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The Expedition SO261 of the Research Vessel SONNE to the Atacama Trench in the Pacific Ocean in 2018

Edited by

Frank Wenzhöfer

with contributions of the participants

HELMHOLTZ GEMEINSCHAFT

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Titel: Bergung des Hadal-Landers in der Nacht (Foto: Kazumasa Oguri, JAMSTEC, Japan)

Cover: Recovery of the hadal lander system during night (Photo: Kazumasa Oguri, JAMSTEC, Japan)

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RV SONNE SO261
Cruise Report / Fahrtbericht

San Antonio (Chile) 02.03.2018
Guayaquil (Ecuador) 02.04.2018

SO261 HADES

Frank Wenzhöfer

Max Planck Institute for Marine Microbiology
Alfred Wegener Institute Helmholtz Center
for Polar and Marine Research

2018

Contents

1. CRUISE SUMMARY / ZUSAMMENFASSUNG

F Wenzhöfer

1.1 Cruise summary

The scientific work during SO261 was related to study hadal ecosystems, which are one of the most extreme environments of the oceans, and was part of the ERC project HADES. The main goal was to get new understanding of biogeochemical processing and community structure of the Atacama hadal trench system which is underlying highly productive surface waters. The integrated multidisciplinary investigations were carried out at 6 sites along the trench axis from 24° to 20° S and will be compared to 3 abyssal reference sites next to the trench. The key focus of the investigations was on benthic biogeochemical and biological sampling and observations, including the composition of the benthic communities (all size classes) as well as ecosystem functions (e.g. remineralization rates). Additionally, