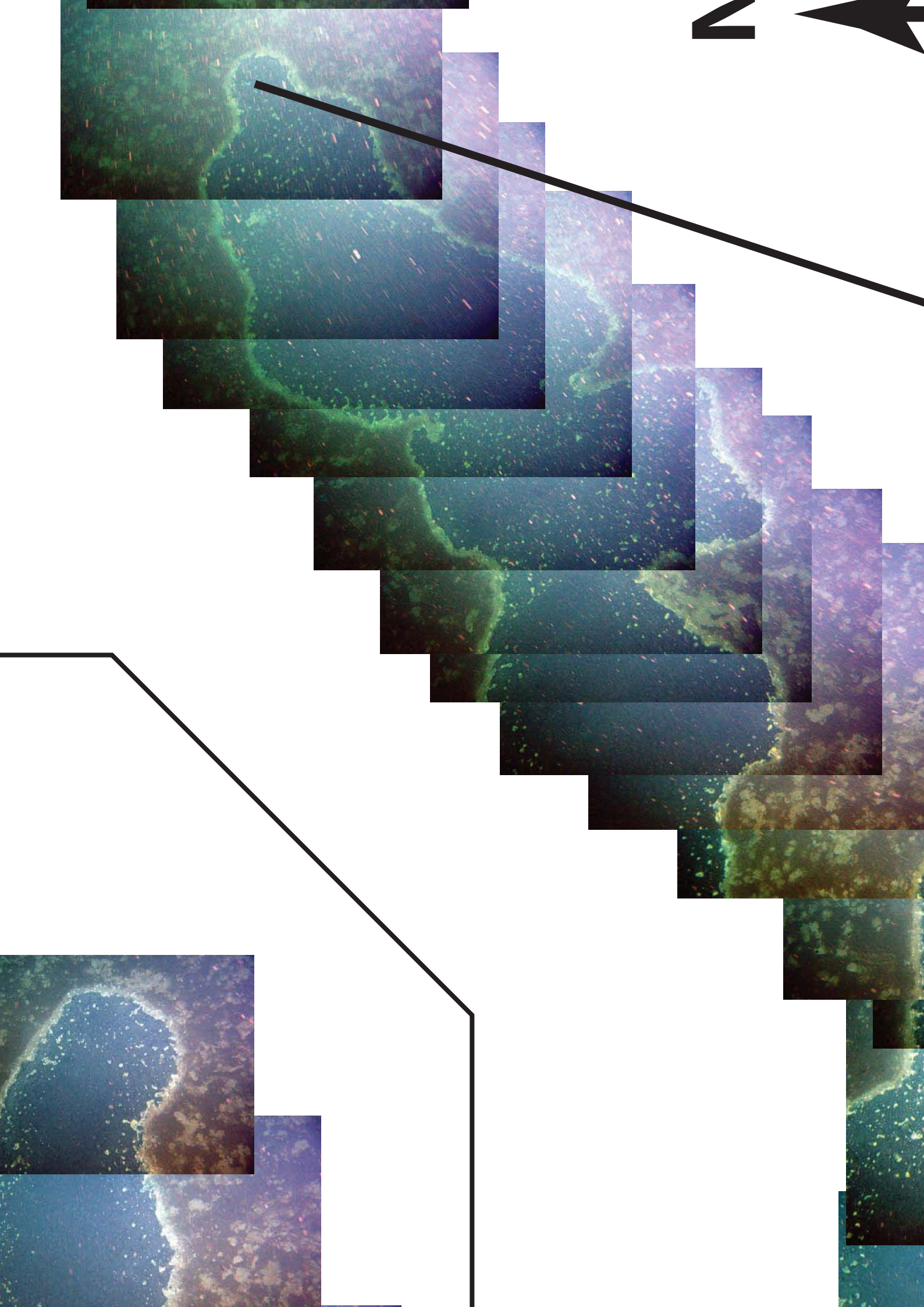
Photo 2: Site of sampling, water samples WS2 and WS3 in front of bacterial mat, push cores PC1 and PC2 behind. PC3 and PC4 were taken 5 meters in the upper right corner direction.

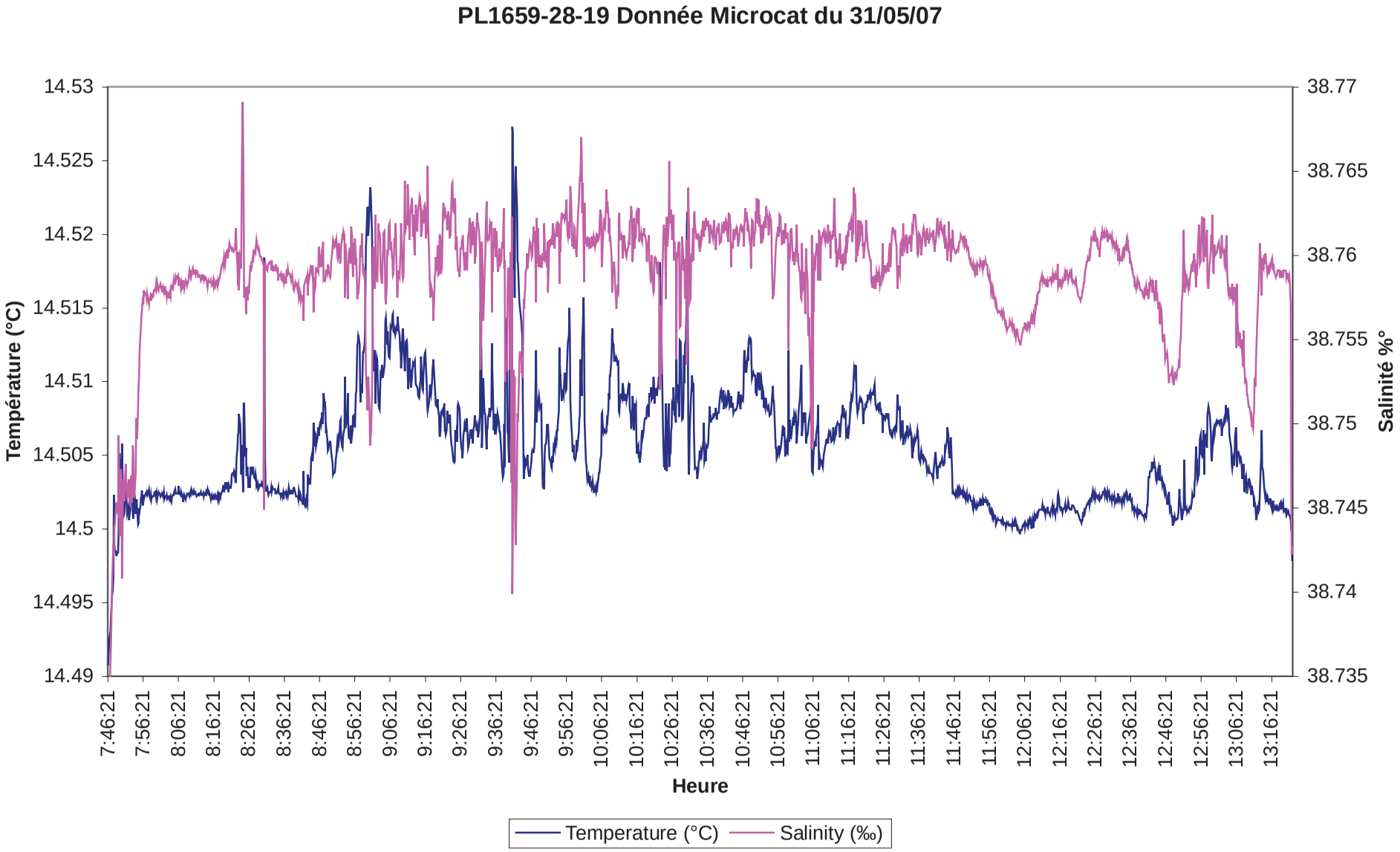
Photo 3: black patch with polychetes and bacterial colonies at Site 2.

Photo 4: Carbonate concretions from a bubble emission center at Site 1


Photo 5: small chimney, 5 cm width, 5 mm opening.

| Table 1: 1659 highlights | | | | |
|---|---|---|---|---|
| time | depth (m) | latitude | longitude | |
| 7:53:55 | 1249 | 40° 43,086' | 029° 07,367' | begin recording |
| 8:18:00 | 1248 | 40° 42,994' | 029° 06,976' | active zone 1: strong sonar echo, black patches with polychetes, bacterial colonies on the rim. Near western end of active swath (30m long trending N090) |
| 8:48:10 | 1248 | 40° 42,991' | 029° 06,991' | Pegaz set for collecting gas, at eastern end of active zone 1 |
| 9:32:05 | 1248 | 40° 42,991' | 029° 06,991' | End of Pegaz sampling, unexplained cloud of sediment rising from behind |
| 9:54:10 | 1248 | 40° 42,991' | 029° 06,991' | Water sampling WS1 at same site |
| 10:04:57 | 1248 | 40° 42,994' | 029° 06,976' | back on black patch seen at 8:18 |
| 10:18:30 | 1248 | 40° 42,994' | 029° 06,976' | Water sampling WS2 in bubble stream |
| 10:20:45 | 1248 | 40° 42,994' | 029° 06,976' | Water sampling WS3, in same bubble stream |
| 10:37:10 | 1248 | 40° 42,994' | 029° 06,976' | Push core 1, |
| 10:48:30 | 1248 | 40° 42,994' | 029° 06,976' | Push core 2, |
| 11:14:56 | 1248 | 40° 42,994' | 029° 06,969' | Push core 3, |
| 11:29:01 | 1248 | 40° 42,994' | 029° 06,969' | Push core 4, |
| 11:41:42 | 1248 | 40° 42,994' | 029° 06,976' | grab sample on two bubble emission points |
| 11:45:00 | 1248 | 40° 42,994' | 029° 06,976' | resuming exploration transect, N220 |
| 11:51:48 | 1243 | 40° 42,926' | 029° 06,888' | reaching active zone 2, changing course to follow along N135 |
| 11:53:24 | 1244 | 40° 42,917' | 029° 06,891' | end of this active swath (20 m long) resume course |
| 12:04:10 | 1234 | 40° 42,784' | 029° 06,760' | end of profile, change course to N020 |
| 12:13:15 | 1242 | | | Active zone 3, in the NW prolongation of zone 2. Strong line of echos on both sides trending N140. Follow active swath in a N320 direction |
| 13:16:09 | 1242 | 40° 42,958' | 029° 06,792' | navigation way point |
| 12:18:52 | 1241 | 40° 42,969' | 029° 06,786' | reach end of active swath (30 m from turning point), resuming N020 course |
| 12:21:30 | 1241 | 40° 42,991' | 029° 06,792' | strong echos trending N140 60m on the right side |
| 12:26:45 | 1248 | 40° 43,068' | 029° 06,839' | change course to N145 |
| 12:32:24 | 1249 | 40° 42,986' | 029° 06,925' | change course back to N140 active zone |
| 12:40:28 | 1243 | 40° 42,938' | 029° 06,849' | Active zone 4 with bubble emissions, between zones 2 and 3 along N140 trend |
| 13:00:52 | 1243 | 40° 42,937' | 029° 06,846' | Water sampling WS4, same site |
| 13:13:06 | 1244 | 40° 42,930' | 029° 06,850' | begin observation profile along swath trend (N320) - activity is nearly continuous over 80 m up to very close to active zone 3 |
| 13:20:17 | 1242 | 40° 42,954' | 029° 06,804' | end of observations |
| 13:21:20 | 1242 | 00° 00,000' | 000° 00,000' | weight released, coming up |




PL1659-28-19 Donnée Microcat du 31/05/07
Température (°C)
Salinité %°
Heure
14.53
14.525
14.52
14.515
14.51
14.505
14.5
14.495
14.49
38.77
38.765
38.76
38.755
38.75
38.745
38.74
38.735
7:46:21
7:56:21
8:06:21
8:16:21
8:26:21
8:36:21
8:46:21
8:56:21
9:06:21
9:16:21
9:26:21
9:36:21
9:46:21
9:56:21
10:06:21
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11:36:21
11:46:21
11:56:21
12:06:21
12:16:21
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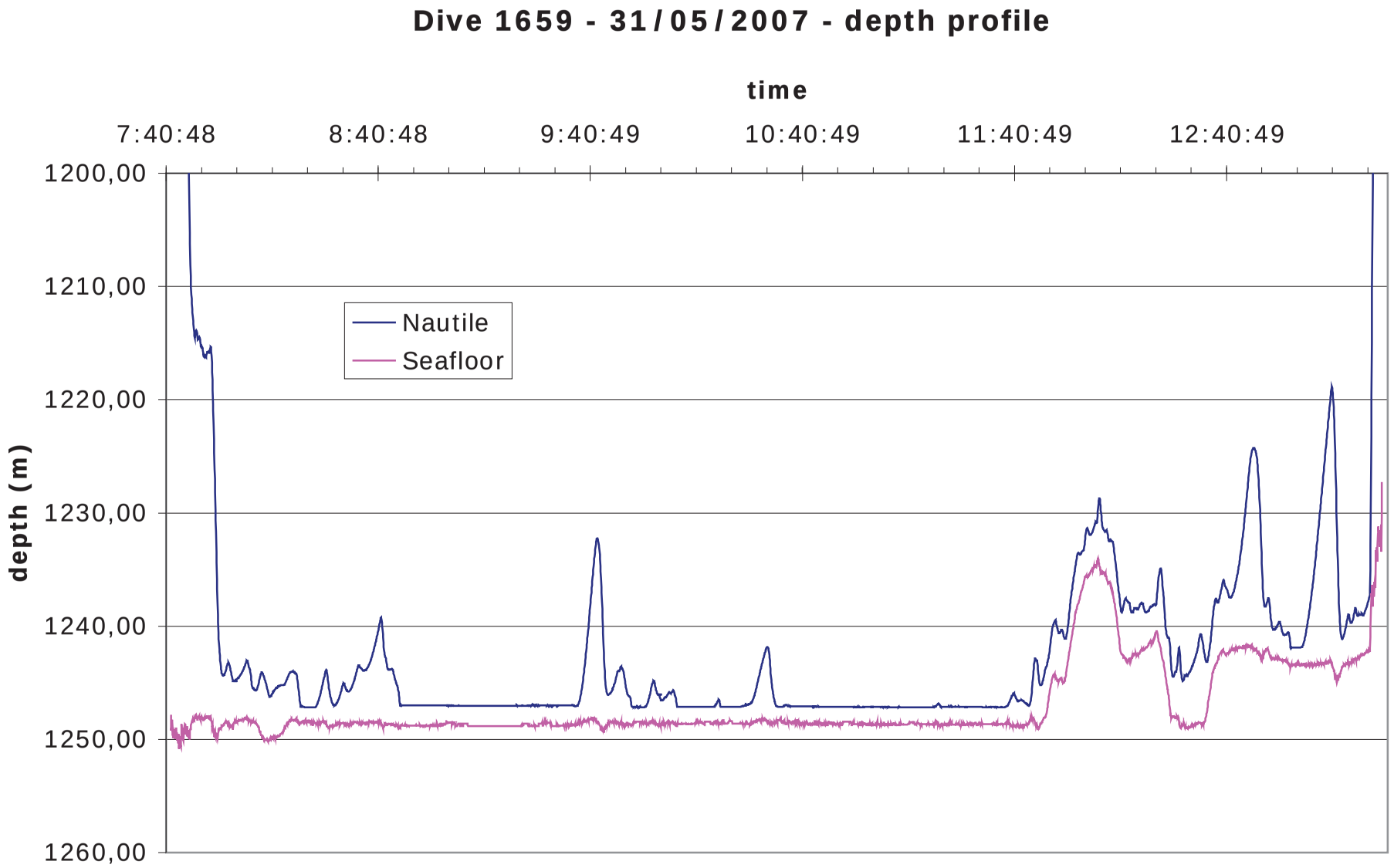
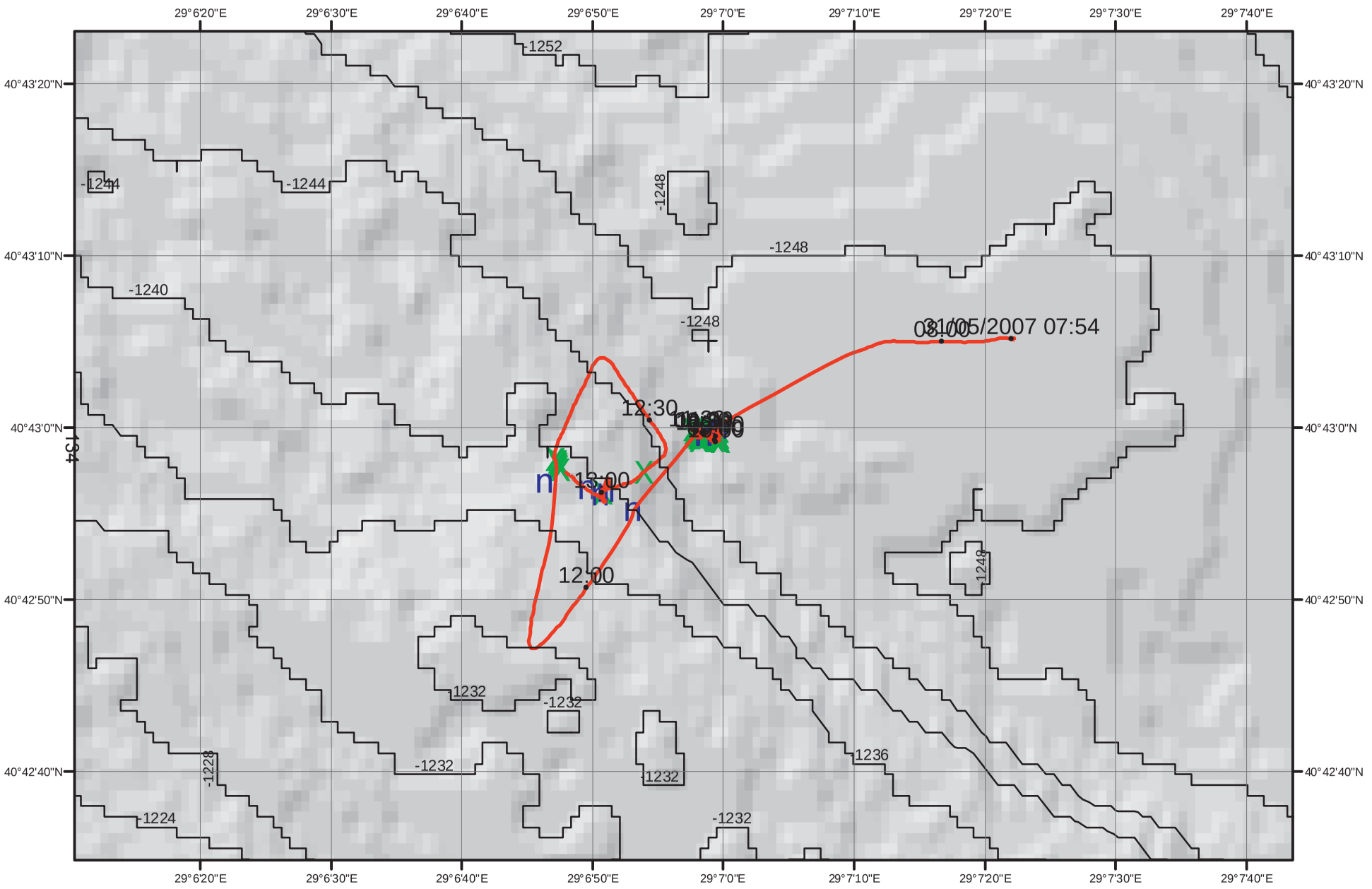
12:46:21
12:56:21
13:06:21
13:16:21
Temperature (°C)
Salinity (‰)


Dive 1659 - 31/05/2007 - depth profile
time
7:40:48
8:40:48
9:40:49
10:40:49
11:40:49
12:40:49
depth (m)
1200,00
1210,00
1220,00
1230,00
1240,00
1250,00
1260,00
Nautile
Seafloor


29°6'20"E
29°6'30"E
29°6'40"E
29°6'50"E
29°7'0"E
29°7'10"E
29°7'20"E
29°7'30"E
29°7'40"E
40°43'20"N
40°43'10"N
40°43'0"N
40°42'50"N
40°42'40"N
-1252
-1244
-1248
-1240
-1232
-1228
-1224
1236
08:00
31/05/2007 07:54
12:30
13:00
12:00

**MARNAUT Dive 1660**

Date: 06/01/2007

Latitude: 40° 46.80' N
Longitude: 29° 6.23'
Maximum depth: 1210 m

Nautile pilot : Patrick CHEILAN
Nautile co-pilot : Frank ROSAZZA
Scientist observer : Purificación LOPEZ-GARCIA

**Objectives:**
Integrated sampling of fluids, microbial mats and underlying sediments as well as associated fauna on one or two major sites previously observed during dive 1654 at the base of the Cinarcik Northern scarp.

**Instruments / tools:**

Nautile basket:
- Microcat
- Water sampler (6 bottles)
- Titanium bottles (2 bottles)
- 4 push corers

Elevator:
- 4 push corers
- 1 bio-box (sealed container)
- 2 blade corers

**Plan of operations:**

1. Microcat close to the target mat surface (and then permanently)
2. Water sampling on black patches over polychaetes (3 bottles) and over white/yellow bacterial communities (3 bottles)
3. Fluid sampling with titanium bottles on black and whitish areas (same as above)
4. Push coring, ideally 2 on black patches, 2 on whitish microbial communities.
5. Exchange of material in the elevator: take bio-box, push cores and blade cores
6. Additional push coring, ideally 2 on black patches, 2 on whitish microbial communities.
7. Sampling with blade cores in two similar patches with polychaetes.
8. Carbonates – in bio-box and, if also possible, in the basket.

**Samples and measurements obtained:**

<u>Sampling spot 1:</u>

1. Two water samples in titanium bottles, one over a black patch covered by polychaetes (bottle 1) and another over a neighboring yellowish bacterial community (bottle 2).
2. Four water samples taken with the water multi-sampler, two over the same yellow microbial community (bottles 4 and 7) and two over the same black patch area as above (bottles 5 and 6).
3. MicroCat measurements over the yellow microbial community and the black patch area, respectively.

4. Four push cores, two in a yellow microbial community area (PC1 and PC2), two in the black patch (PC3 and PC4).
5. One triangular rock fragment (apparently not carbonate).

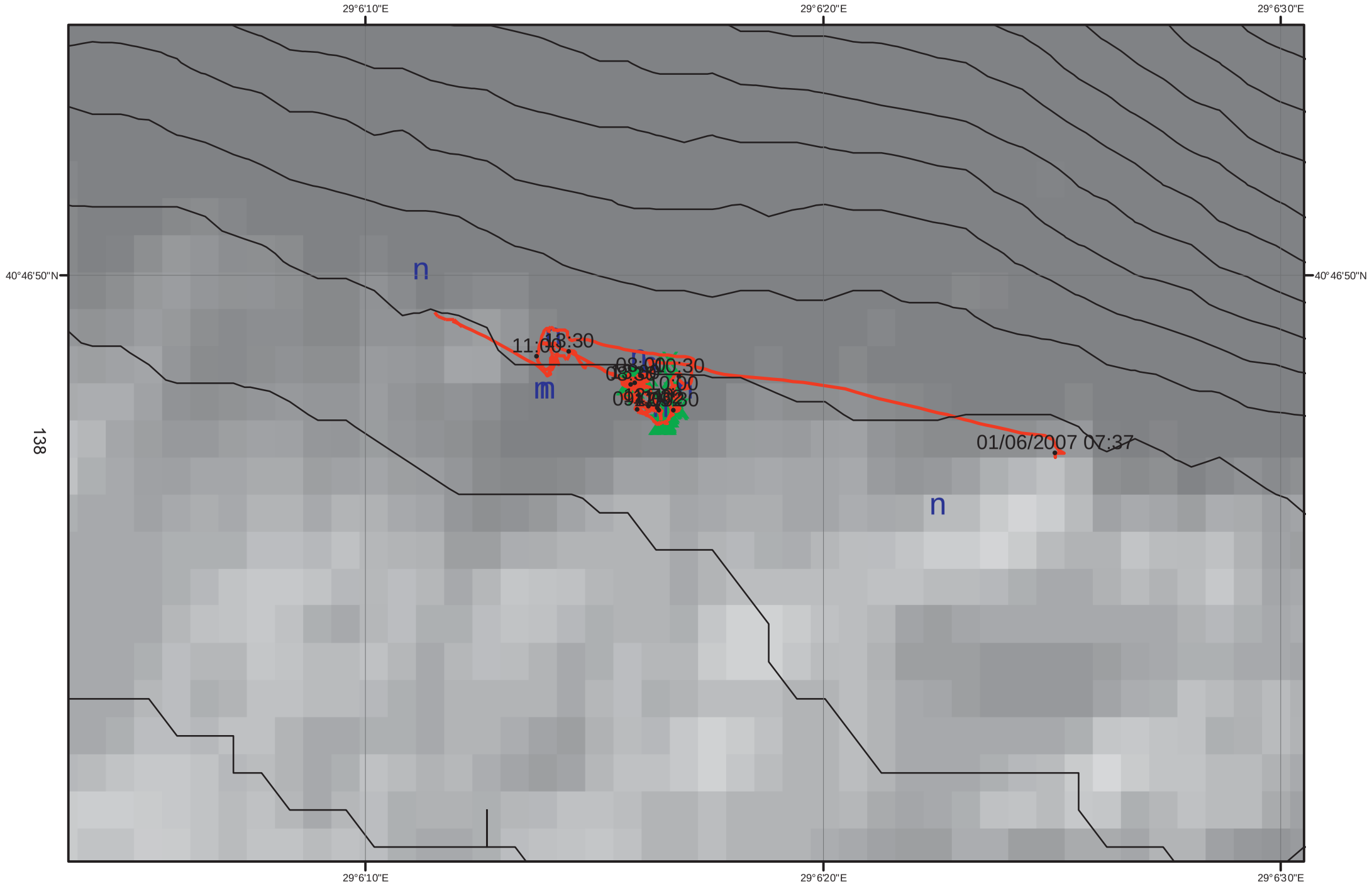
Sampling spot 2 (a few meters displaced in the same large black patch area):

6. Four push cores along a transect: one in a black patch zone with polychaetes (PC7), two on a relatively wide rim area covered by ivory-colored microbial filaments (PC5 and PC6) and a final one in the neighboring brown-greenish deep-sea sediment (PC8).
7. A small carbonate fragment (10 X 8 cm approx.) lying on the black patch.
8. Two blade cores in an extensive polychaete-covered black patch (L7 and L8).

**Record of operations:**

6:50. Dive starts.
7:36. Arrival to bottom, 1186 m.
7:54. While going to the spot identified by Pierre Henry during the dive 1654, which was the initial target of this dive, we identify a large area covered by black patches, covering several $m^2$, with white to yellow mucilaginous rims corresponding to microbial communities that are relatively extensive at some points. We decide to sample here.
8:11. Water sampling with titanium bottle 1 over the black area covered extensively and uniformly by polychaetes (tubes 3-4 cm long).
8:24. Water sampling with titanium bottle 2 over a relatively large yellowish microbial community extending from the black patch rim.
8:26. Some shrimps in sediment holes.
8:30-8:40. Water sampling with water multi-sampler. Bottles 4 and 7 are filled on the same yellow microbial extension as before and bottles 5 and 7 on the same neighboring black patch area as before. One bottle fails. 1192 m depth.
8:46-8:48. MicroCat measurements on the same yellow community.
8:49-8:50. MicroCat measurements on the same black polychaete-colonized patch.
8:52. Push core sampling. We first try on black patch twice. It's hard and we think we touch the basement of the scarp (there is some inclination). We move a little towards the lowest part trying to find a more suitable area within the same big black patch.
9:05. New interesting microbial mat area in sight.
9:08. A colony of anemones under a rock, 7-8 individuals, around 2 cm high.
9:10. More shrimp images.
9:15-9:18. We push cores PC2 and PC1 in parallel in a yellow area a triangular extension of a yellowish microbial community from the black patch rim, around 0.5 $m^2$. 1193 m depth.
**9:31. END OF DVD1.**
9:40. Cores PC1 and 2 in the rack again. I see here and there what are likely polychaetes with dark-red to brown plumes emerging from sediment holes, 3-4 cm long.
9:53-10:19. Sampling of black patches with push cores PC3 and 4. We push core PC3 on the black patch but it only enters a few centimeters. We manage to push PC4 well in the sediment only 10-15 cm away. We empty the little sediment in core PC3 and we push it again a few centimeters again, it is hard and we try it once more. We succeed.
10:29. Shrimp in a hole.
10:31. We take a rock fragment from the bottom and put it in the basket.
10:36-11:20. We go to the elevator and exchange sampling material, leaving the push cores and the water sampler and recovering the sealed box for microbiology, the blade cores and additional push cores.
11:26. We are back to the spot where we sampled. We see the exact place where we took the push cores.
11:30. **END OF DVD2.**

11:33. We find a place to leave the blade cores while we sample with the push cores. It falls laterally onto the sediment.
11:52. We try to core in a place with brownish mucilaginous stuff, but it is hard and we try to find a better place further.
11:58-12:04. I identify a region a few meters away from the first sampling place with an extended rim of ivory- to very light yellow-colored mucilaginous microbial communities, approximately 20-30 cm wide in its central part and 50 to 70 cm long following the rim of the black patch. We push cores PC5 and PC6 in parallel there. The idea is to make a transect, coring here and in the adjacent black patch and normal sediment. 1196 m depth.
12:18. We try to fill one push core (PC7) in the black patch. It is hard, we try again without success. The third attempt  a few centimeters away is successful. 1193 m depth.
12:25. We obtain a final push core, PC8, in the normal deep-sea sediment close to the black patch.
12:31-40. We recover a small fragment of carbonate that we put in the sealed box. We try to take a bigger one laying close to it, but we failed due to the sediment cloud that has formed. 1195 m depth.
12:51-13:01. We come back to the place where we left the blade corers and recover them.
13:10-13:18. We find a black patch area suitable for filling the two blade cores, and we succeed to get them, L7 and L8. 1194 m depth.
13:26-13:38. We go to the elevator and leave the blade cores.
13:41. We start coming up.
14:18. On board.


29°6'10"E
29°6'20"E
29°6'30"E
40°46'50"N
138
11:00:30
01/06/2007 07:37

**MARNAUT**
**Dive 1661**

Date: 06/02/2007
Immersion point : 40º 51.445' N/ 28º 09.471' E
Scientist observer : Namık CAGATAY
Nautile pilots : Jean Paul JUSTINIANO and Xavier PLACAUD

**Objectives:**
Geological observations and sampling in the NE corner of the Central Basin (Fig. 1) in the Sea of Marmara with the following objectives:

1) To investigate the nature of submarine scarps
2) To observe the distribution and nature of black bacterial patches, chimneys and carbonate crusts and recover their samples.

**Dive summary:**
Mainly two scarps, each with associated bacterial mats and carbonate crusts, were explored in the area: the first is trending E-W along 40º51'30'' N between latitudes 29º09'26'' E and 28º10'0'' E and the second has a NW-SE trend in the location around 40º51'15''N / 28º10'10''E. The E-W trending scarp is characterized by relatively fresh fractured surfaces of carbonate crusts. The NE-trending scarp is sediment covered and appears to have been inactive and relatively older. Both the scarps have black sulphide patch and carbonate pavement crusts lying parallel to their base. Although the NE-trending one has the larger (several m wide and at least 75 m long) bacterial mat associated with it in the dive area, there are no active chimneys or other fluid emissions observed along its course. The E-W trending scarp has carbonate chimneys and mounds, some of which are active with fluid emissions. The submarine canyon along the dive traverse between 40º51'30''N / 28º10'00''E and 40º51'18''N / 28º10'12''E appears to be inactive concerning the transport of coarse sediments in to the Central Basin. Seven carbonate crust samples, one mud clast sample from the NE trending scarp, and two push cores from the black patches were collected during the dive.

## Observations

07:49:06 GMT, *Nautile* arrived on the sea floor at 40,8574167N /. 28,1578500E. The seafloor is covered by bioturbated buff and light gray sediments. The benthic burrows are 2-3 cm in diamater.

07:54 We arrived at point 0 where the the sefloor is covered by soft, bioturbated, buff and biege sediments.

07:58:30 We observe that the seafloor is covered with about 5 cm-thick fractured carbonate crust.

7:59 to 8:03 We see the active black chimney with colonization equipment deployed on its top. The chimney is surrounded by black sulphide patches with scattered white bivalve shells.

8:09 There are two black patches with 20-30 cm in diameter.

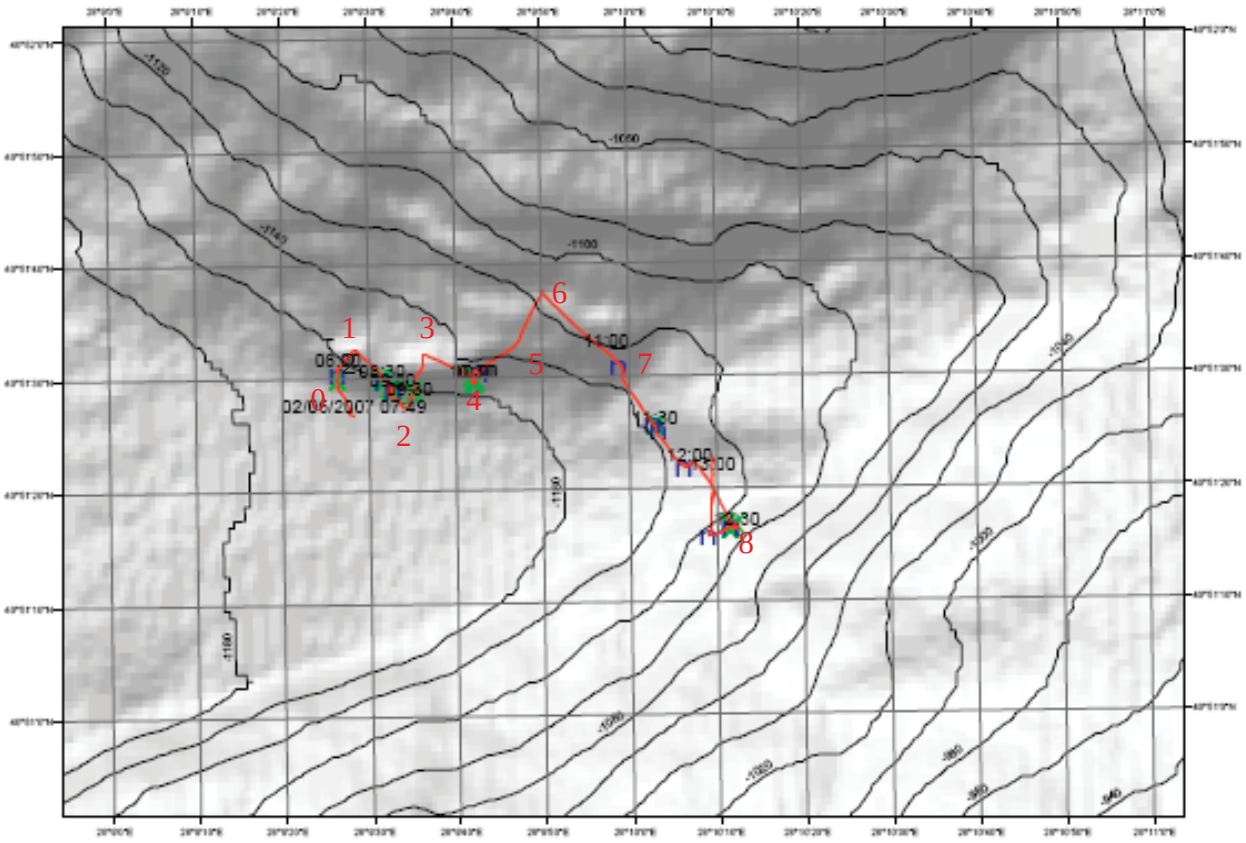


Fig. 1. Bathymetric map showing the path of *Nautile* dive 1661.

8:21 to 8:46 The seafloor is covered by a carbonate pavement and black patches. The carbonate crust has a spongy texture with gray colour and local black to brown coating. First carbonate crust samples are collected here: Sample 1 at 8: 34 and Sample 2 at 8:43 (Table 1).

8:46 to 9:14 Moving SE, there is an increase in depth suggesting presence of a scarp. We see platy carbonate-crust blocks on a scarp. Sample 3, a 60 cm-long carbonate cemented mud, is taken here (9:14; Table 1).

9:14-9:27 There are black patches around broken carbonate-crust pavement. Beds of carbonate crust dip SE at about 40-50º. Broken pieces of carbonate crust lie on the scarp slope. We arrive at point 2 at 9:27.

9:35 Carbonate crust with black sulphide patches. Broken pieces of carbonate as large as 1 m size are present here.

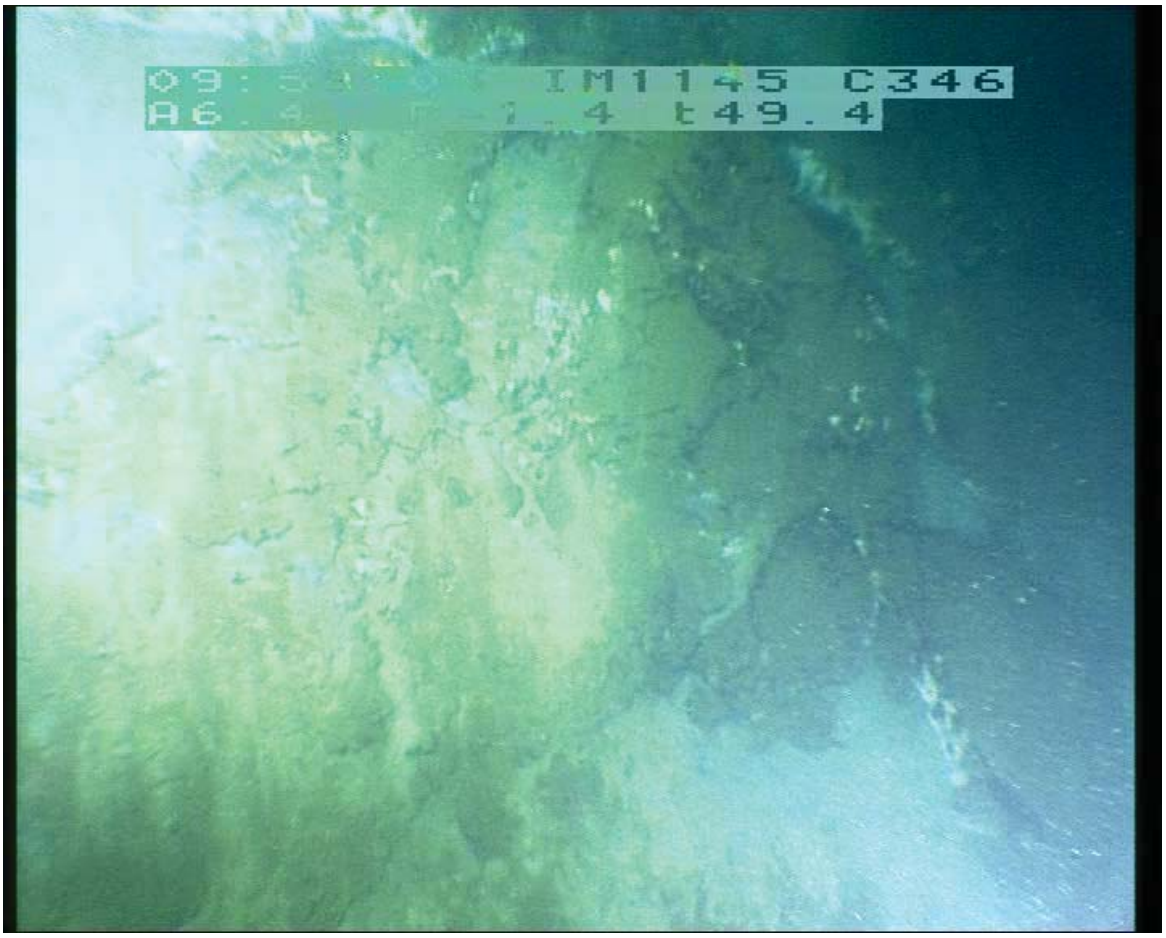



Fig. 2. Scarp with carbonate-crust blocks lying at the base (40.8582323N/28.1675000E); NE of point 5.

9:36-9:46 We climb up the top of the scarp, where thin carbonate crust is covered by a drape of 2-3 cm-thick bioturbated, buff sediment. We reach point 3 at 9:46. Here the seafloor is relatively flat and covered with bioturbated, buff to biege, soft sediment.

9:53-10:01 Fractured carbonate pavement with relatively fresh fractured surfaces near the base of a slope (Fig. 2). The black patches are in between the carbonate pieces and includes scores of white bivalves at 10:01 (Fig. 3). There is a carbonate mound in the vicinity.

10:08 Sample 4 is collected at the edge of thinly bedded carbonate crust with brown surface (Table 1).

10:19-10:30 Carbonate mound of about 2.5 m height and with buff to brown colours is observed (Fig. 4). It appears to have grown upwards layer by layer. The carbonate crust layer at its base is fractured. Sample 5 is collected near its top (Table 1).

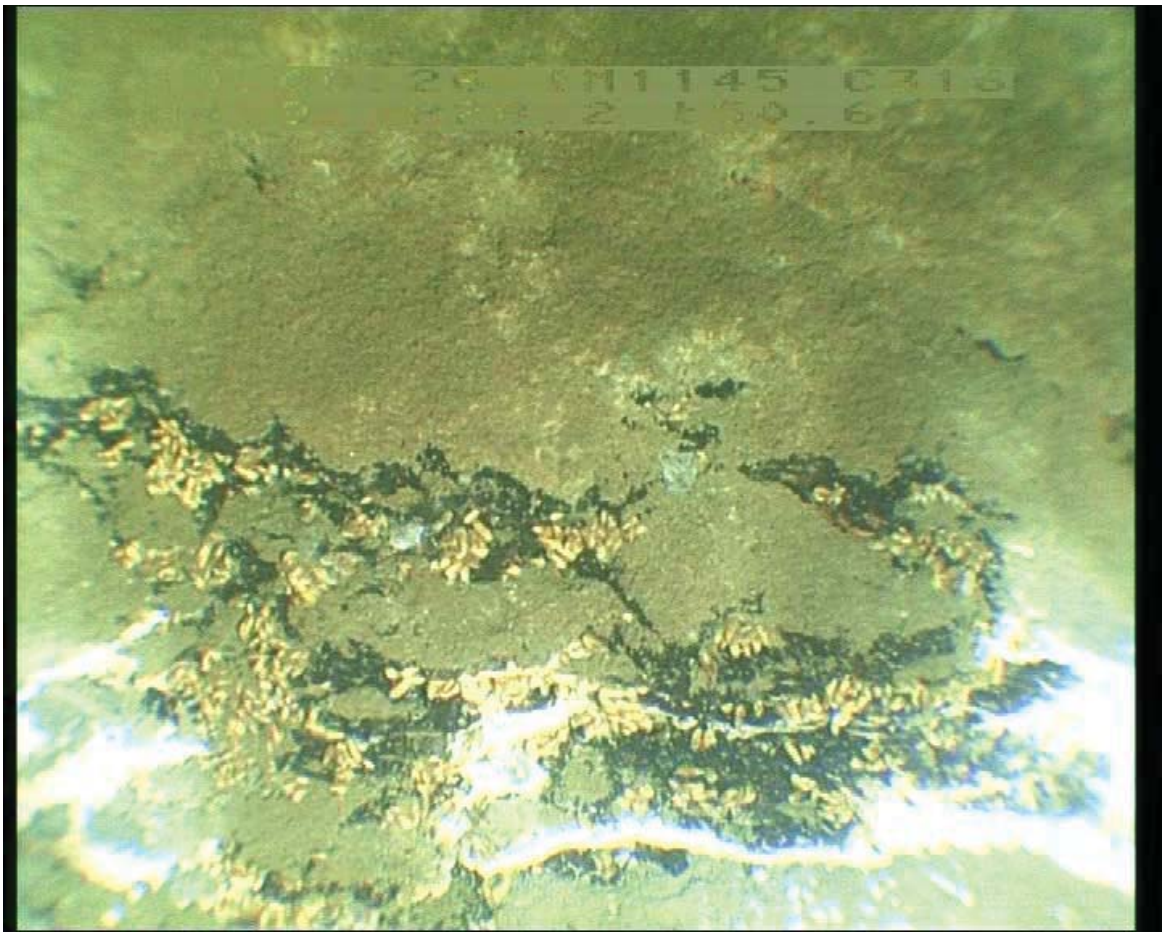


Fig. 3. Fractured carbonate pavement with black sulphide patches colonized with bivalves (40.8582333N/28.1617500E)

10:32- 10:45 Moving from point 4 to points 5 and 6, the seafloor is covered with a drape of bioturbated, buff and biege soft sediment. We arrive at point 6 at 10:45.

10:47-10:49 We observe two black sulphide patches about 60 and 30 cm in diameter.

10:52-11:08: We move down the slope into the canyon towards point 7. The seafloor along the traverse draped with bioturbated soft sediment. The canyon appears to be inactive in terms transporting course sediments. We see a scarp about 20 m south of point 7 (at 10:06). Here the carbonate crust is fractured with some bivalve shells, and covered with 2-3 cm-thick, buff sediment. Broken pieces of carbonate crust are present along the slope. There is no fluid activity.

11:10 We descend along the slope. Seafloor draped by soft buff and biege bioturbated sediment.

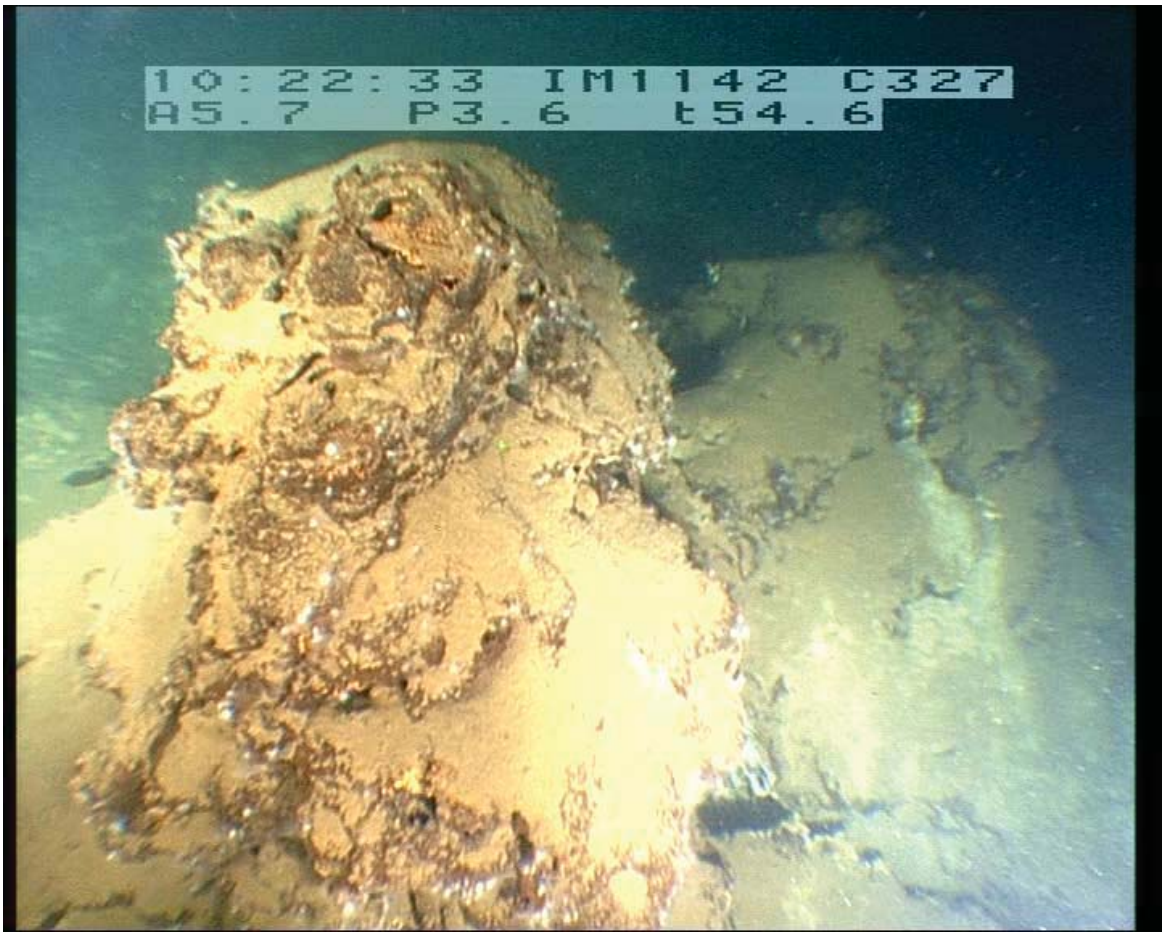



Fig. 4. Carbonate mound (40.8582167N/28.1617333E). Note that the base of this carbonate is fractured

11:19 1-2 cm-thick, discontinuous carbonate crust with black patches having scattered bivalve shells. There is no fluid activity. The site is surrounded with biotubated, buff to biege, soft sediment.

11:23: 11:25 Penetration into black patch was not possible because of the underlying carbonate pavement (Figs.5 and 6).

11:30-11:39 Platy, thin (about 1 cm thick) carbonate crust was collected as Sample 6 (Table 1).

11:45 We obtained a push core no. 1 from a small (20-30 cm in diameter) black patch (Fig. 7; Table 2).

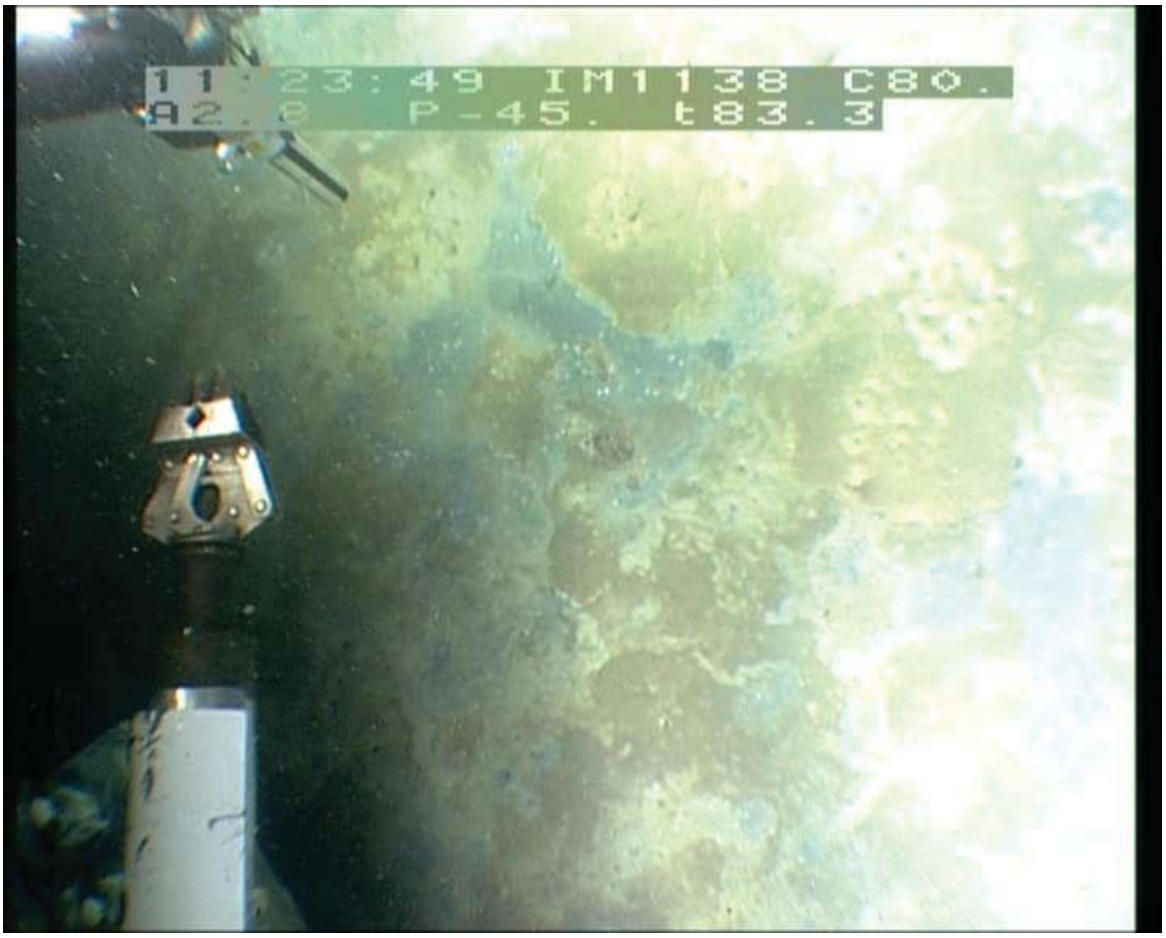



Fig. 5. Black sulphide patches and carbonate pavement between points 7 and 8 (40.8570833N/28.1674833).

11:56-12:02 Widespread black patches are present together with carbonate crusts having white bivalve shells about 200 m NW of point 8. The large patch is 20 m x 30 m and aligned E-W. It doesnot continue eastwards (Fig. 8). No fluid activity.

12:07-12:12 On the way topoint 8, the seafloor is draped with bioturbated soft sediment.

12:12-12.18 There is a large black patch at the slope of the base of a WSW-ENE trending scarp.

12:20-12:22 The scarp trends 225-245º, and is covered with soft sediment (Fig. 9). At its base there is a carbonate patch extending at least 75 m with a width of 2.5 to 10 m. Push core no. 2 is

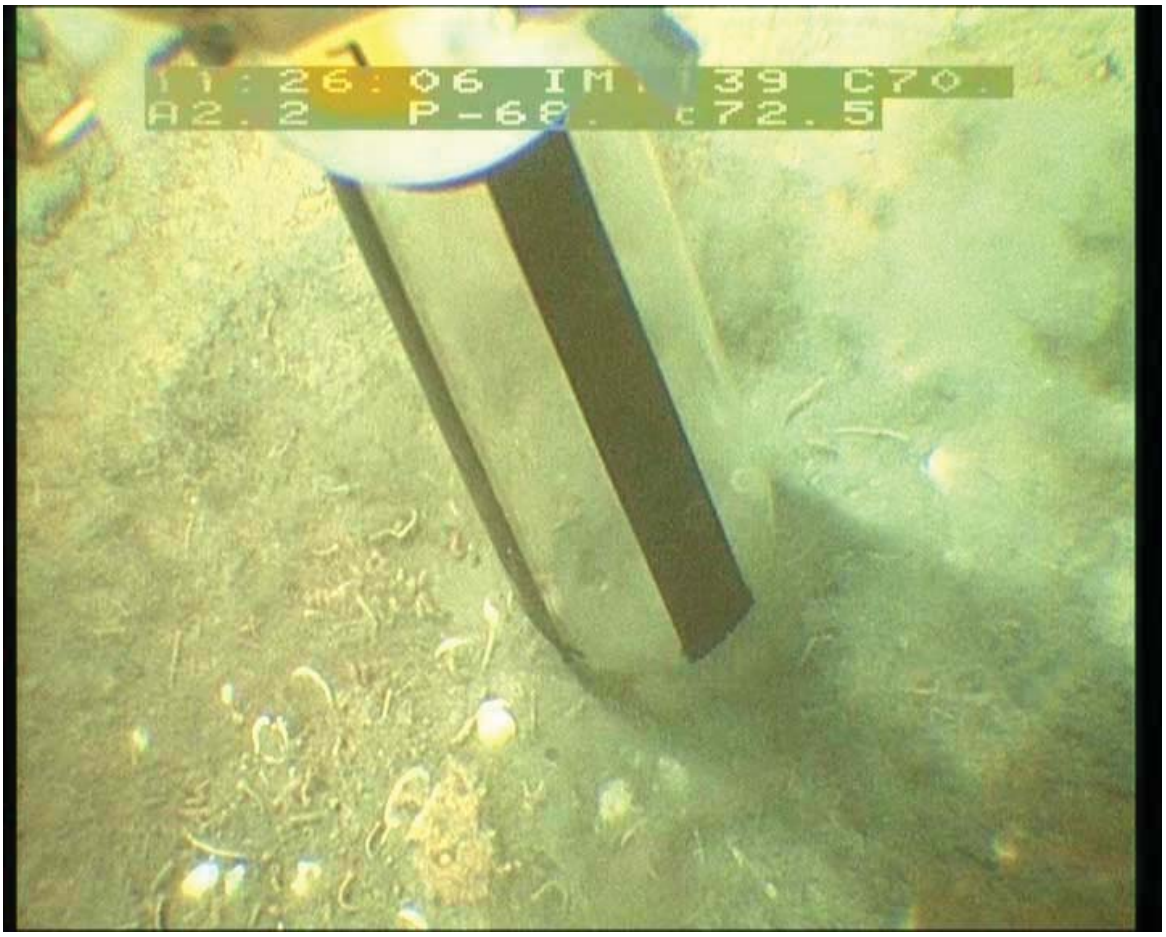



Fig. 6. An attempt to sample the black patch with filamentous bacterial mat and bivalve shells was unsuccessful (40.8570667N/28.1674833E)

obtained at the slope edge of the black patch having some mm size red spots, which were later observed to belong to the tenticles of live bivalves buried in the black sediment (Fig. 10).

12:37-12:41 Following the scarp WSW, we see a carbonate crust pavement in places fractured.

12:50 A mud clast sample sticking out on the scarp surface was collected (Fig. 11, Table 1). The clast is dark brown suficial staining.
The dive ended after taking the sample.

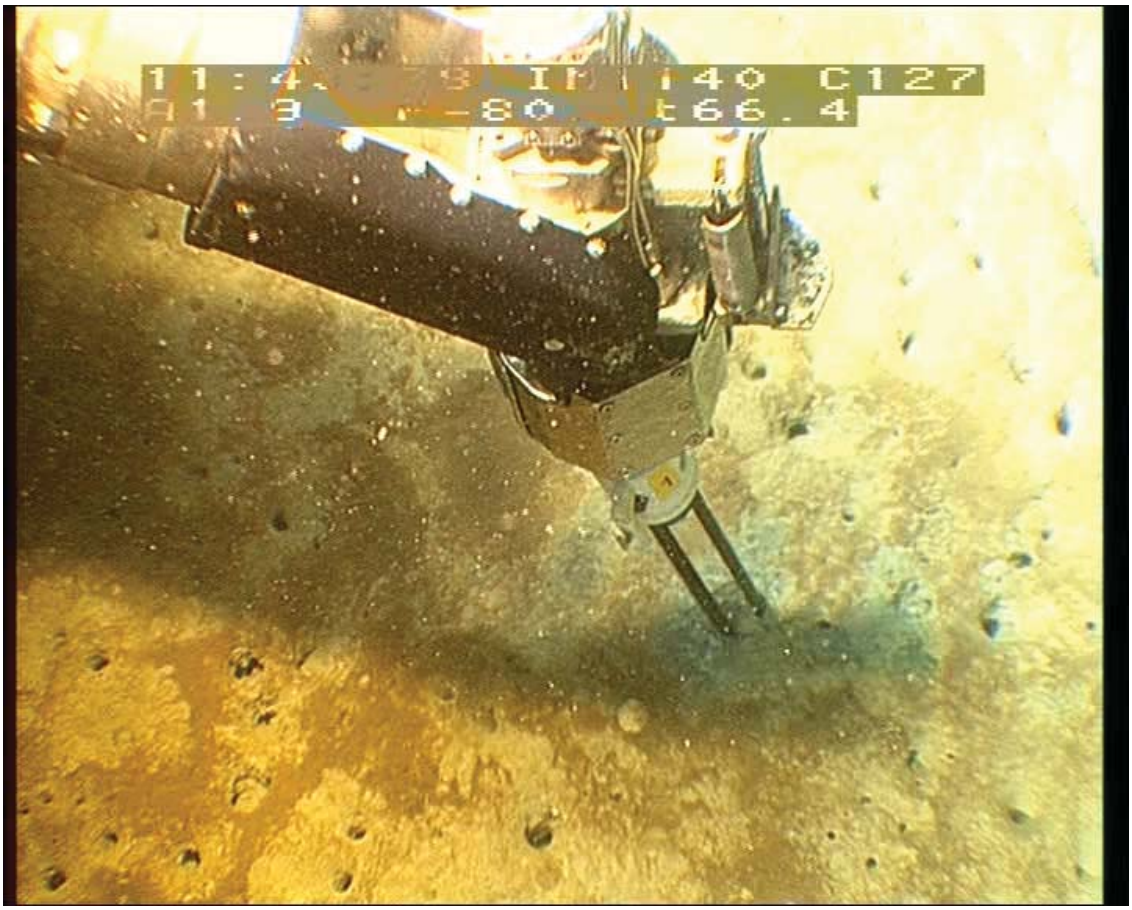



Fig. 7. Push core no 1 on a small patch at 40.8569333N/28.1674667E).

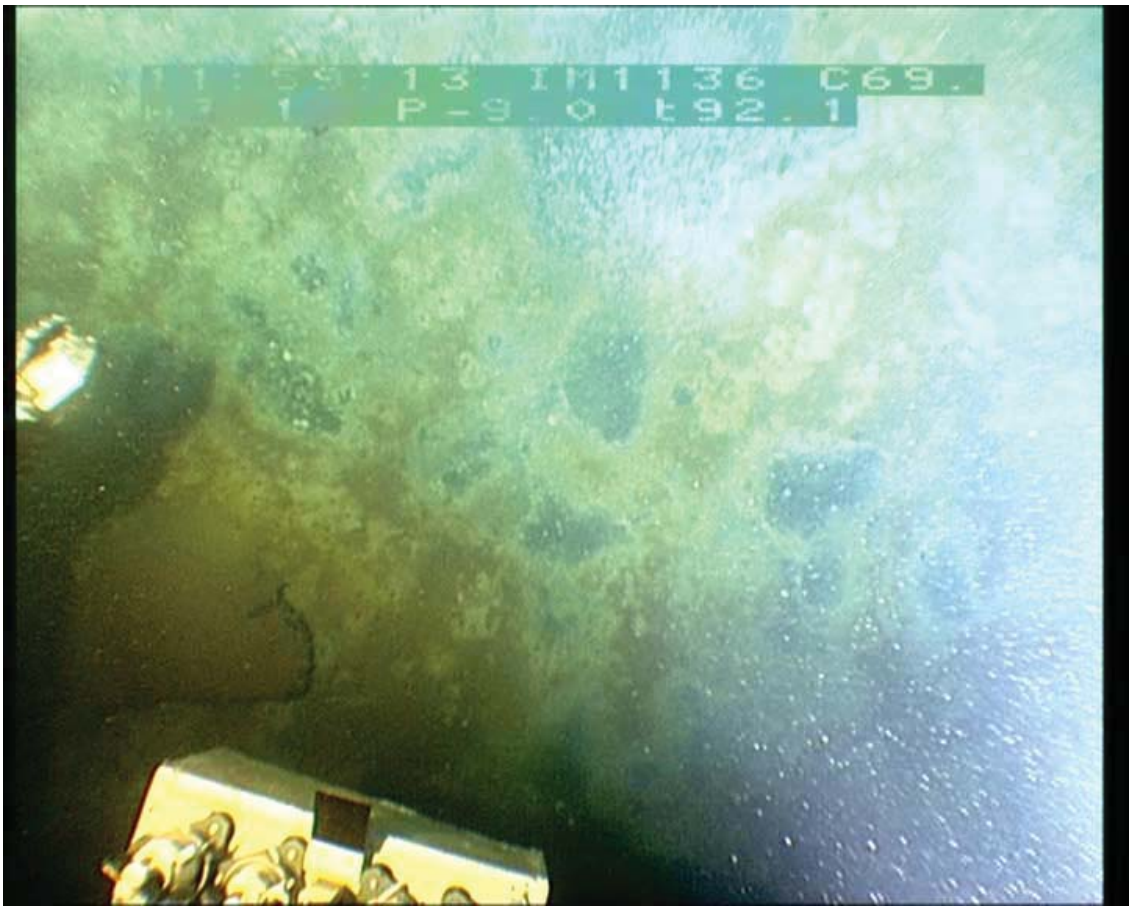



Fig. 8. Large black patch with carbonate crust, 200 m NW of point 8 (40.8569333N/28.1674667E).

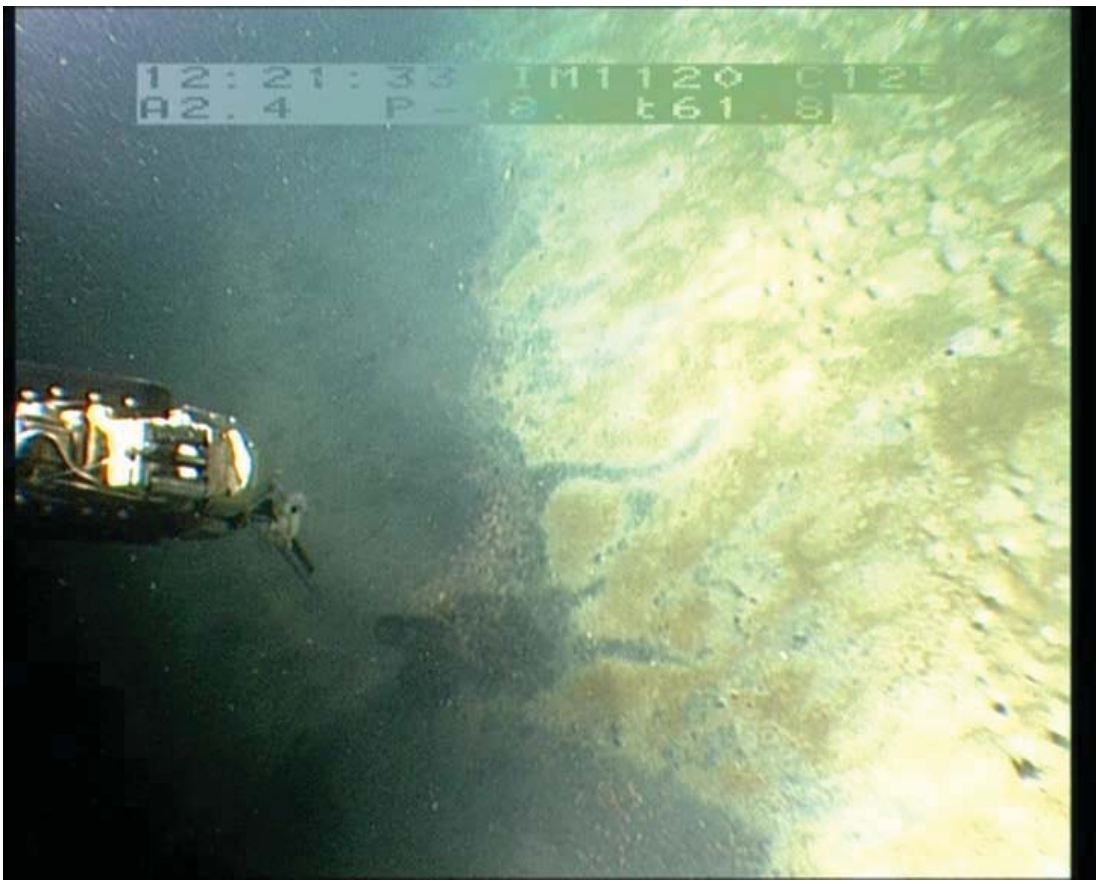



Fig. 9. A sediment covered scarp trending about 240º. At its base is an extensive (at least 75 m long and 2-10 m wide) and black sulphide patch.

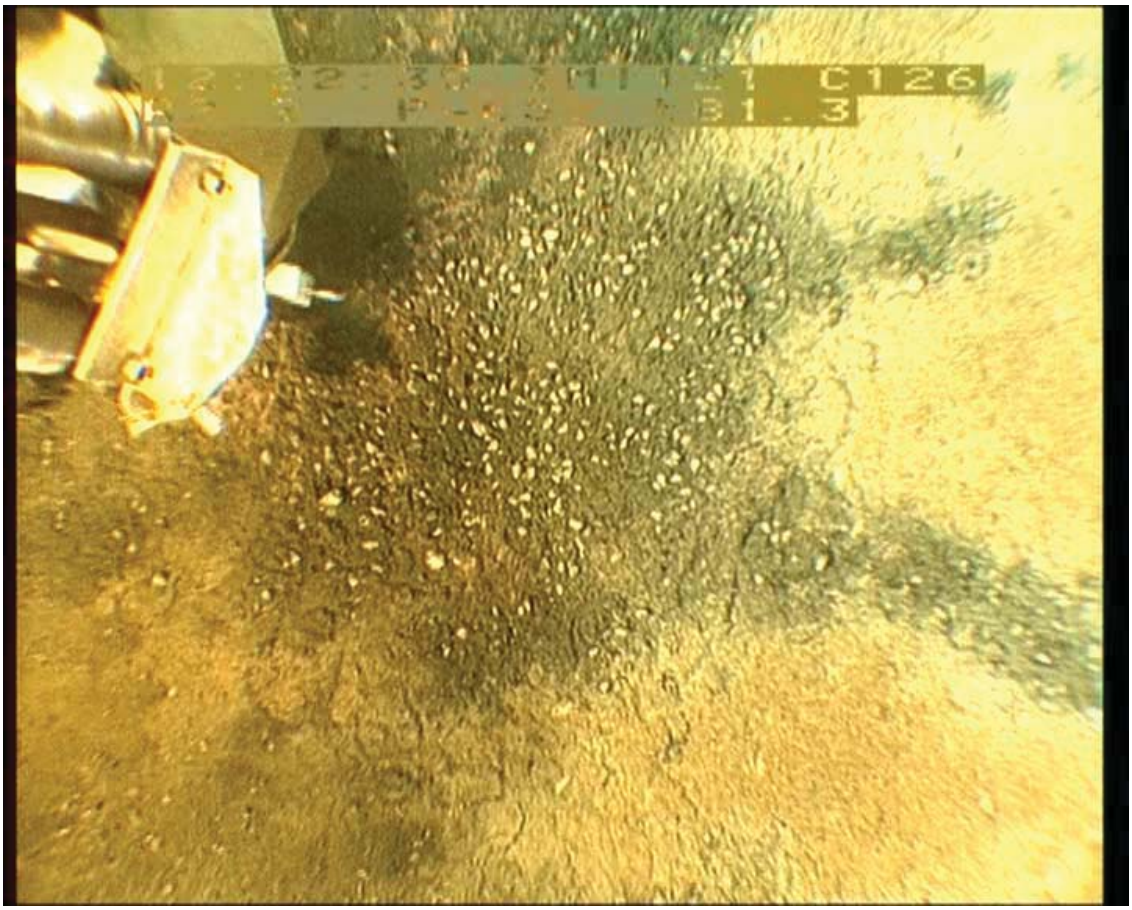



Fig. 10. Second push core at the edge black patch at the base of the scarp (40.8545667N/28.1699000E).

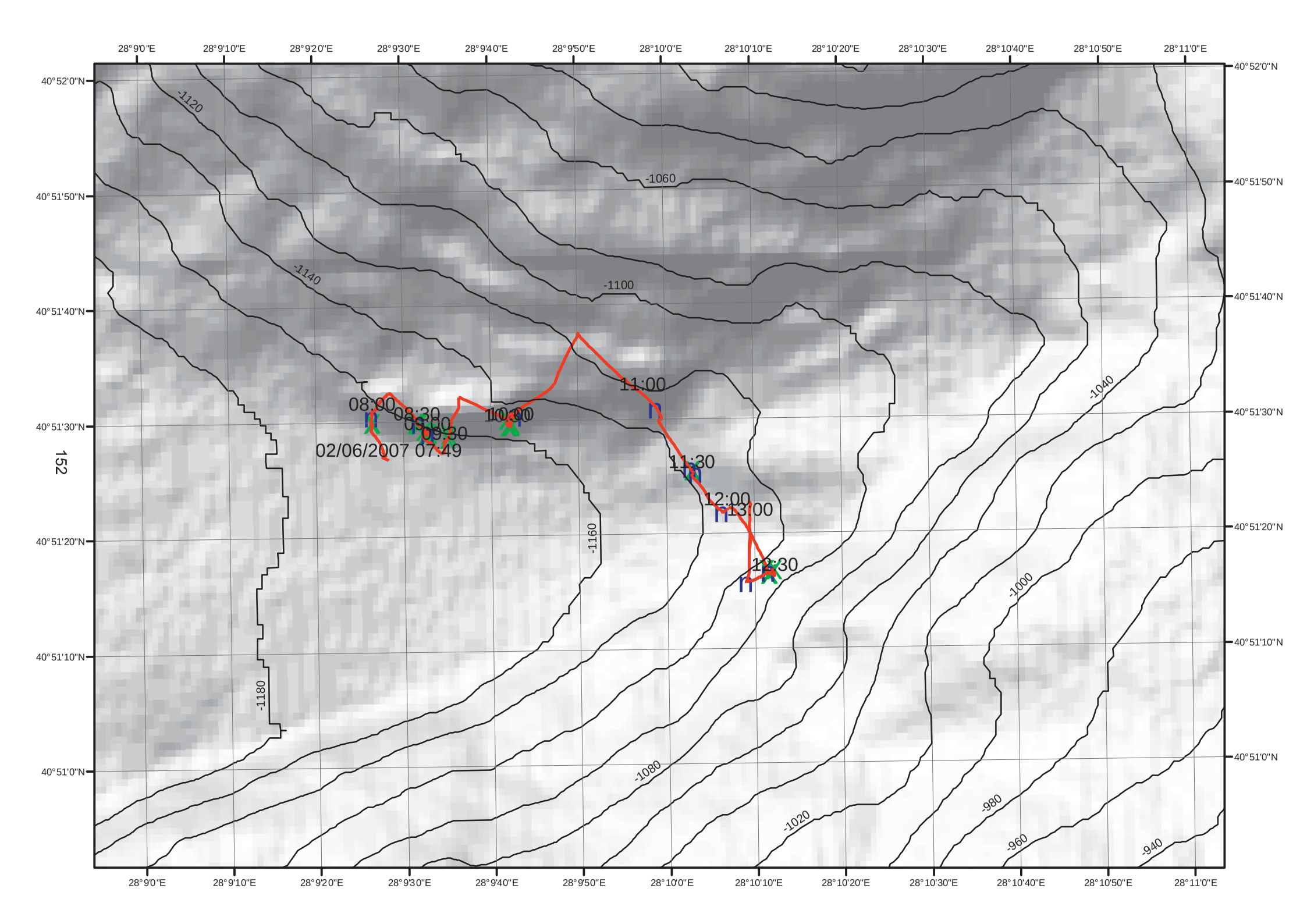

Fig. 11. Sample 8 is being taken on the scarp trending about 240º. This scarp is covered with bioturbated soft sediments and delimited at its base by a few m wide and several tens of m long black patch of sulphide.

Table 1. Rock sample list and description

| Sample No | Latitude | Longitude | Depth | Description |
|---|---|---|---|---|
| 1 | 40,8583000 | 28,1587667 | 1156 | Spongy textured gray carbonate crust with local black to brown coating; 10 cm size (sample Ionna Bouloukbassi) |
| 2 | 40,8583000 | 28,1587667 | 1156 | Same as sample 1, but larger (20 cm) (sample with ITU) |
| 3 | 40,8580167 | 28,1591000 | 1159 | Sample 3a: Two corals; one dark brown and the other brown (3 and 7 cm long).<br>Sample 3b: A large platy, carbonate cemented mud crust, with smooth surface covered with white tube worms and stained with brown to dark brown coating (size: 45 cm x 60 cm) (Split between ITU and Ionna Bouloubassi) |
| 4 | 40,8582000 | 28,1617500 | 1143 | Horizontally banded, dark brown to black carbonate crust;1-3 cm thick, 5 pieces (Split between ITU and Ionna Bouloubassi) |
| 5 | 40,8582167 | 28,1616333 | 1141 | Carbonate crust with nodular and cavernous surface texture and buff to black surface staining; the broken surface shows a rough banding with one buff and one gray band (Split between ITU and Ionna Bouloubassi) |
| 6 | 40,8570500 | 28,1674833 | 1139 | Platy light gray carbonate crust bored by tube wurms; smooth surface; 0.6-0.8 cm thick and 4 to 8 cm long four pieces. One piece shows a double banded structure (Split between ITU and Ionna Bouloubassi) |
| 7 | 40,8570167 | 28,1674833 | 1139 | Gray carbonate crust, with local dark brown to black surface staining (Split between ITU and Ionna Bouloubassi) |
| 8 | 40,8543833 | 28,1691333 | 1119 | Mud clast collected from the fault scarp. It is green mud with a chaotic structure and rare white shell fragments; it has dark brown staining (sample with ITU) |

Table 2. Push core locations

| Push core no | Latitude | Longitude | Depth m | Description |
|---|---|---|---|---|
| 1 | 40,8569333 | 28,1674667 | 1128 | About 16 cm long; sliced and sampled |
| 2 | 40,8545667 | 28,169900 | 1111 | About 16 cm long; sliced and sampled |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02/06/2007 07:49
152

# MARNAUT 2007
# Dive 1662
# Western High

**Date:** Sunday 03 June 2007
**Immersion point:** N40º46.784 E27º41.264

**Scientist:** Sylvain BOURLANGE
**Pilots:** Franck ROSAZZA and Patrick CHEILAN
**Localisation:** Near suspected active bubbling site from EK60 acoustic anomalies. 300 m North-East from dive 1648.

**Objectives:**

Finding and sampling the gaz emission
Sampling carbonate crust
Collect push cores and microcat data

**Equipment:**

1 Pegaze for gaz sampling
4 titanium syringe fluid samplers
4 push cores
microcat CTD

**Dive summary:**

The dive took place place 300 m North-East from Louis Gely's dive # 1648. During this dive, we have been able to observe a wide area with a **strong activity in term of fluid emission**. We observed and sampled black patches covered with a white blanket of fluffy material. This material doesn't look like what we usually described as bacterial film. It is more likely made of **gas hydrates**. We also observed gaz bubbles venting from the sediments associated with the presence of carbonate precipitation in form of isolated crusts, with a "chaotic" look. We were also able to observe the emission of **oil bubbles** directly from the sediment.
The biological activity was important (anemones, urchins, bivalves, polychetes, fishes,…), possibly due to the active vent sites.
During the dive, we were able to sample gaz using the Pegaze system as well as the fluid preleveur, 4 push cores, 5 carbonated crust samples. However, the two push cores taken from the suspected gas hydrates site were lost due to tilting of one tube during the Nautile come back to the surface, and to the unexplicated absence of the metallic obturator at the base of one of the core that prevents the drop of the material.

**DVD structure:**

DVD Number 1: 7:28 – 9:26
DVD Number 2: 9:29- 11:35
DVD Number 3:

**Dive Report:**

7:28 Bioturbated pelagic sediment
7:31 Black patch (~50 cm) with a white bacterial cover
7:32 several bacterial black/white patch. Also a large number of anemones (one each ~2 meters). White material could be bacterial or gas hydrate. We prefer this second

hypothesis.
7:33 Large black patch with white cover. Urchins, Anemonas, Seafloor seem more encrusted.
7:38 Sites with many white patches, discontinuous cover. Many bivalve shells. Carbonated blocks (made of shells).
7:42-7:46 Zoom showing shells, bacterial mat, animal tubes,

7:49 Large black patch maybe 10 m long, with carbonated chimneys. Gaz bubbles. (N40º49.078 E27º46.819)
7:52 Small continuous stream of gaz bubbles.
7:56 Zoom on the bubbling point at the sediment. Looks like if some fluid is also escaping.
7:58 Three points emitting gaz bubbles beside a carbonated crust. Strike of the bubbling line is about N080. We noted some oil bubbles at this point (not visible on the video)
7:59 Fluids also seem to escape with the gaz.
8:05 Site with many carbonated crusts. Chaotic aspect. With white fluffy cover (gas hydrate ?)
8:07 Gaz vent from a carbonate crust
8:10 Very abundant carbonate striking close to E-W. The carbonate developps in height. Like several small chimneys.
8:17 Large bacterial patches
8:21-42 Large bacterial patch. With a large cover of white fluffy material, presumably gas hydrate. (N40º48.99 E27º46.755. Remarkable point)
8:26-27 Zoom on the white material.
8:32 general view of the patch area
8:34-42 Taking push core 1 and 2. Bubbles coming out while pushing the core.
8:55 Reaching the point where the acoustic anomaly was found. Nothing remarkable (but a few black patches)
8:55-9:11 Nothing remarkable
9:12 Few little patches with white fluffy material.
9:13-21 Large carbonate crust (with a small shark) forming some sort of a little chimney (~2-3 m). Remarkable Point (crust). First rock sampling (RS1). (N40º49.056 E27º46.777)
9:30 small “white” patch.
9:32-38 Large carbonate crust (2-3 m) with black patch with bacteria. Below the crust. A “moraine” fish is hiding below the crust. Polychetes ans bivalves on the black patch. (N40º48.99 E27º46.81)
9:39 Several carbonate chimneys-like. Black patch/carbonated crust
10:00-05 Amphora, close to a large white patch. The amphora is lying up.
10:13 Back to the first bubbling site
10:26:17 Gaz bubbles
10:30-11:11 Sampling with pegaze. Closure was difficult.
11:15-11:28 Sampling gaz with Multipreleveur from the remaining gaz from Pegaze sampling (11:27: interesting transfer)
11:35 Microcat deployment

DVD number 3
11:53 Push core # 4 in the same area. Couldn’t penetrate more than 2/3 because of a hard substratum)

11:57 Sampling rock sample RS2 (carbonate crust)
12:12 Push core #3 in a white patch.
12:15 Observe oil gently bubbling from the sediments
12:21 Video sequence of bubbling oil
**12:28 Sampling fluids at the bubbling oil vent site (bottle #4).**
12:36 Sampling Carbonate (RS3)
12:39 Sampling Carbonate (RS4): little chimney. Bubbles escaped while sampling). Sampling an anemone.
12:42 Sampling Carbonate (RS5)

**Samples**

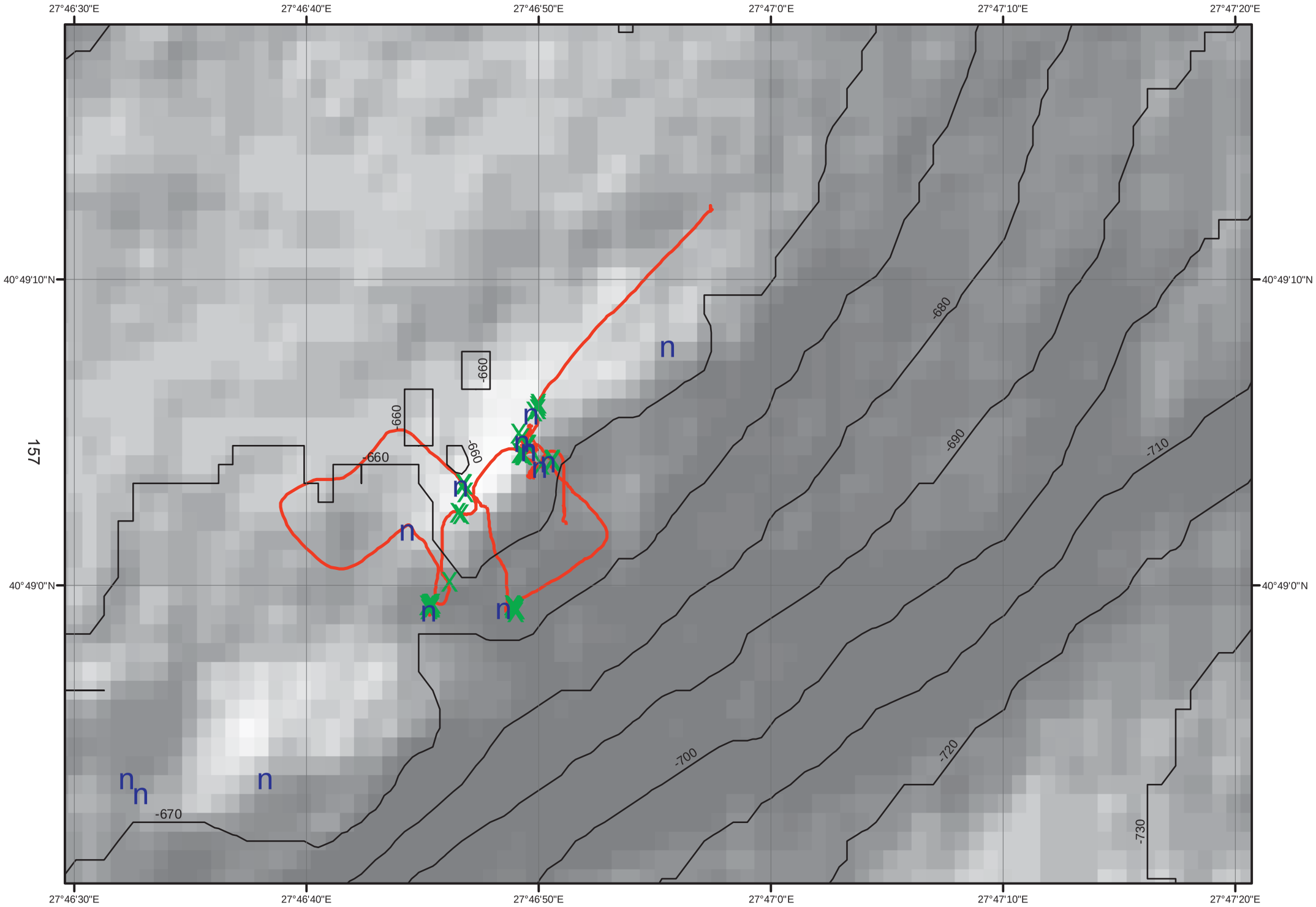
| Time | name | acronym | lat | lon | immersion (m) | |
|---|---|---|---|---|---|---|
| 11:00 | Pegaze | PG-1662-1 | 40º49.071 | 27º46.822 | 648 | |
| 11:25 | Multipreleveur 2 | WS-1655-6 | 40º49.071 | 27º46.822 | 648 | |
| 11:25 | Multipreleveur 3 | WS-1655-7 | 40º49.071 | 27º46.822 | 649 | |
| 12:28 | Multipreleveur 4 | WS-1655-8 | 40º49.058 | 27º46.828 | 651 | |
| 08:35 | push core 1 | PC-1662-1 | 40º48.99 | 27º46.755 | 657 | the metallic obturator had disappeared. The core could not be recovered |
| 08:35 | push core 2 | PC-1662-2 | 40º48.99 | 27º46.755 | 657 | Fused near the seasurface during the Nautile returned, dropped and emptied in the sea. |
| 12:12 | push core 3 | PC-1662-3 | 40º49.063 | 27º46.831 | 652 | shared between microbiologists (frozen) and geochemist (pore fluid). Presence of oil. |
| 11:53 | push core 4 | PC-1662-4 | 40º49.071 | 27º46.821 | 651 | Few centimeters remained, Microbiologists centrifugated it for pore fluids. |
| 09:17 | rock sample 1 | RS-1662-1 | 40º49.056 | 27º46.777 | 654 | |
| 11:57 | rock sample 2 | RS-1662-2 | 40º49.070 | 27º46.822 | 650 | |
| 12:36 | rock sample 3 | RS-1662-3 | 40º49.060 | 27º46.828 | 649 | |
| 12:39 | rock sample 4 | RS-1662-4 | 40º49.061 | 27º46.827 | 653 | |
| 12:42 | rock sample 5 | RS-1662-5 | 40º49.061 | 27º46.827 | 653 | |

**Pictures of the rock samples:**
All the rock samples are carbonated crusts. Rock sample 2 was impregnated with hydrocarbons.


1662-R2


1662-R4


1662-R5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**MARNAUT Leg 3 Nautile Dive 1663**
**04/06/2007**

**Scientist** : *Ioanna BOULOUBASSI*
**Pilot** : *Jean-Paul JUSTINIANO*
**Co-pilote** : *Xavier PLACAUD*

**Location of the Dive zone** :

NE edge of Marmara sea central basin, at the base of the escarpment
N 40° 47.941 , E 28° 6.743 , Zone 12
Immersion maxi : 1179m

**Objectives:**

- Recovery of the two microbial colonisation modules installed during dive 1650
- Integrated sampling of fluids, sediments (for microbiology/biology/biogeochemistry studies), crusts

**Equipement:**

- *Nautile basket* :
  - Microcat CTD
  - 4 Titanium syringe fluid microsamplers
  - 1 biological box
  - 4 push corers
- *Shuttle*:
  - 2 biological boxes,
  - 2 blade corers,
  - 4 push corers

**Dive Summary:**

During dive 1663 we succesfully recovered the two microbial colonisation modules that had been installed during Leg 2 (dive 1650). We realised that virtually all dark black spots that had been previously identified in this area are not soft sulphidic sediments but small black mounds chimney-like. The sediments around them have greyich colour which rather results from admixture of very thin (and not dense) filaments (presumably bacterial) and white (dead)bivalve shells with underlying black sediment. Cores could not penetrate more than ca. 10cm, due to hard substrate. Recovery of the upper sediment layer was also poor because the material is too soft. We succeeded to bring fragments of chimney-like structures. We also managed to get sediments (PC) from an actively bubbling spot along with a crust sample. It became clear that this area is not an appropriate one for quantitative sampling dedicated to faunal studies as previously thought.

**LIST OF RECOVERED SAMPLES**

Microcat CTD
4 Titanium bottles (2 on whitish surface, two on blackish)
PC 4 sediment on greyish patch
PC 3 it empties
PC 1 it empties
PC 7 sediment on grey patch near bubbling point
PC 8 idem as PC 7
BC 7 chimney 1
BC 8 sediment in black patch
BB 1 MC1
BB 2 MC2
BB 3 chimney 2
R 1 carbonate crust near bubbling point

**DVD 1**

7:38 Arrival near the seafloor, visibility is not good, we are 5m above the seafloor and we do not distinguish it
7:42 Pelagic sediment when we distinguish the seafloor we have ca 250 m to the point remarquable of the colonisation modules
7:46 We change cap, we had bad XY from the ship. Still pelagic sediment, still 250m to the sampling point
8:11 Supposed to be on the point, we see nothing
8:12 We distinguish the MC2 (buoy N° 1) installed on the pelagic sediment (reference)
8: 18 Low visibility, we finally distinguish the MC1 (buoy N°2) near the chimney and in a black patch (not very large) having in most its area a rather geyish colour with white spots; it is surrounded by carbonate pavements covered apparenttly by a thin layer of oxidized sediment. Black patches are recognised around the main one wher the MC is located. The chimney with the MC does not seem active.
8:24 Nice view of the chimney with the MC, the greyish surface sediment around and numerous white bivalve shells (not living)
8:28 Start recovery MC1. Problem to close the biological box due to the buoy attached to the MC
8:42 End of recovery…the MC1 is in the biological box
8:52 Return to the sampling point, we need to localise it again
9:01 Return to the chimney (where MC1 was placed); we realise that the chimney is in fact still active with 2 small fluid venting spots; the top of this chimney was apparently destroyed during operations of dive 1650
9:03 Microcat CTD measurements along whitish –blackish sediment near the chimney
9:10 We realise that all the really dark black patches within the greyish/whitish area are not sulphidic sediment (as assumed during previous dives on this site); a close observation permits to recognise that these are outcroppig chimney-like black structures (small moundsof 20-30cm, apparently not active).
9: 16 Titanium bottle N° 7 above whitish point
9:19 Titanium bottle N° 6 above whitish point

9:22 Close-up on greyish surface where we see some white filaments (not dense) mixed with black sediments (thus grey colour) and dead bivalve shells.
9:23 Nice close-up of fluid venting on the chimney
9:25 Titanium bottle N° 8 on blackish point
9:27 Titanium bottle N° 5 on blackish point

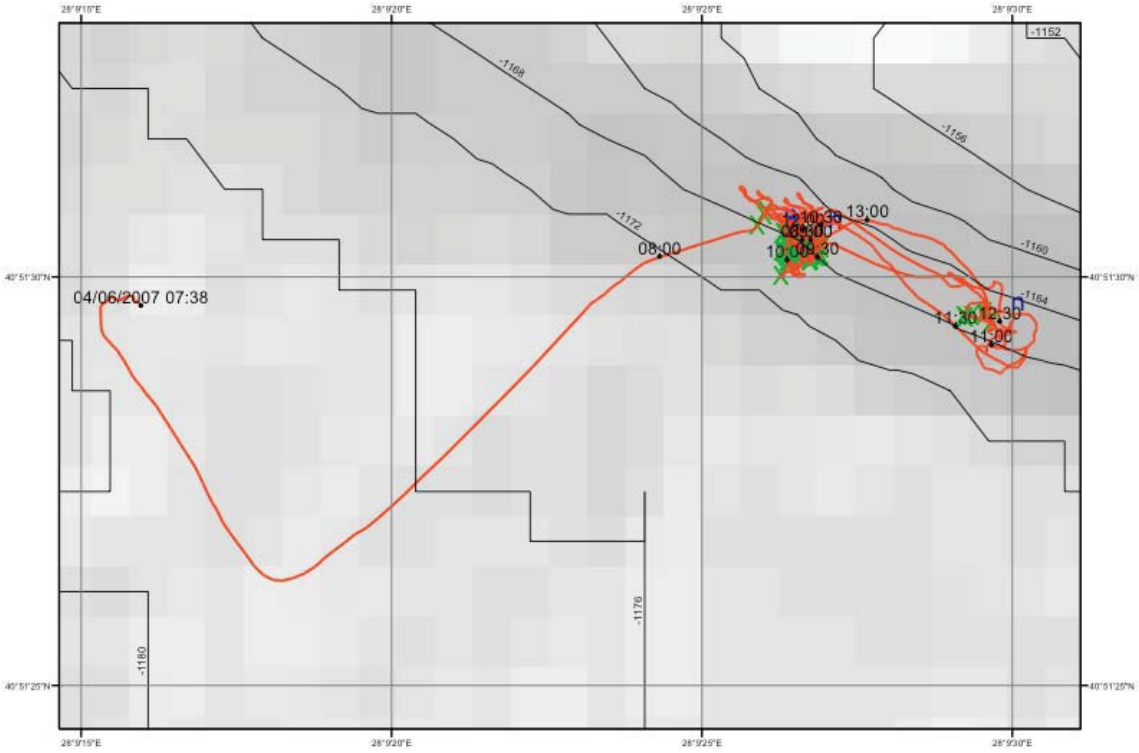
**DVD 2**

9:45 We prepare the PC coring at the point where we got the Titanium bottles
View of the whitish/greyish patch where the black areas are actually chimney-like structures
9:51 PC 4 on the whitish/greyish point; penetration ca 10cm then hard substrate; PC is closed and we recover ca 7cm, which appears rather grey (not black) with small and thin white filaments on the top. The filaments appear like "dried", mixed with underlying dark sediement.
10:01 PC3 very close to the PC4 (twin cores); same penetration as for PC4 but the core empties before reaching the basket
10:22 PC1 close to PC3 and PC4 but on a darker-coloured layer; PC 1 penetrates for some cm but can not close. We empty it.
10:27 We try again the PC1 some cm away with the same difficulties; finally we suceeded to close it in the water, but the core empties afterwards.
10:42 Going to the lift
10:43 A black "patch" between the main area we were working on and the reference MC is an isolated chimney- like apparently not active (I decide to try to sample it afterwards)
10:47 Seeking the lift…low visibility, it is supposed to be ca 10 m in front of us, we see nothing
10:53 We finally locate the flasher of the lift
10:57 Start exchanging the equipment; the operation lasts more than half an hour
11:30 We quit the lift going back to the sampling site (50 m away)
11:38 We reach the sampling site
11:46 Blade corer L7 on the chimney (active), trying to get it; the chimney material is very fragile, it almost desintagrates and turns to powder when we touch it. We finally recover a very small part which appears like very black powder in the blade corer L7.

**DVD 3**

12:09 Blade corer L8 on the point where the PC were taken; small penetration, we try twice and we get some material. The recovered sediment apparently has some shells on the top.
12:15 Going to recover the MC2 installed on the reference (background) sediment
12:16 View of the carbonate pavements covered with oxidised sediment and the chimney ca 25cm high (the one we target for the subsequent sampling)
12:19 Recovery of the MC1 (buoy number 2)
12:21 Going to the lift to leave the two blade corers and the biological box with teh MC
12:29 Arrival at the lift; we notice some ascending bubbles in front of our window (we are at A=11-12m)
12:38 We decide to go near the seafloor below the lift to check about the origin of bubbles. There is effectively a block of carbonate crust and close to it (ca 30cm) a spot of greyish sediment with emission of bubbles. I decide to take here the two PC cores left
12:42 Coring PC8 on the greyish patch (there ar ealso polychaetes) where bubbling occurs; good penetration.
12:48 Coring PC7 close to PC8. OK

12:53 Try to get a piece of the crust with the arm, we finally recover a small piece, put it in the basket.
12:53 We go to the chimney we located between the sediment sampling spot and the background sediment (with the MC)
13:06 View of the chimney; it stays actually on the carbonate pavement
13:09 We try to recover at least a piece of the chimney by using the submersible arm and a biological box. As for the first chimney the material is very thin and fragile; we rather succed to put some part in the box 3, it appears like a very black powder . Difficulty to close the basket.
13:16 End of sampling work, we head north to get off the "rail".
13:23 End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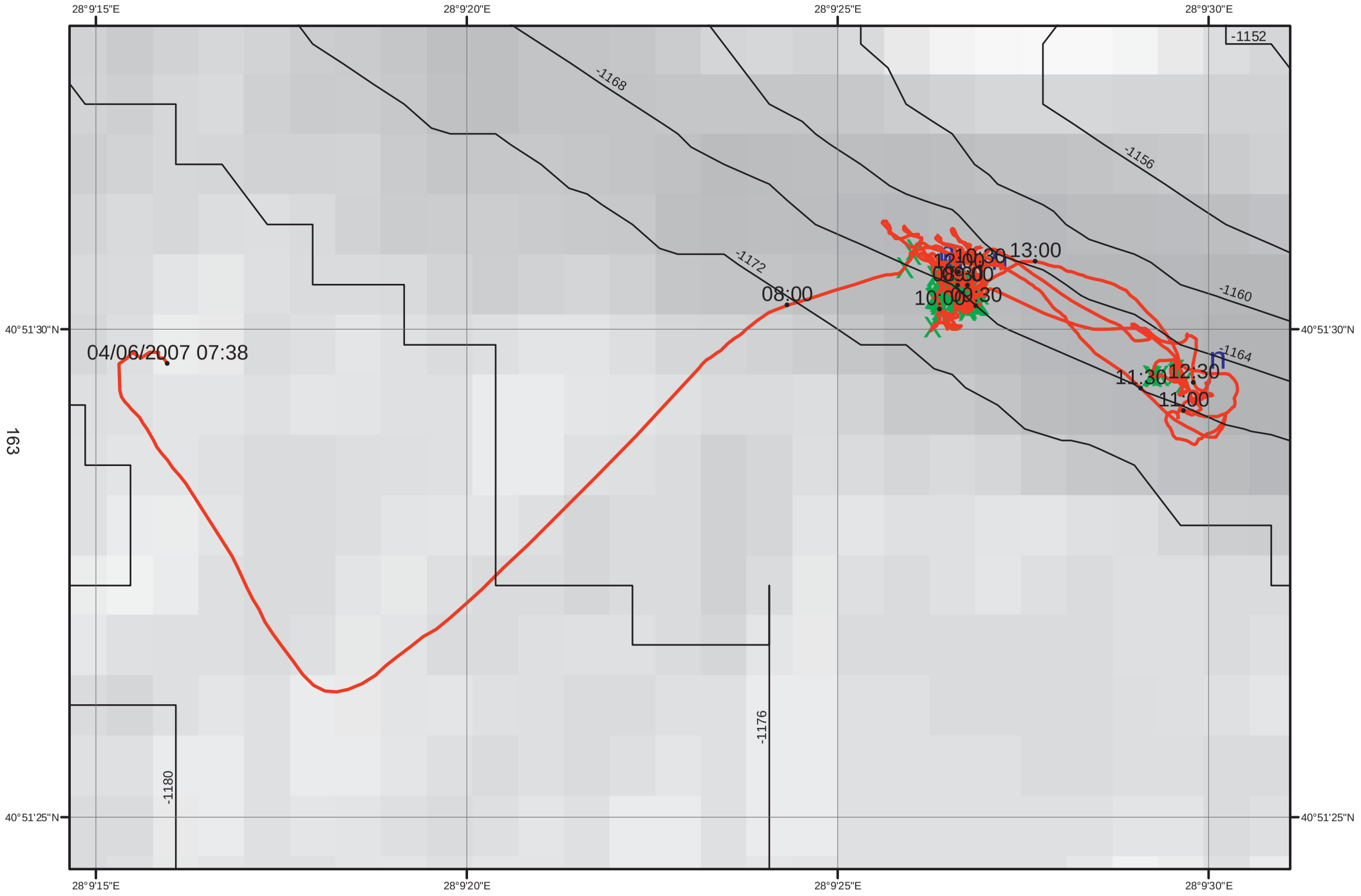
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# Nautile Dive 1664 – June 5th, 2007

Pilots:

Cheilan
Fauvin

Scientist:

Géli

Location:

Eastern branch of central high, near 40°51.7 N ; 28°35.0'E
near suspected active site inferred from Side-Scan Sonar and EK-60 acoustic anomalies

Objectives:

Identify source of EK-60 acoustic anomalies
Collect Pressurized Gaz
Collect fluid samples
Collect push cores
Collect microcat data

Equipment:

1 PEGAZ system flow meters
4 titanium syringe fluid samplers
4 push cores
microcat CTD

Note :

Absence of short-base navigation after 11:57 affected the accurate positioning during the end of the cruise. For navigation, use two files : Dive1664_navbuc_copy_smooth.xls and Dive1664_Estime_after157.xls.

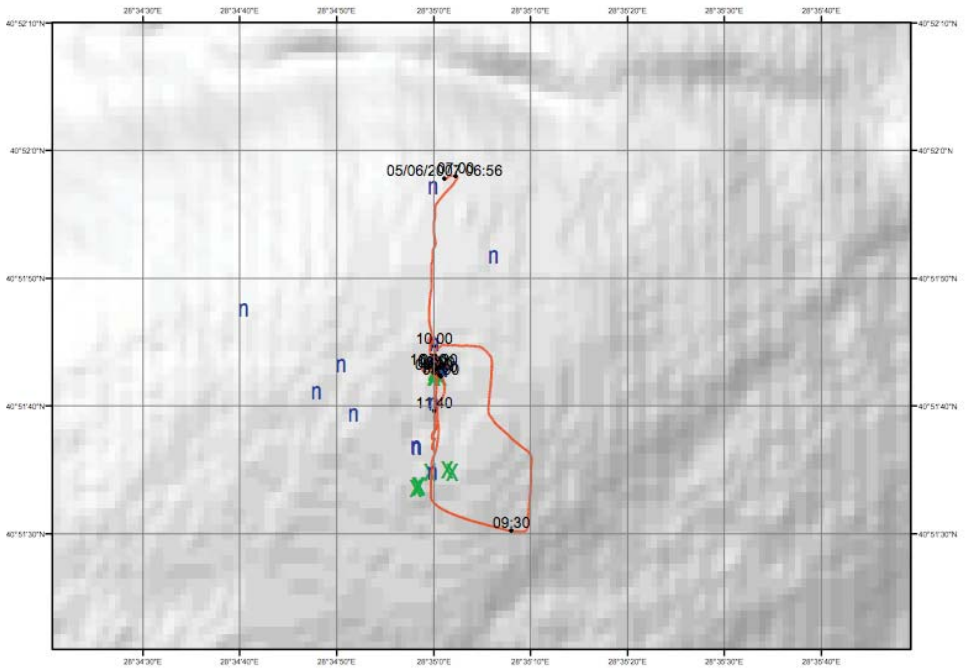



*Fig. 1 : Nautile filtered navigation during Dive 1664.*

sediments. We did not see any bivalves, nor worms living on it. Grey patches rimmed of white mats were found. We tried to insert push cores in these grey patches, but they were indurated.

Numerous gas bubbles were seen escaping from the carbonate platform through small, cm-sized chimneys. Gas flows from these chimneys appear to be unsteady and irregular. After a careful inspection of the carbonate platform, we tried to use the PEGAZ system to sample the gas bubbles at 7:59, but a leak trough the cone prevented this operation. The decision was made to require a new PEGAZ sampler sent by the elevator from R/V L'Atalante. In the meantime (30 minutes are needed to prepare the elevator), Nautile made tow micro-cat measurements near bubble venting sites and sampled one piece of carbonate crust. Two push cores were also collected, from a black patch located less than 1 m away from the carbonate platform. Abundant gas bubbles streams escaped from the black patch as the corers (#1 and #2) were pushed in.

At 09:02, we cleared the area for safety reasons, away from the elevator launching position located 40 m north of site 1. We departed to the south, to explore other sites originating acoustic anomalies. At 09:11, small pieces of rocks (possibly carbonate pebbles) were seen on the seafloor. At 09:14, a small black was observed and immediately after, a new carbonate platform with gas outlets appeared at 09:15:25. This platform will be referred to as site 2 hereafter in the text.

Between 09:15 and 09:52, the exploration did not prove successful in finding new active sites. Nautile arrived to the elevator site at 09:52, to replace the deficient PEGAZ system and take a new one. After leaving the elevator, three small black patches were found within less than 40 m around site 1.

Between 10:34 and 11:30, Nautile sampled gas using the PEGAZ device. The PEGAZ cone was used to collect gases and fill two titane bottles (operation on bottle # 1 was not successful ; gas sampling in bottle #4 was OK).

After 11:30, Nautile headed south towards Site 2. In absence of visibility, sonar aided navigation helped find the site at 11:57. After 11:57, no short-base navigation is available (use instead file : Dive1664_Estime_after157.xls).

The carbonate platform at site 2 is located near 40°51,71 N ; 28°35.01 E, less than 20 m from where the source of acoustic anomaly W9 was expected. It presents the same characterisitics as the platform from site 1 : elongated shape (~8 x 4 $m^2$), oriented approximately NS ; thin cover of dust ; same beige colour as the sediments; presence of grey patches rimmed of white mats were found ; numerous gas bubbles through small, cm-sized chimneys ; unsteady gas flow.

Between 12:00 and 12:20, the PEGAZ cone was used to successfully collect gases in titane bottles #2 and #3. Two micro-cat measurements were made at gas venting sites.

A last, unsucessful attempt was then made to find black patches for push-core sampling. No black patch was found in the immediate vicinity of Site 2. A attempt to sample carbonate crust was also unsuccessful.

Nautile started to pop up at 12:47. It is important to note the presence of a cloud of fine particles with small bubbles floating in the water column at about 120 m above seafloor.

The list of samples is described in the table below :

**Rationale :**

Dive 1664 is an attempt to find the source of a cluster of strong acoustic anomalies observed, ~10 km south of the main fault, near the summit of the Central high, by 350 m water depth (Fig. 2). These anomalies were detected on the Central Ridge : 1) in September 2000, using the 112 kHz Side Scan Sonar system towed behind R/V Le Suroit and 2) during the MarNaut cruise, prior to the dive, using Simrad EK-60 38 kHz echosounder ((Fig. 1). The dive route was designed to explore sites where acoustic anomalies were found along EK-60 Lines T and W, namely :

- T3/W8/W11 on N 40°51,72' , E 28°35.00'
- W9 on N 40° 51, 84 ; E 28°35.00'

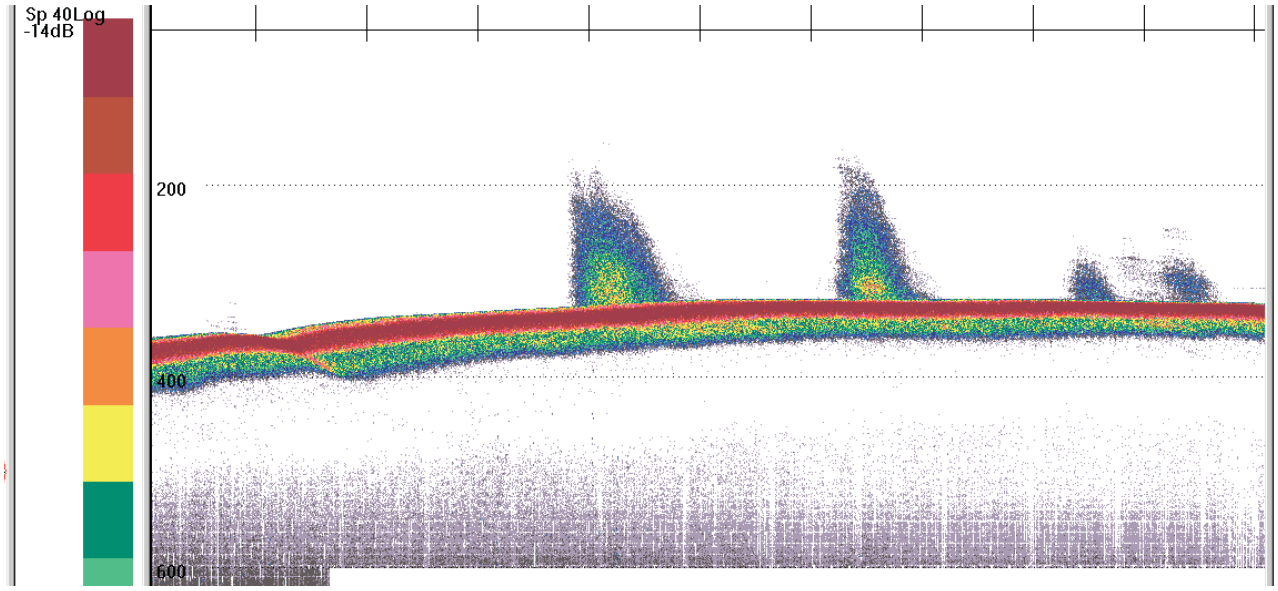



*Fig.2 : Example of acoustic anomalies(T2, T3, T4 and T5) detected on the summit of the central high. Dive 1664 was designed to find out the source of these anomalies.*

**Short dive narrative:**

Dive started by 342 m water depth, less than 200 m away from the summit of the eastern ridge of the Central High. Very bad visibility. A sonar echo was detected very soon after the start of dive. This sonar echo was efficiently used to guide Nautile.

No trace of active site was found between the area between the starting point and waypoint T3. At 7:28:45, a small black patch with white bacterial mats appeared on the seafloor. Immediately after (at 7:29:15), a carbonate platform was found, outcropping by more than 30 cm above seafloor. This platform (hereafter identified as Site 1) was located exactly at the site where the source of acoustic anomalies T3 and W8 were expected near 40°51,72 N ; 28° 35,00 E. It is of elongated shape (~8 x 4 $m^2$), oriented approximately NS.

The platform appears to be covered by a thin film of dust, of the same beige colour as the

| Sample # | Time | Lat | Lon | imm. | Observations |
|---|---|---|---|---|---|
| PC-1664-2 | 08:36:15 | 40°51,710 | 28°35,002 | 326 | from small black patch < 1 m away from carbonate crust |
| PC-1664-1 | 08:38:05 | 40°51,711 | 28°35,003 | 325 | in same black patch ; bubbles as corer is pushed in |
| R-1664-1 | 09:00:05 | 40°51,705 | 28°35,012 | 323 | from carbonate patch above sediments |
| R-1664-2 | 11:26:00 | 40°51,711 | 28°35,006 | 326 | carbonate crust sample from same platform |
| TWS-1664-1 | 11:07:05 | 40°51,710 | 28°35,008 | 327 | titane bottle # 1 triggered ; problem : no gas sampled |
| TWS-1664-4 | 11:10:05 | 40°51,710 | 28°35,006 | 326 | titane bottle # 4 triggered : good gas sampling |
| TWS-1664-3 | 12:12:01 | 40°51,612 | 28°34,979 | 331 | titane bottle # 3 triggered : gas sampling with water |
| TWS-1664-2 | 12:18:04 | 40°51,612 | 28°34,978 | 331 | titane bottle # 2 triggered : gas sampling with water |
| Microcat | 08:14:05 | 40°51,712 | 28°35,003 | 327 | 2 meas., 10" each, over bubbles leaking out from carb. crust |
| " | 08:19:05 | 40°51,712 | 28°35,003 | 327 | 2 meas., 10" each, over grey pach located on a carb. crust |

Figure 3 : Capture at 08:24:32. Gas bubbles coming escaping from carbonate crust at site 1.

Fig. 4 : Capture at 08:26:27. Push-core testing hardness of greyish patch found on carbonate crust.

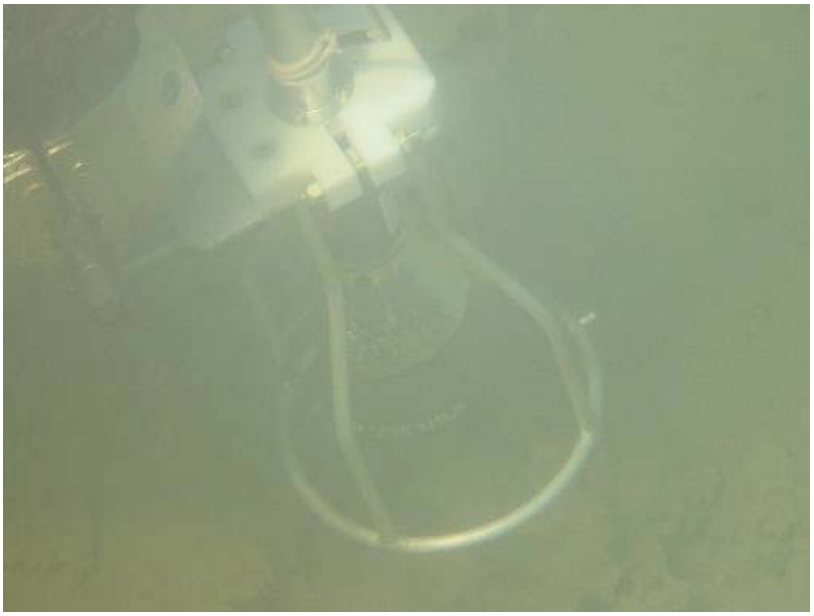


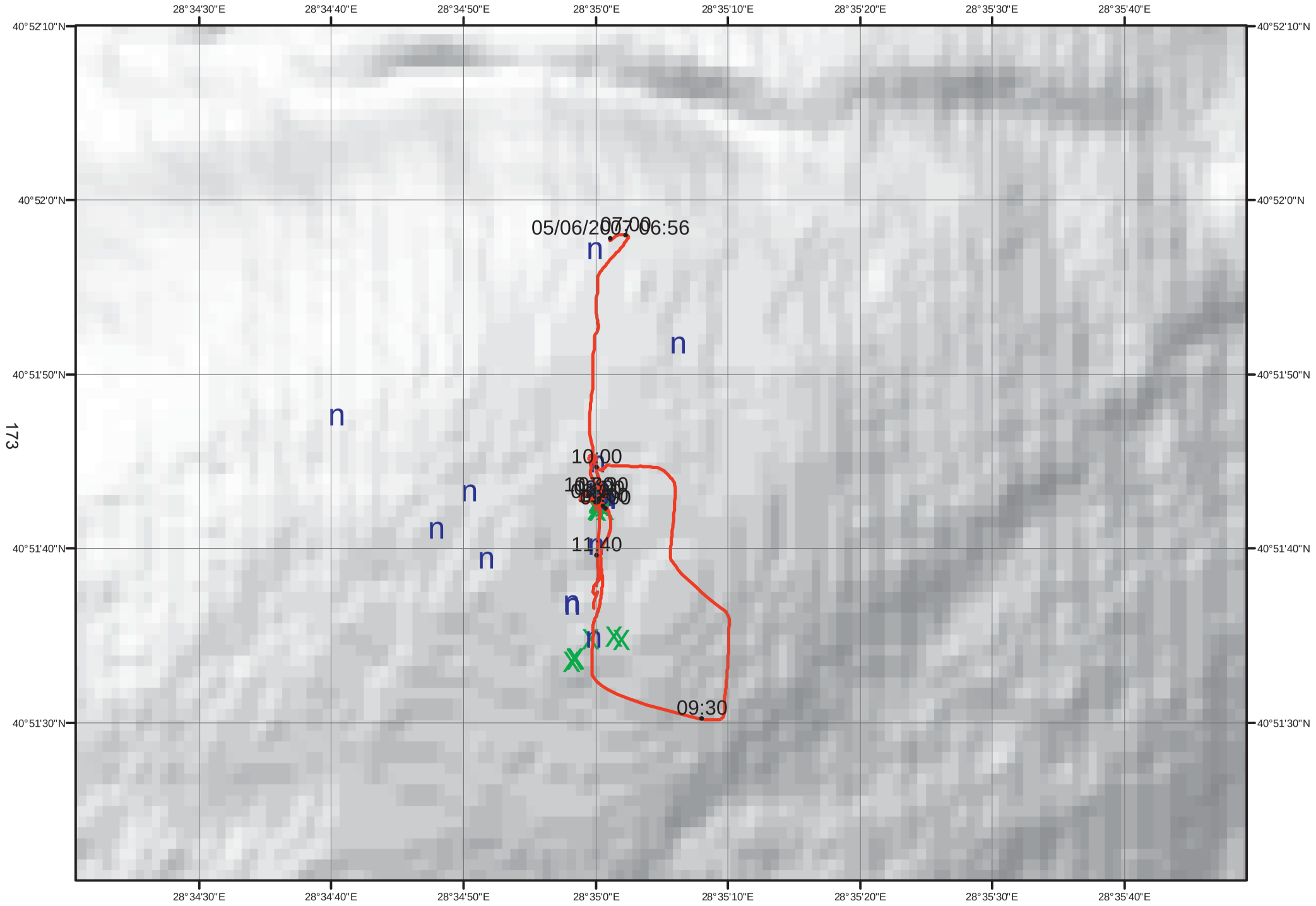
Fig. 5 : Capture at 10:47:52. Gaz sampling using PEGAZ system at site 1. Note the gas filling the cone.

Fig. 6 : Carbonate crust found at Site 2. Note the small greyish patch in the lower right center of the picture.

| Dive 1664 - Comments and report | | | | | | | |
|---|---|---|---|---|---|---|---|
| Begin/End | HEURE | deg_Lat | min_lat | deg_lon | min_lon | imm. | Observations |
| punctual | 0 | 40 | 51,963 | 28 | 35,018 | 342 | on bottom |
| punctual | 7:27:05 | 40 | 51,729 | 28 | 35,006 | 326 | sonar echo (strazza) |
| punctual | 07:28:45 | 40 | 51,719 | 28 | 35,006 | 333 | small black patch - hardly visible on video at 07:28:50 |
| punctual | 07:29:05 | 40 | 51,719 | 28 | 35,007 | 335 | bubbles escaping from a large carbonate patch (Site 1, corrresponds to acoustic anomaly T3) |
| | | | | | | | |
| begin | 07:29:15 | 40 | 51,718 | 28 | 35,007 | 332 | explore carbonate patch for identifying PEGAZ sampling site |
| | | | | | | | carbonate patch is 8 x 4 m oriented ~NS ; outcropping by 30 cm high above sediments |
| | | | | | | | beige colour (indicating thin sediment cover ?) ; |
| | | | | | | | presence of isolated grey patches with white boundaries ; |
| | | | | | | | small streams of bubbles of iregular flow escaping from patch through finger-sized chimneys |
| end | 07:54:05 | 40 | 51,716 | 28 | 35,002 | 331 | end patch inspection - try to find gas source for PEGAZ sampling |
| | | | | | | | |
| begin | 07:59:05 | 40 | 51,714 | 28 | 35,005 | 327 | begin first attempt for PEGAZ gas sampling |
| end | 08:07:05 | 40 | 51,713 | 28 | 35,006 | 325 | PEGAZ cone leaking - stop first attempt - decision is made to send new PEGAZ with elevator |
| | | | | | | | |
| 2x10 " | 08:14:05 | 40 | 51,712 | 28 | 35,003 | 327 | 2 MicroCat measurements, 10" each, over gas bubbles leaking out from carbonate crust |
| 2x10 " | 08:19:05 | 40 | 51,712 | 28 | 35,003 | 327 | 2 MicroCat measurements, 10" each, over grey pach located on a carbonate crust |
| | | | | | | | |
| begin | 8:22:00 | 40 | 51,712 | 28 | 35,003 | 328 | begin inspection of carbonate crust to find a place for inserting push core |
| | 8:24:05 | 40 | 51,712 | 28 | 35,001 | 51,712 | attempt to insert push core in "grey patch" on top of carbonate crust generates bubble escapes |
| | 8:29:25 | 40 | 51,712 | 28 | 35,001 | 51,712 | capture video image : illustrative example of gas bubbles escapes |
| end | 8:31:05 | 40 | 51,711 | 28 | 35,000 | 51,711 | end of inspection. no suitable place to insert push core. carbonate crust is too hard. |
| | | | | | | | |
| punctual | 08:36:15 | 40 | 51,710 | 28 | 35,002 | 326 | push core #2 inserted in small black patch with white mats located less than 1 m away from carbonate crust |
| " | 8:36:25 | 40 | 51,710 | 28 | 35,002 | 326 | bubbles escaping as core # 2 is pushed in |
| " | 08:38:05 | 40 | 51,711 | 28 | 35,003 | 325 | push core # 1 inserted in same black patch ; bubbles as corer is pushed in |
| " | 08:40:05 | 40 | 51,712 | 28 | 35,002 | 326 | capture video image : bubbles degassing as corer is pushed in ; gas outlets (small chimneys) clearly visible |
| " | 08:45:05 | 40 | 51,709 | 28 | 35,000 | 325 | capture video image of bubbles degassing |
| " | 08:48:05 | 40 | 51,703 | 28 | 35,001 | 328 | bubbles coming out from sediments near black patch |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| " | 08:53:05 | 40 | 51,708 | 28 | 35,003 | 325 | push core # 1 in rack |
| " | 08:54:05 | 40 | 51,707 | 28 | 35,001 | 328 | push core # 2 in rack |
| | | | | | | | END OF DVD # 1 - START DVD # 2 |
| " | 09:00:05 | 40 | 51,705 | 28 | 35,012 | 323 | small sample of carbonate crust taken ; |
| " | 09:02:05 | 40 | 51,696 | 28 | 35,018 | 320 | Departure from site ; exloration to the south waiting for elevator |
| " | 09:02:15 | 40 | 51,694 | 28 | 35,018 | 315 | small black patch just after leaving site 1 - echoes to the south |
| " | 09:11:05 | 40 | 51,609 | 28 | 35,004 | 324 | small pieces of carbonate type pebbles ; small black patch |
| " | 09:14:05 | 40 | 51,585 | 28 | 34,997 | 325 | new carbonate platform found (site 2) with numerous bubbles escapes |
| | | | | | | | |
| begin | 09:56:05 | 40 | 51,747 | 28 | 35,015 | 316 | arrive on elevator for PEGAZ replacement, 40 m north of site 1 |
| end | 10:08:05 | 40 | 51,751 | 28 | 34,997 | 314 | quit elevator - departure to site 1 - Sonar guided navigation |
| | 10:09:05 | 40 | 51,750 | 28 | 34,998 | 314 | 3 small black patches |
| | 10:36:55 | 40 | 51,708 | 28 | 35,010 | 327 | capture video image : global view of carbonate patch |
| | | | | | | | |
| begin | 10:39:05 | 40 | 51,708 | 28 | 35,009 | 329 | begin PEGAZ sampling at site 1 |
| | | | | | | | capture images of bubbles within PEGAZ cone at 10:45:00 ; 10:46:32 ; 10:47:29 ; 10:48:00 |
| end | 10:49:25 | 40 | 51,705 | 28 | 35,013 | 341 | end PEGAZ |
| | 10:50:25 | 40 | 51,706 | 28 | 35,014 | 336 | capture video image : general view of carbonate patch |
| | | | | | | | |
| begin | 10:51:35 | 40 | 51,706 | 28 | 35,012 | 343 | begin sampling for titane bottles using PEGAZ cone |
| | | | | | | | END OF DVD # 2 - START DVD # 3 |
| | 11:07:05 | 40 | 51,710 | 28 | 35,008 | 327 | titane bottle # 1 triggered ; problem : no gas sampled |
| | 11:10:05 | 40 | 51,710 | 28 | 35,006 | 326 | titane bottle # 4 triggered : good gas sampling |
| | | | | | | | capture video images at 11:20 ; 11:22:20 ; 11:26:29 |
| punctual | 11:26:00 | 40 | 51,711 | 28 | 35,006 | 326 | take carbonate crust sample # 2 |
| end | 11:29:25 | 40 | 51,667 | 28 | 35,002 | 325 | end sampling operations for titane bottles - end sampling at site #1 - departure to site #2 |
| | | | | | | | BUC navigation lost after 11:30 ; estimated navigation until site 2 |
| | | | | | | | |
| | 11:57:43 | 40 | 51,57920 | 28 | 34,98390 | 331 | arrival at site 2 ; carbonate patch very comparable to site 1 in size and shape |
| begin | 12:02:01 | 40 | 51,61700 | 28 | 34,97110 | 330 | begin sampling operations with titane water samplers using PEGAZ cone |
| | 12:12:01 | 40 | 51,61170 | 28 | 34,97910 | 331 | titane bottle # 3 triggered : gas sampling with water |
| | 12:15:21 | 40 | 51,61370 | 28 | 34,97040 | 331 | capture video image of gas bubbles trapped in PEGAZ cone |
| | 12:18:04 | 40 | 51,61200 | 28 | 34,97770 | 331 | titane bottle # 2 triggered : gas sampling with water |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| end | 12:19:00 | 40 | 51,61200 | 28 | 34,97770 | 331 | end samplig operation ; capture image : general view of carbonate crust borders |
| punctual | 12:24:04 | 40 | 51,61150 | 28 | 34,97920 | 331 | 2 microcat measurements in gas bubbles |
| | | | | | | | |
| begin | 12:25:01 | 40 | 51,61430 | 28 | 34,97000 | 331 | begin search for black patches around carbonate crusts |
| end | 12:34:04 | 40 | 51,60970 | 28 | 34,97110 | 331 | end |
| | | | | | | | |
| | 12:44:28 | 40 | 51,60700 | 28 | 34,97160 | 331 | small black patch |
| | 12:45:41 | 40 | 51,61080 | 28 | 34,96980 | 331 | bubbles popping up in front of camera |
| | 12:46:06 | 40 | 51,61080 | 28 | 34,96980 | 331 | capture video image : bubbles escaping as small streams from slightly sedimented carbonate crusts |
| | 12:47:01 | 40 | 51,61020 | 28 | 34,96900 | 313 | Release weight - Nautile pops up |
| | 12:47:41 | 40 | 51,60970 | 28 | 34,96720 | 278 | END DVD # 3 |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**MARNAUT**
**Dive 1665 (Marnaut 25)**

Date: 06/06/2007
Immersion point: 40°47,777 N/ 28°7,108 E
Maximum depth: 1125 m
Timing (UTC) begin dive: 08:00 (0m), dive end: 14:00 (1059m)
Dive duration: 09:57

Nautile pilot: Jean-Paul JUSTINIANO
Nautile copilot: Franck ROSAZZA
Scientist observer: Bénédicte RITT

**Objectives:**
Faunal quantitative and geochemical sampling in the central basin NE.

1) To return to the wide black patches observed during the dive #1661 where living organisms are expected
2) To sample fluids and sediment close to the fauna in order to establish the links between the faunal distribution and the environmental factors (in collaboration with Jean-Claude Caprais (Ifremer-Brest)
3) To process to a faunal quantitative sampling of macrofauna (3 replicates) in the reduced sediment in order to assess biodiversity, density and biomass data of this habitat

**Equipment:**
Nautile's basket:

- 4 push corers
- MicroCat
- Water sampler (4 bottles)
- Titanium seringes (2 bottles)

Shuttle:

- 4 blade corers
- 4 push corers
- 1 biological box

**Dive summary:**
The area was already observed during the dive #1662. The main objective of this dive was to find living organisms on the surface of the black sediment. Wide black patches were quick found with visible tubeworms on the surface. The black sediment is surrounding by a thin boundary of white bacterial mat and wide area of brown sediment with several holes. We managed to take three blade corers in the black sediment and one in the brown sediment as reference site. For each blade core, 2 push corers, 2 water samplers and the MicroCat were deployed. Five carbonate crusts samples are taken later on an escarpment with living mussels (*Idas aff. Modiolaeformis*). We did not observed active chimneys or other fluids emissions during the course.

**Observations:**
09:15 (UTC) The Nautile arrived on the sea floor at 40°47,777 N/28°7,108E, 1125m depth  The bottom is covered by a light grey sediment with bioturbations. We have never seen the animals involved in these burrows.

09:31 We arrived at the wide black patch with white boundary, tubeworms and dead sea urchins on the surface. Some grey patches are visible inside the black one.

09:46 to 09:50 We put the push corers #8 and #7 in the black sediment at 40°51,267 N/28°10, 194 E, 1121m. This area is my first spot (replicat #1).

09:53 We deployed the MicroCat for one minute above the sediment close to the couple of push corers.

09 59 to 10:02 We put the push corers #5 and #6 about 1m on the right of the first ones. This area is my second spot (replicat #2).

10:04 We deployed the MicroCat for one minute above the sediment close to the second couple of push corers.

10:12 to 10:14 We took two water sampling close to the sediment and the first couple of push corers, bottle #7 and #9.

10:15 to 10:17 We took two water sampling close to the sediment and the second couple of push corers, bottle #8 and #5.

10:27 to 11:13 We pick the for push corers  up (Figure 1) before the way-back to the shuttle in order to take for new push corers, for blade corers, the biological box and to leave the water sampler.

Fig. 1. Push corers at the spot 1 on the left, at the spot 2 on the right.

11:29 We recovered the study area with the two spots.

11:38 to 12:07 We put the blade corer #6 close to the holes of the first couple of push corers and the blade corer #7 close to those of the second couple. The blade

corers are half full. Carboante crusts must be at 20 cm depth under the sediment layer.

12:13 We moved the Nautile 10m on the right to find a new area undisturbed.

12:21 We put the push corers #4 and #3 in the black sediment at 40°51,278 N/28°10,199 E, 1121m. This area is my third spot (replicat #3).

12:23 We deployed the MicroCat for one minute above the sediment close to the third couple of push corers.

12:28 to 12:31 We took two water sampling close to the sediment and the first couple of push corers, bottle #1 and #2.

12:39 to 12:40 We put the blade corer #8 close to the holes of the third couple of push corers.

12:40 to 12:43 We get the push corers and the blade corer back to step back with the Nautile on the brown sediment (Figure 2).

Fig. 2. Blade corer and push corers at the reference site with brown sediment covered by bioturbation.

13:00 We put the push corers #2 and #1 in the brown sediment, about 1m50 to the third spot at 40°51,279 N/28°10,198 E, 1122m. This area is my reference site.

13:03 We deployed the MicroCat for one minute above the sediment close to the couple of push corers.

13:10 We put the blade corer #5 close to the holes of the couple of push corers.

13:12 to 13:33 We get the blade corer and the push corers back to go back to the shuttle in order to leave the for blade corers. The shuttle is ready to be released.

13:48 We go back to an escarpment with carbonate crusts at 40°51,272 N/28°10,185 E, 1111m (Figure 3). The crusts are at mid slope which is covered by

brown sediment. The black patch is at the bottom of the slope. Mussels are visible on the carbonates.

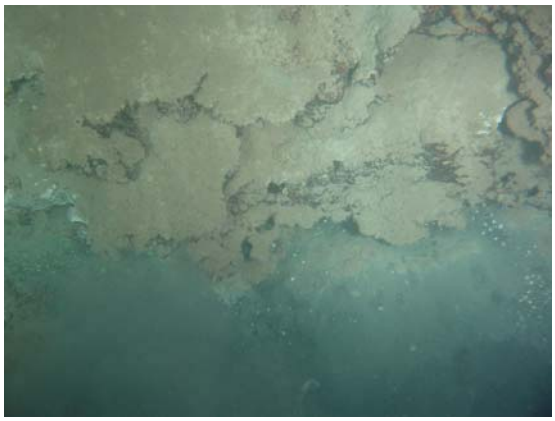



Fig. 3. Right: escarpment with carbonates crusts covered by musels *Idas aff. Modiolaeformis* in details above.

13:54 First sample of crust in the biological box.

13:59 Second sample of crust in the biological box.

14:09 Third sample of crust put in the Nautile's basket.

14:16 We tried to take a forth sample, it was too weak and is broken by the claw.

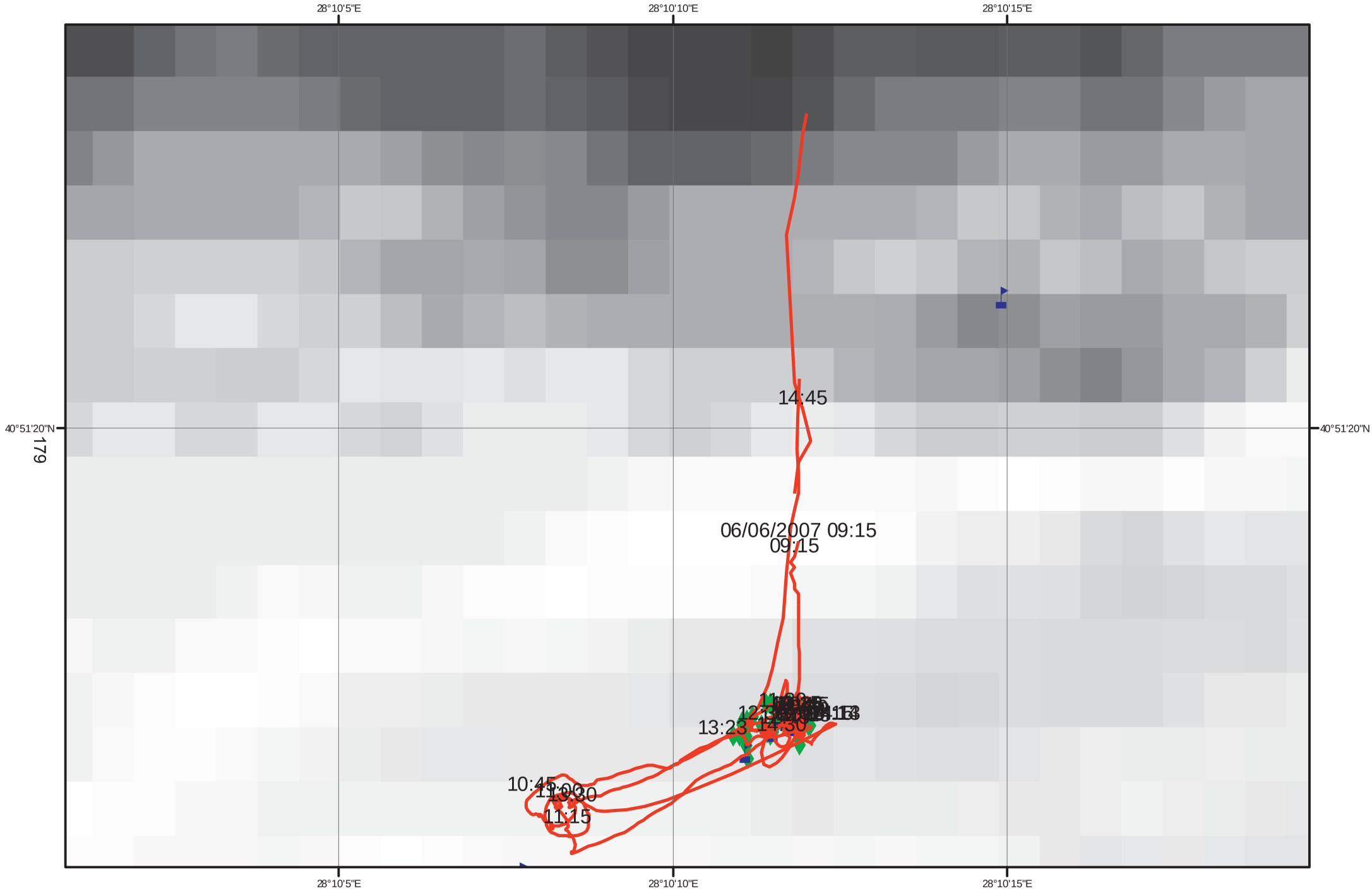
14:24 Fifth crust in the Nautile's basket.

14:37 Sixth crust in the Nautile's basket.

14:50 We are leaving the sea floor at 1060m.

| Sample | Latitude | Longitude | Depth | Observation |
|---|---|---|---|---|
| Push core #8 | 40°51,267 N | 28°10, 194 E | 1121 | Black patch |
| Push core #7 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PC 8 |
| Push core #5 | 40°51,267 N | 28°10, 194 E | 1121 | Black patch |
| Push core #6 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PC 5 |
| Water sample #7 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PCs 7-8 |
| Water sampler #9 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PCs 7-8 |
| Water sampler #8 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PCs 5-6 |
| Water sampler #5 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PCs 5-6 |
| Blade core #6 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PCs 7-8 |
| Blade core #7 | 40°51,267 N | 28°10, 194 E | 1121 | Close to PCs 5-6 |
| Push core #4 | 40°51,278 N | 28°10,199 E | 1121 | Black patch |
| Push core #3 | 40°51,278 N | 28°10,199 E | 1121 | Close to PC 4 |
| Water sampler #1 | 40°51,278 N | 28°10,199 E | 1121 | Close to PCs 3-4 |
| Water sampler #2 | 40°51,278 N | 28°10,199 E | 1121 | Close to PCs 3-4 |

| | | | | |
|---|---|---|---|---|
| Blade core #8 | 40°51,278 N | 28°10,199 E | 1121 | Close to PCs 3-4 |
| Push core #1 | 40°51,279 N | 28°10,198 E | 1122 | Brown sediment |
| Push core #2 | 40°51,279 N | 28°10,198 E | 1122 | Close to PC 1 |
| Blade core #5 | 40°51,279 N | 28°10,198 E | 1122 | Close to PCs 1-2 |
| Carbonate crust #1 | 40°51,272 N | 28°10,185 E | 1111 | |
| Carbonate crust #2 | 40°51,272 N | 28°10,185 E | 1111 | |
| Carbonate crust #3 | 40°51,272 N | 28°10,185 E | 1111 | |
| Carbonate crust #4 | 40°51,272 N | 28°10,185 E | 1111 | Broken by the claw |
| Carbonate crust #5 | 40°51,272 N | 28°10,185 E | 1111 | |
| Carbonate crust #6 | 40°51,272 N | 28°10,185 E | 1111 | Mussels |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11:15

**MARNAUT Dive 1666**
**07/06/2007**

**Scientist :** Mike TRYON
**Pilot :** Xavier PLACAUD
**Co-pilot :** Patrick CHEILAN

**Objectives:**

Deploy 2 flow meters

**Equipment:**

-2 flow meters (deployed by wire before dive)
deploy location 40°49.080' 27°46.770' depth: 660 m
-Titanium water sampler
-Microcat
-4 Push cores

**Targets:**

| | | | |
|---|---|---|---|
| GAS: | 40°49.080' | 27°46.830' | depth: 651 m |
| MAT: | 40°48.990' | 27°46.752' | depth: 660 m |
| DROP: | 40°49.080' | 27°46.770' | depth: 660 m |
| NE: | 40°49.140' | 27°46.920' | depth: 665 m |
| SW: | 40°48.900' | 27°46.650' | depth: 667 m |
| LOUIE: | 40°48.895' | 27°46.541' | depth: 667 m |

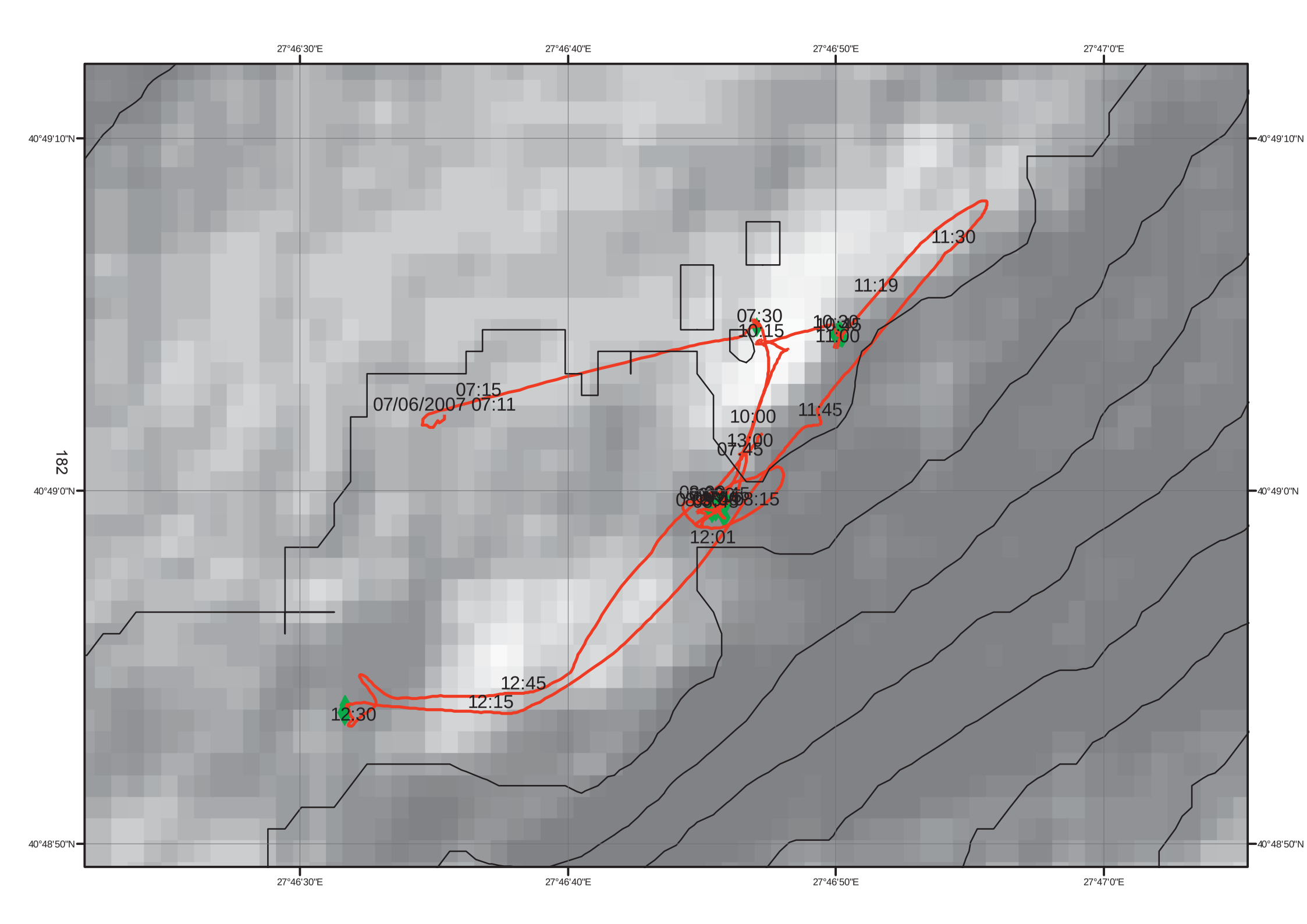
**Dive plan operations:**

Locate flow meters on bottom at DROP
Take the single meter to MAT and deploy
Return to DROP
Take the double meter to GAS and deploy
Collect Pgas sample
Explore to NE target
Offset to southeast 10 m and return by parallel track towards GAS
Continue exploring heading southwest toward SW target
Continue to LOUIE if time

**Dive highlights:**

| TIME | LAT | LONG | DEPTH (m) | EVENT |
|---|---|---|---|---|
| 07:13:00 | 40,817 | 27,776 | 654 | dive begins |
| 07:25:00 | 40,818 | 27,780 | 653 | flow meter S found, Q is very near by |
| 08:33:00 | 40,817 | 27,779 | 655 | after much searching we finally find the site with thick microbial mat |
| 08:43:00 | 40,817 | 27,779 | 658 | beginning to deploy the instrument on the left-most site - where coring was done |
| 09:07:00 | 40,816 | 27,779 | 660 | chamber 18 on site just below core holes |

| | | | | |
|---|---|---|---|---|
| 09:20:00 | 40,817 | 27,779 | 659 | chamber 28 just below the other one |
| 09:35:00 | 40,817 | 27,779 | 658 | trying unsuccessfully to core |
| 10:15:00 | 40,818 | 27,780 | 655 | back at flow meter Q and picking it up |
| 10:31:00 | 40,818 | 27,781 | 652 | sulfide patch with lots of white mat found - looks good for deployment |
| 10:47:00 | 40,818 | 27,781 | 656 | deployed Q on site |
| 11:02:50 | 40,818 | 27,781 | 652 | trying to core but not having much luck - core #6 |
| 11:12:00 | 40,817 | 27,779 | 715 | we give up coring and start exploration part of dive |
| 11:41:00 | 40,817 | 27,780 | 651 | a new seep like the other thick white mat is found - target for dive 1669 |
| 12:11:00 | 40,815 | 27,777 | 660 | we are at waypoint SW and haven't found anything so heading to point LOUIE |
| 12:13:00 | 40,815 | 27,777 | 656 | we see a good size seep with lots of carbonate but not much mat |
| | | | | this turns out to be the site with hydrate in the core |
| 12:23:00 | 40,815 | 27,776 | 658 | we arrive at LOUIE but find nothing good - just a little seep |
| | | | | we head back on parallel tract to the hydrocarbon seep location |
| 13:01:00 | 40,817 | 27,780 | 644 | end of dive - we found nothing more |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27°46'50"E
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**MARNAUT Dive 1667/36/27**
08/06/2007

**Scientist observer :** Tiphaine ZITTER
**Nautile pilot :** Jean-Paul JUSTINIANO
**Nautile co-pilot :** Franck ROSAZZA

**Dive zone :**
South east of Tekirdag Basin, in the Jack the smoker area

**Objectives :**
- Deploy a flowmeter at Jack the smoker site
- Make a microcat measurement other a chimney site
- Sample crusts
- Explore the zone westwards of Jack in order to recognize some other carbonate chymneys (seen in the ROV)

**Tools :**
Four push corers (Nautile basket)
Fluid microsampler (Nautile basket)
Microcat device (Nautile basket)
1 flow meter (deployed by wire on prior night)

**Dive report:**

STARTING DVD1
7:40: Arrival on the hemipelagic flat seafloor. We are looking for the flowmeter with the help of the sonar.
7:59:49: We find on the LOTOBS J.
8:07: We find the flowmeter N, which is already deployed and should stay there on the seafloor.
8:19: a fish
8:23:23: At last, we find the flowmeter! We pick it up and make our road towards Jack site.
8:47: First signs of activity. The submersible is at 7 m altitude, and we distinguish some small carbonate chimneys on the right hand side.
8:54: Arrival on active sites.
8:57: We can see several carbonate chimneys.
9:01: We have identified Jack the smoker. Jack is sitting on a gentle slope in front of a scarp made of carbonate slab and about 1 m high.
9:07: We stop for deployment of the flowmeter.
9:09: The flowmeter is put the seafloor. We are looking for a relatively flat area.

9:11: Zoom on the scarp. There is quite a lot of mussels. Small carbonate chimneys are found at the middle of the scarp in front of us.
9:16: We are taking the probe of the flowmeter and inserting it into the orifice of the chimneys.
9:23: the probe is inserted into Jack. The manipulation was successful.

STARTING DVD 2
9:26: Zoom on Jack orifice. We can clearly see the water seepage.

9:27: Zoom on a small chimney, on a slab in the middle of the scarp with white and orange colors. Seepage seems to occur from beneath the slab and upwards.
9:29: Another chimney higher within the scarp.
9:30: We are moving eastward to make a microcat measurement on another chimney.
9:33: Taking the microcat out of the basket.
9:38: We can see there the alignment of the small chimneys around Jack. A first one about 1.5-2m eastward is to close to the fmlowmeter. Another one is found 1-2 m eastwards.
9:40: We are getting closer to the structures.
9:42: beginning of the microcat measurement.
9:44: end of microcat measurement. The chimney where the microcat has been made broke when the microcat touched it.
9:44: chimneys appear aligned 15° with regards to submersible direction. Cap is N230.
9:45: Sampling crust. Sample **1667-R-1**
9:47: We can see the broken chimney where the microcat measurement was made.
9:48: samples in the basket.
9:52: Completing the sampling in the same place. 1667-R-1
10:02: Samples in the basket.
10:09: Small crust with a chimney.
10:15: View of the scarp, westward of jack. We can see a lot of small yellow mussels. It is not obvious on video. Also actinians, and small chimneys.
10:17: small chimney in the middle of the scarp with mussels and crabs.
10:19: We are moving westwards along the scarp, facing it.
10: 19: Sampling crusts on the top of the scarp. The 1 m high scarp appears to be made of stratified slab of carbonate crusts. Chimneys are found at the bottom of the scarp or on the slabs within. We are sampling one of the slab sticking out.
10:22: Sample **1667-R-2**
10:24: sample in the basket.
10:27: Over the active area at 8m altitude.
10:29: Small chimney on the border of a carbonate slab. 2 big black patches behind.
10:32: Carbonate crusts on the seafloor.
10:33: We can't see so much, 6 m altitude.
10:38: Big black patch. It seems a good place to take some pushcores. No bacterial mat are seen on the patch but shells and dead urchins.
10:39: Taking out 2 push cores.
10:45: Coring
10: 54: Push cores within the basket.
10:57: Black patches.
11:04: We find the site where the flowmeter K is deployed. It is at the western end of the big rocky scarp. The scarp appears nearly EW, submersible cap N167 + 90°
11:12: Crossing a small isolated chimney, within a zone of black patches.
11:13: We are moving slowly westwards with the slope on the left.
11:15: Again small black patches.
11:17: The black patches are aligned.
11:18: We are crossing again a zone with small carbonate chimneys.
11: 20: They appear on a cluster. The bigger construction is about 30 cm high with a round white top and focused flow, with orange bacterial mat on top. A smaller one is found 20 cm aside, and two others respectively, 50cm and 1 m behind.

11:21: Zoom on the biggest chimney. Water seepage on top is focused. Small shells on the black patch, but no bacterial mat. A fish is coming and is resting on the seafloor. Two other fishes are eating on the chimney.
11:22: Seepage is very focused with high flux.
11:27: Microcat measurement on top of this chimney.
11: 29: End of microcat measurement.
11:30 END OF DVD 2

STARTING DVD 3
11:33: Another isolated chimney with a sharp peak.
11:35: View of this chimney and 2 others behind.
11:36: We are continuing towards west.
11:38: few crusts are outcropping at the base of the slope. 11:42: Black patches with shells at the bottom of the slope.
11:43:09: Suddenly I can see bubbles to my window.
11:44: A grey-blackish patch is bubbling. Shells are seen and crust is found in the middle of the patch.
11:45: Two zones are bubbling. Bubbles are escaping regularly by cluster.
11:46:53: Bubbles. It is interesting to note we are on a zone where strange artefact peaks were detected with the ROV microbathymetry.
11:48: Sampling number 3. We are sampling the crust in the middle of the balck patch.
11:51: **1667-R-3**.
11:56: Big pieces of crust.
11:59: Steep slope on the left hand side.
12:07: Small crust and black patches. Then ther is nothing to see for a while.
12: 47: Nothing except the bioturbated hemipelagic seafloor, however, some echos are detected on the sonar. We are in an area where bubbles were expected from EK60 survey, but we have no time to look for them.
12:50 END OF THE DIVE

**Dive Photos**

Fig. 1: Jack the smoker (left)with a small carbonate chimney in the middle of the scarp

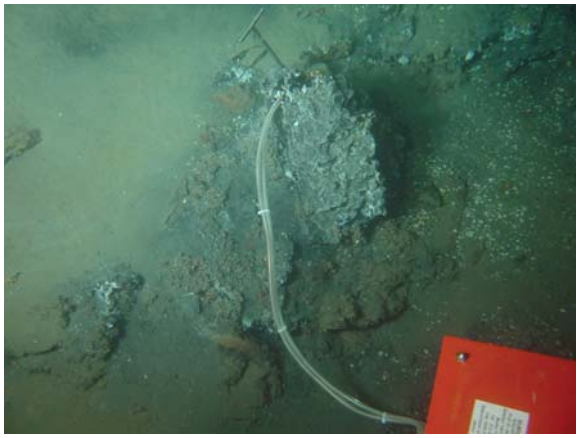
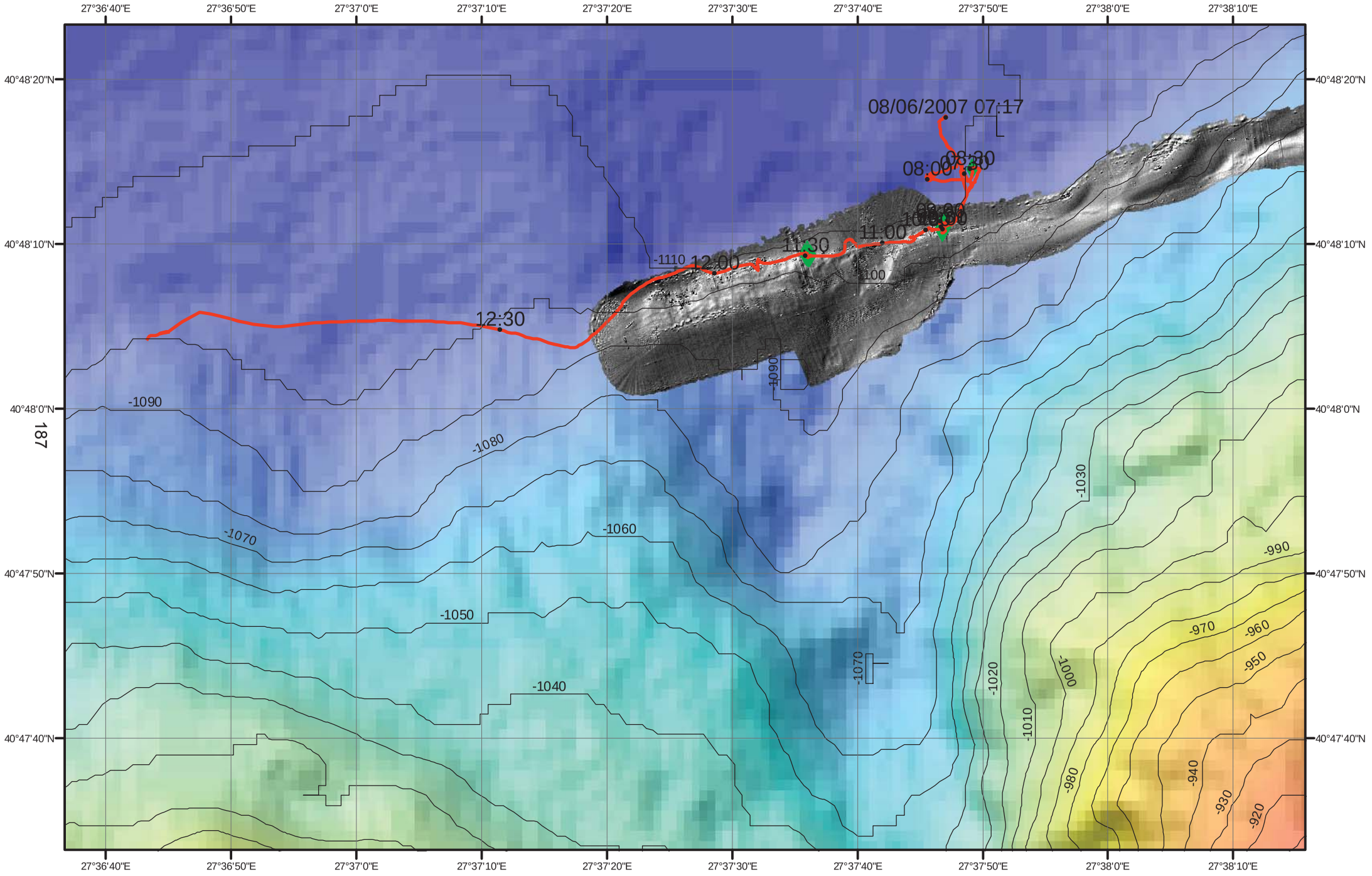


Fig. 2: Deployment of the flowmeter within Jack orifice.

Fig. 3: Two active chimneys (seen at 11:20 and 11:33 respectively)

**Operation and sample list**

| Time | latitude | Longitude | Operation and samples |
|---|---|---|---|
| 07:59:43 | 40,8039000 | 27,6293000 | Found LOTOBS J |
| 08:07:03 | 40,8040500 | 27,6298167 | Found N |
| 08:23:03 | 40,8038667 | 27,6303333 | Found flowmeter |
| 09:23:13 | 40,8030333 | 27,6296667 | Flowmeter deployment |
| 09:42:03 | 40,8030167 | 27,6296833 | Microcat 1 |
| 09:45:03 | 40,8030000 | 27,6296833 | Sample 1667-R-1 |
| 10:23:03 | 40,8029833 | 27,6294833 | Sample 1667-R-2 |
| 10:39:23 | 40,8029167 | 27,6289667 | Push core 1 and 2 |
| 10:51:03 | 40,8028667 | 27,6289833 | Sample1667-R-3 |
| 11:27:23 | 40,8025667 | 27,6266833 | Microcat 2 |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27°37'20"E
27°37'30"E
27°37'40"E
27°37'50"E
27°38'0"E
27°38'10"E
40°48'20"N
40°48'10"N
40°48'0"N
40°47'50"N
40°47'40"N
08/06/2007 07:17
08:00
08:30
09:00
10:00
11:00
11:30
12:00
12:30
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100
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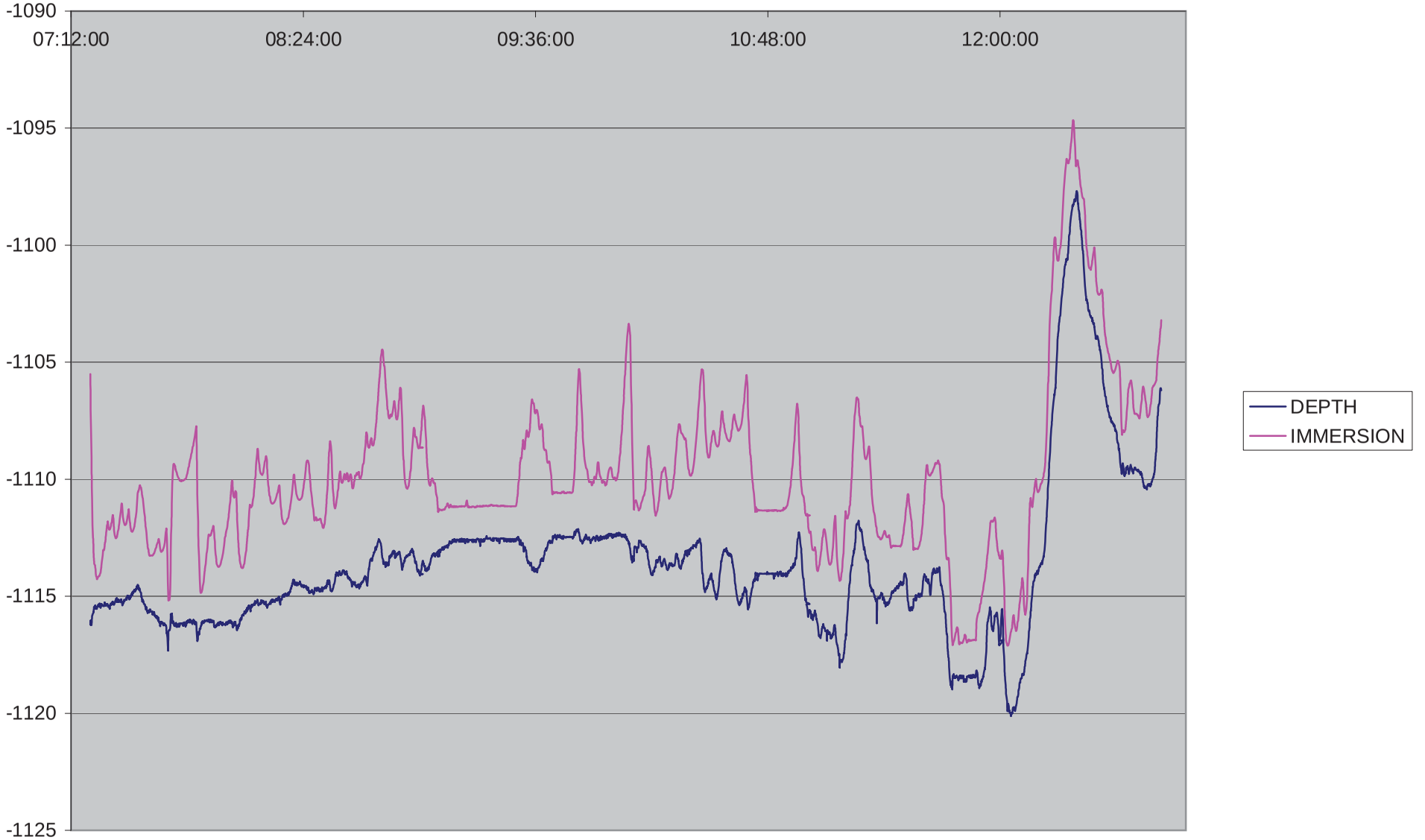
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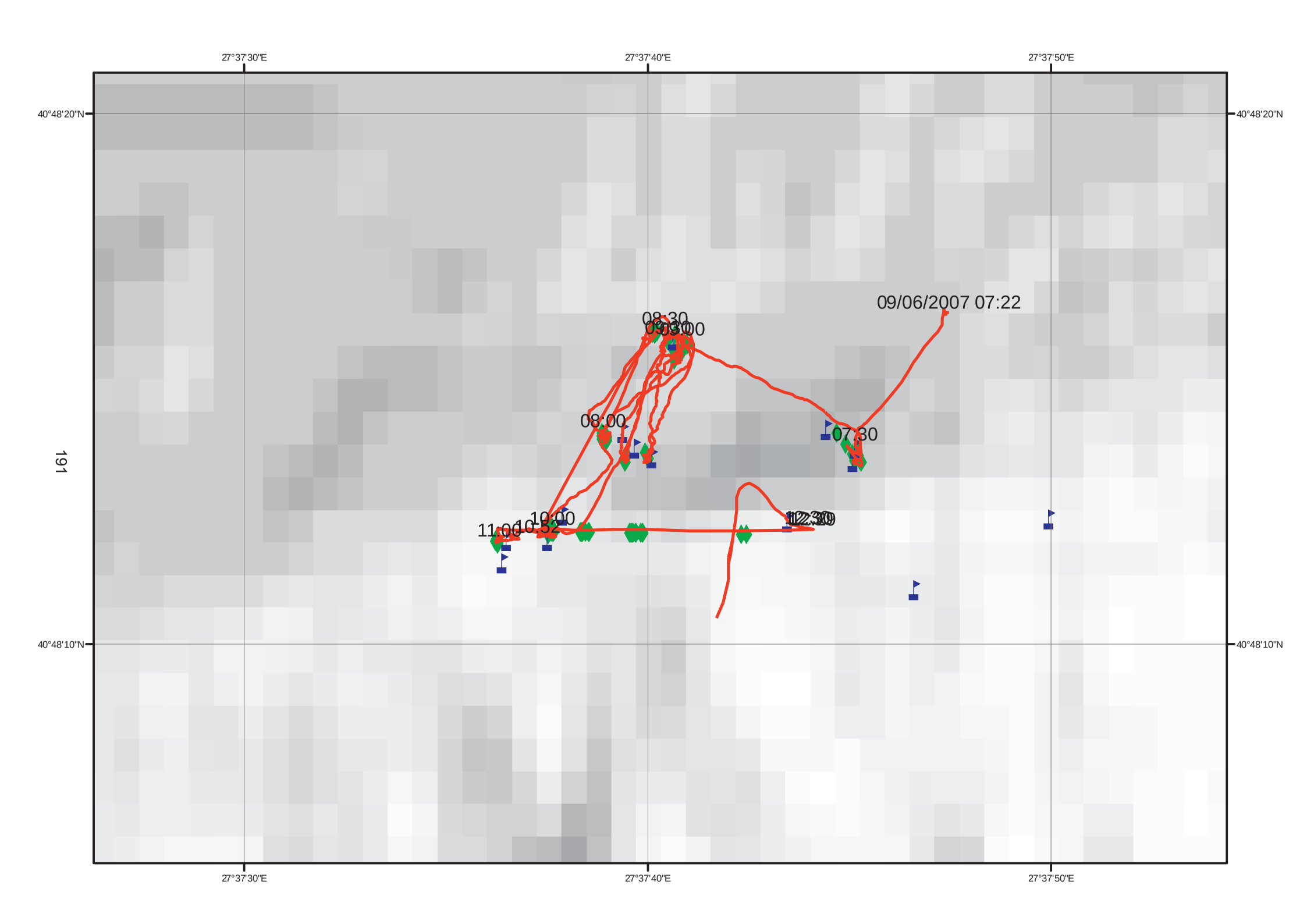
07:12:00
08:24:00
09:36:00
10:48:00
12:00:00
DEPTH
IMMERSION

# MARNAUT 2007
# Dive report

## LEG4
**09/06/2007-11/06/2007**


27°37'30"E
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27°37'50"E
40°48'20"N
40°48'10"N
191
09/06/2007 07:22
08:30
08:00
07:30
10:00
11:00
10:32

# MARNAUT
# DIVE 1669
# Western High

**Date** : 10/06/2007
**Immersion point** : N 40°49,038  E 27°46,822
**Maximum depth** : 690 m

**Scientist observer** : Nicolas Chevalier
**Nautile pilots** : Jean-Paul Justiniano and Franck Rosazza

**Objectives :**

Integrated sampling of sediments and crusts (microbiology, organic geochemistry, and biogeochemistry) in the new mat site and old mat site with push cores, blade cores and biological boxes

**Equipment** :

Nautile basket :
- 4 push cores
- Microcat CTD
- 2 biological boxes

Elevator :
- 4 push cores
- 2 blade cores

**Dive report :**

**DVD 1**

07:36 We go in direction of new mat site
08:00 We observe, on the way, carbonate crusts with black and white patches
08:16 We observe a small white patch : photographs
08:24 We arrive on new mat site : photographs
08:46 PC4 sampling of white bacterial mat
08:49 PC3 sampling of the same white bacterial mat : Presence of oil
08:54-08:57 : Microcat deployment between PC3 and PC4
08:58 Recovery of PC3
09:01 There is a probleme with the recovery of PC4. It does not close.
09:13 PC4 was closed but there is no sediment in the core
09:15 PC4 (closed) sampling near to the first sampling of PC4
09:25 PC2 sampling of white bacterial mat : probleme to close the push core
09:32 PC2 sampling of an other place but always in the white bacterial mat

**DVD 2**

09:33 PC2 sampling of an other place but always in the white bacterial mat
09:42 PC1 (reference) sampling with 2 meters of the new mat site in the bioturbide sediment
09:54 We go in direction of the lift
09:56 We observe the presence of carbonate crusts
10:01 We change the push cores (PC1 to PC4 with PC5 to PC8) and we take blade cores L7 and L8

10:21 End of the lift. We return of the new mat site
10:47 Blade core L7 sampling of white bacterial mat between the two carbonate crusts
10:52 We go in direction of the old mat site
10:58 We observe, on the way, the presence of white patch and carbonate crusts
10:52-11:42 We observe only bioturbide sediments. It was impossible to find the old mat site

**DVD 3**

11:42 We decide to return in the new mat site
11:56 Blade core L8 sampling of white bacterial mat between the big white patch and carbonate crusts
12:10 PC6 sampling of white bacterial mat
12:13 PC5 in the same place but probleme, we lost the tube in the sediment
12:23 PC7 and PC8 sampling of white bacterial mat near to the big white patch
12:35-12:40 Carbonate crusts sampling in one biological box
12:45-12:52 We observe bubbles gaz with the site of the blade core L8 sampling
12:53 We return to the lift
13:03 We deposit the blade cores

**13:05 END OF THE DIVE**

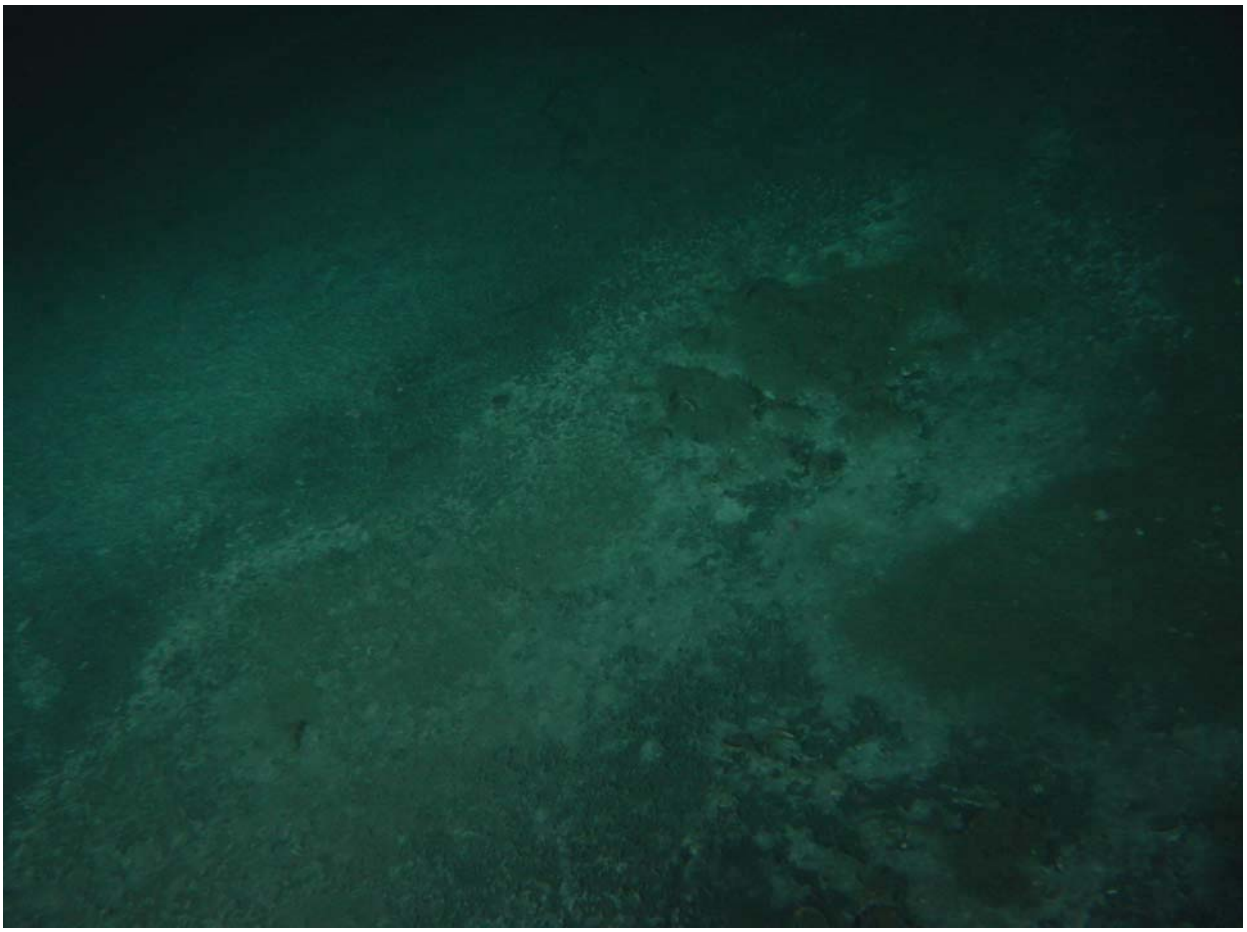
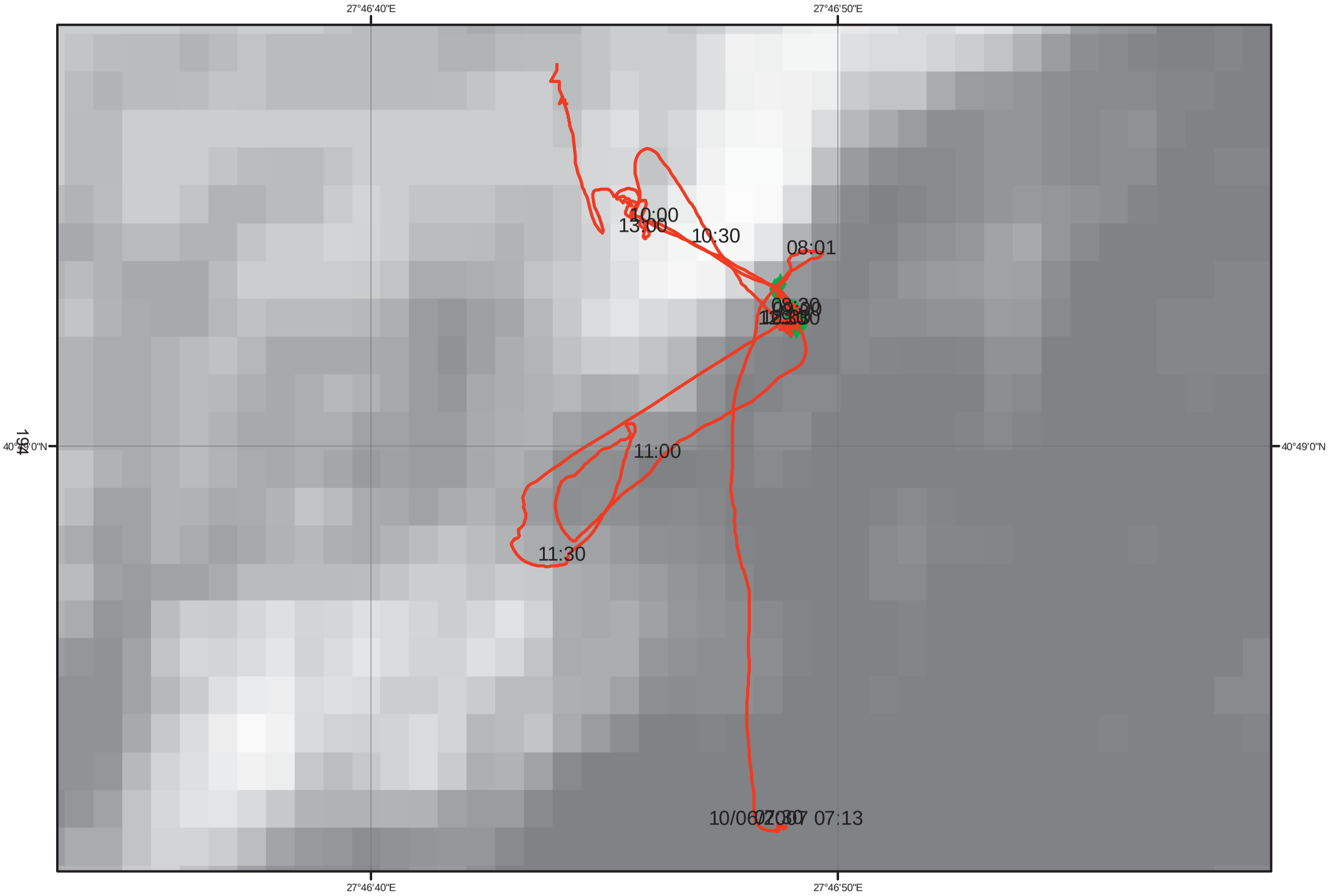


Fig. 1. The new mat site with white filamentous bacterial mat and carbonate crusts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11:00
11:30
07:13

**Marnaut Nautile Dive 1670 Report by Xavier Le Pichon**

This dive occurred on June 11 2007 in the Darica basin of the western Gulf of Izmit, west of the Hersek peninsula. The purpose of the dive was to test whether the geologically fresh fault trace mapped in earlier cruise by Luca Gasperini had any evidence of surface ruptures during the 1999 Kocaeli earthquake. In favor of the rupture, there were the interpretation of the SAR images that show a rupture of up to 1.5 m in the easternmost Cinarcik Basin and the evidence collected by Luca Gasperini for a freshly ruptured continuous fault. On the other hand, the field studies on the Hersek peninsula show only a few cracks with no significant displacement during the 1999 earthquake.

The dive presented some logistical difficulties: significant surface ship traffic, shallow depths (170-100m) and muddy water. We benefited from the detailed microtopography communicated by Luca Gasperini.

The dive was supposed to start in the large canyon that joins the Darica Basin to the Cinarcik Basin, 100 m to the north of
Point 1 : 40°43?772'N, 29°23.0414E, -191m
which is situated right on top of the E-W fault on the floor of the canyon. The idea was that if the canyon is active, erosion would have cleaned the fault and made it easily observable. Then we were supposed to follow the fault gully toward the east over a distance of several kilometers. Actually, we could only join successively
Point 2: 40°43.772'N, 29°23.041'E
Point 3: 40°43.733'N, 29°23.812'E
Point 4: 40°43.680'N, 29°24.157'E
We could not go east of this last point because of ship traffic and rose back to the surface 100m ENE of this point.

The water visibility was very poor and did not exceed 2.5 to 3 m. However a good part of the dive was made very close to the bottom (2m) thanks to the remarkable quality of the piloting and we could see clearly any feature on the bottom although the cameras that are higher have a much poorer resolution.

No evidence of any fresh scarp or erosion of any kind was observed. We did not observe either any scour marks or ripple marks, but only relatively soft mud. At one point in the canyon (7h04:50, -194m), we could test that the arm of the submersible penetrated without effort to at least 40 cm.

The only evidence of any venting activity was observed on the east flank of the canyon, west of point 2 along the 50m right lateral offset of the canyon by the fault. This consisted of first two small dark patches (10-15cm in diameter, 7h31:40, -168.5m) and then one slightly larger one (70 by 20 cm, 7h35:47, -168.5m).

The canyon appears to be non erosionally active at the present. The steepest slope observed on the canyon walls or on the walls of the fault gully were 10 to a maximum of 15° which is probably the angle of repose.

As stated above, the canyon is clearly offset right laterally about 50 m by the fault. We followed the E-W offset of the scarp on the east wall of the canyon between 7h40 and 7h44

but could not see any evidence of fresh faulting. The 10-15° sediment cover appeared completely undisturbed.

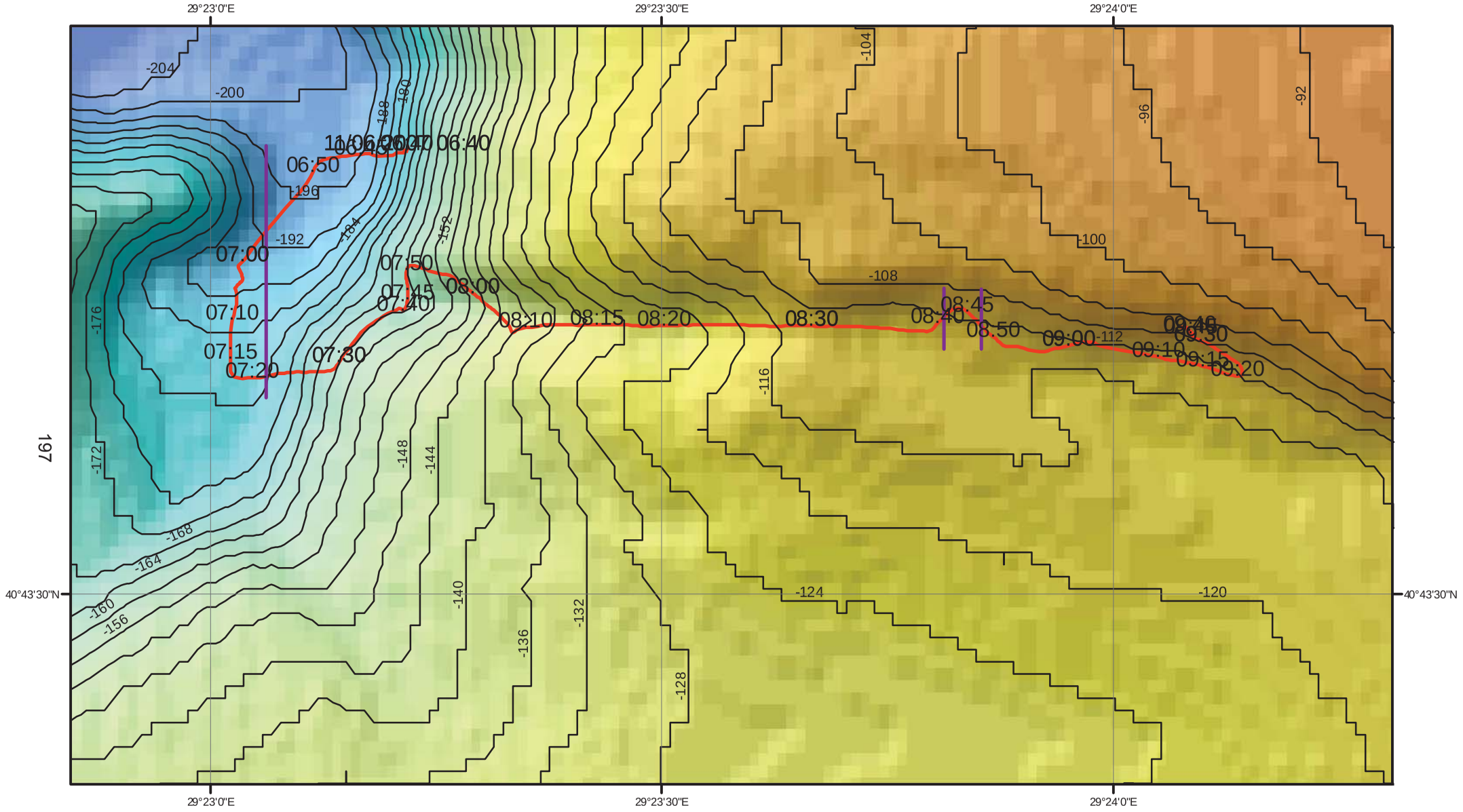
Within the canyon, the presence of the fault near 7h11 could only be noticed by an abrupt increase of slope below 190 m. Apparently, the gully related to the fault to the north has been filled by sediments. We could actually note a change in the nature of sediment cover that appeared to be somewhat coarser immediately north of the scarp.

As for the gully of the fault east of the canyon, it has a regular E-W 10-12° north slope of about 9 m but no outcrop or scarp of any kind and we did not see any other indication of venting activity.

We can conclude that the 1999 Kocaeli earthquake did not rupture the sea floor along the fault that we investigated and that was considered as the most probable location of such a rupture. It is thus probable that the surface rupture stops east of the Hersek peninsula although the rupture may have extended further west at depth. We can also conclude that the canyon in the part we investigated is not presently active as an erosional canyon.

Documents:
1/2000$^{th}$ map of dive area with navigation and depths from submersible along track.
Three N/S submersible bathymetric N/S profiles along fault.
A detailed narrative of the dive can be obtained.

Samples: none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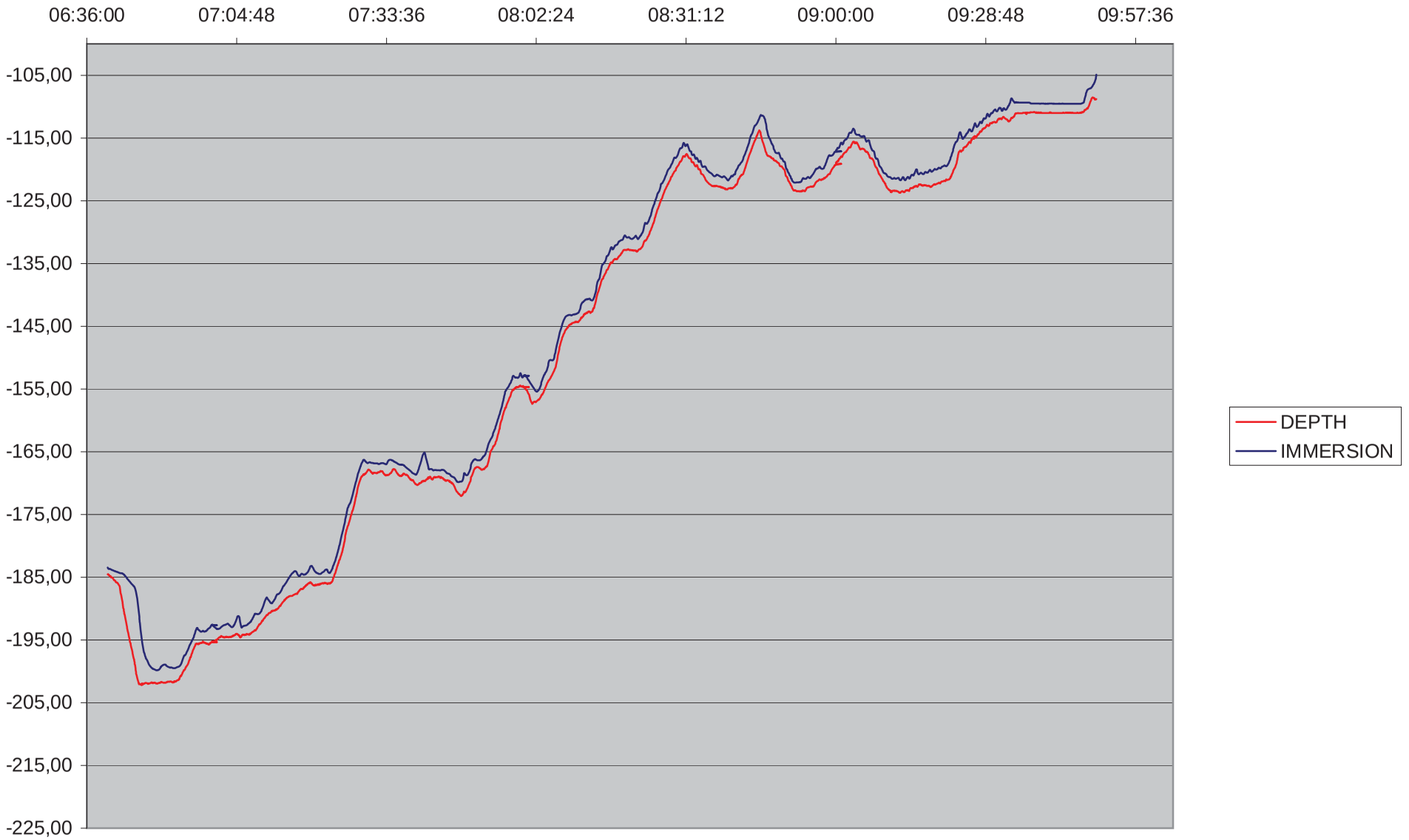
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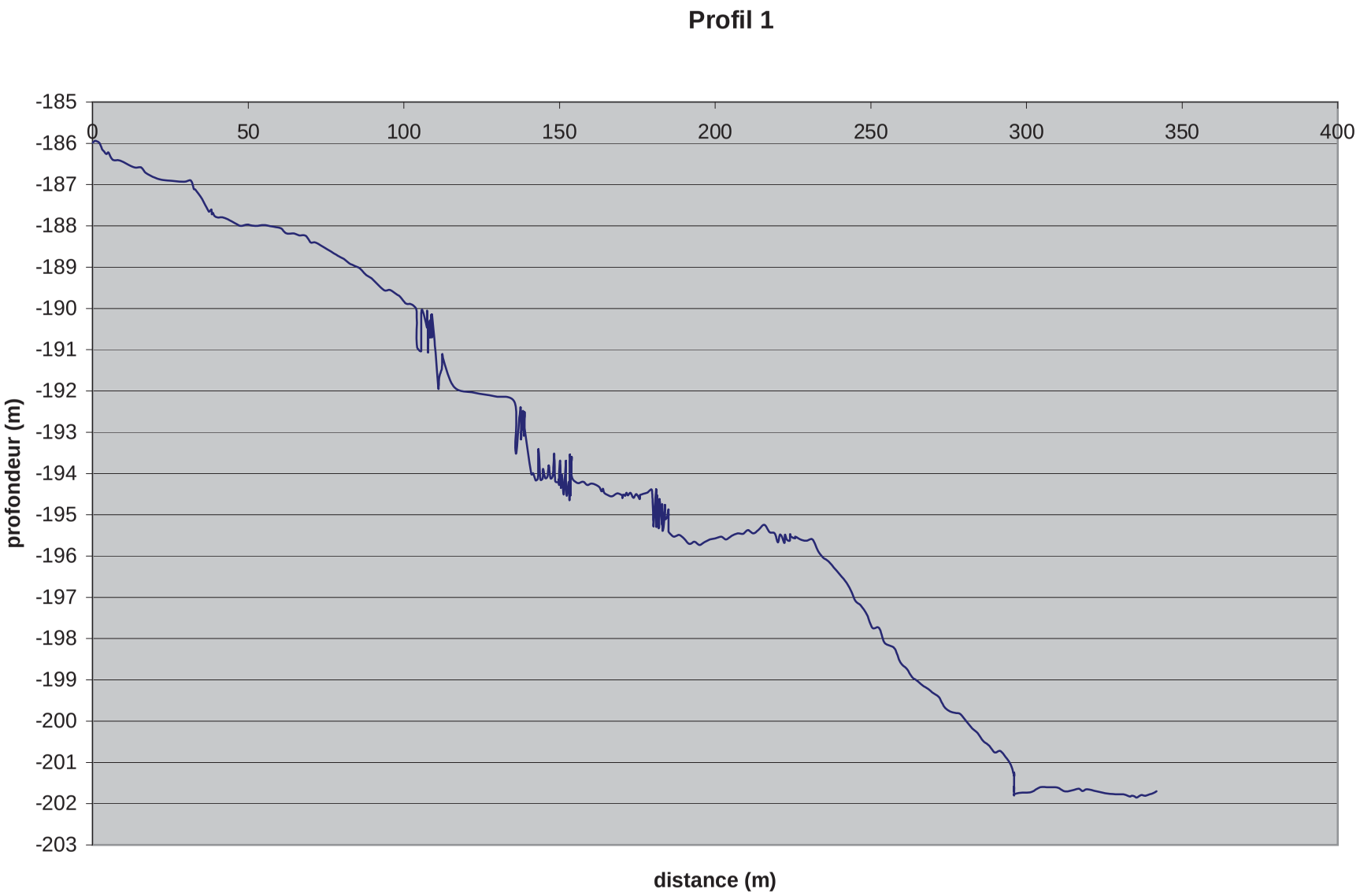
DEPTH
IMMERSION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-187
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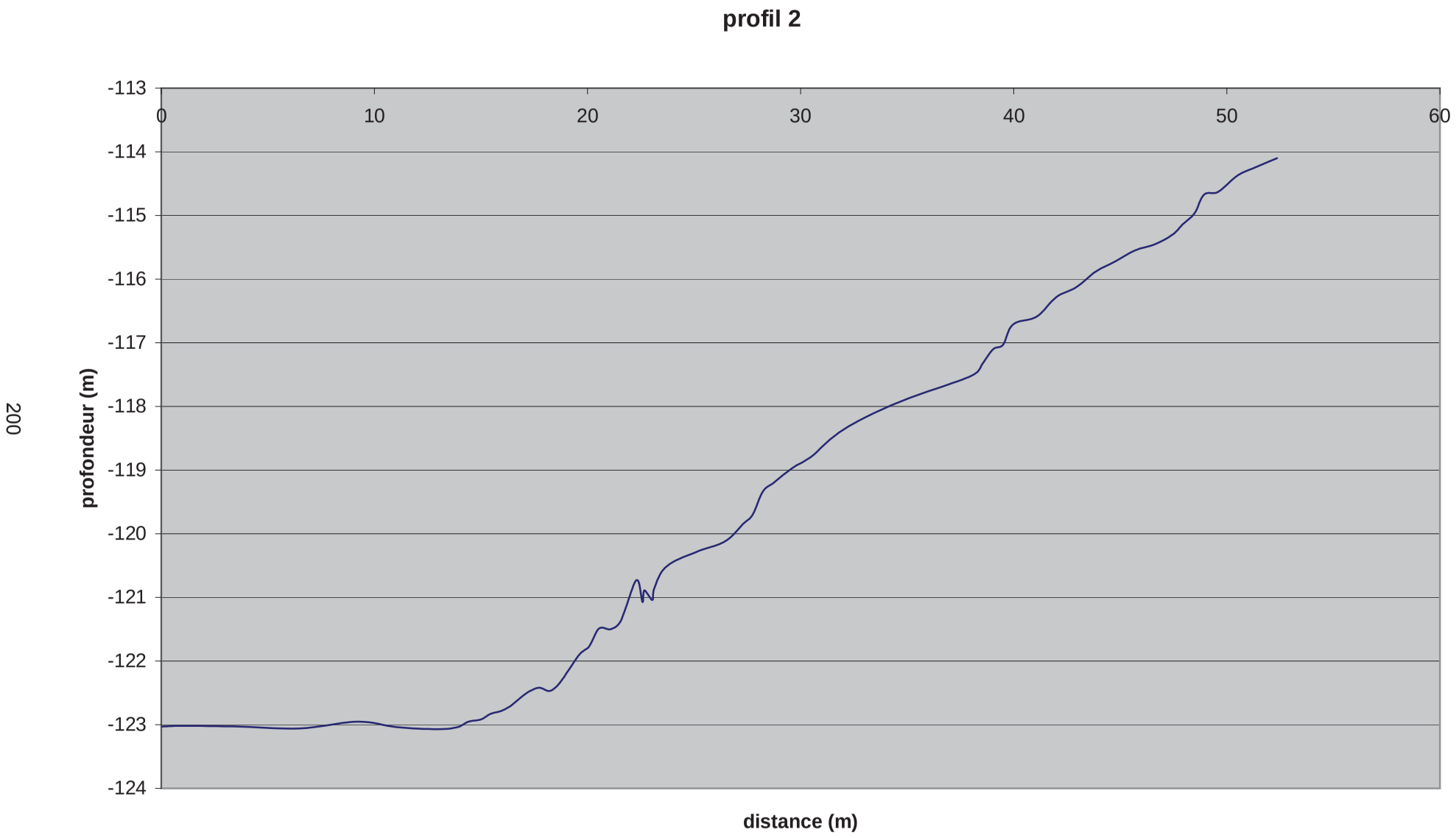
-196
-197
-198
-199
-200
-201
-202
-203
0
50
100
150
200
250
300
350
400
distance (m)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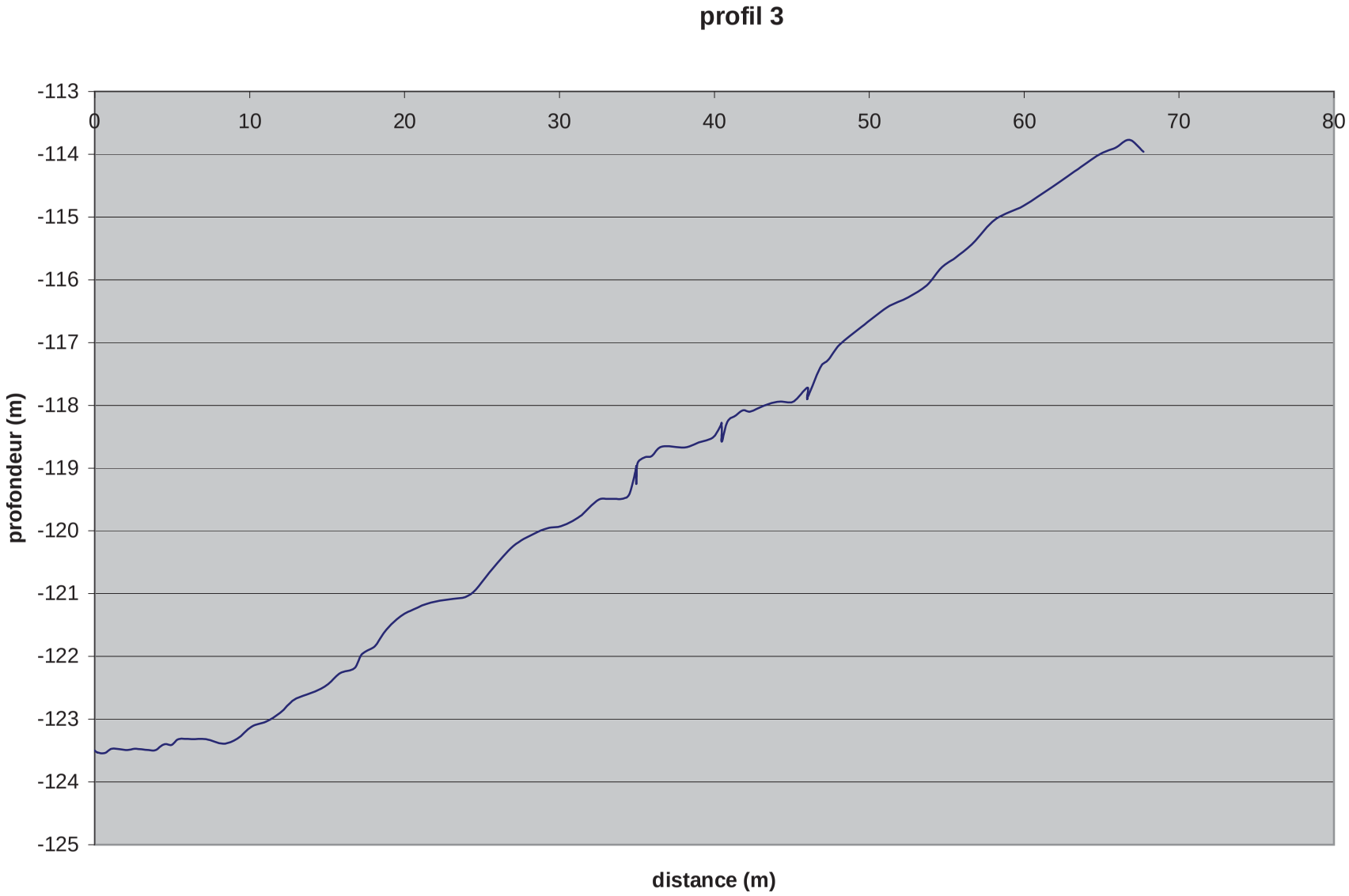
10
20
30
40
50
60
profondeur (m)
distance (m)

200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-114
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-119
-120
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-122
-123
-124
-125
profondeur (m)
0
10
20
30
40
50
60
70
80
distance (m)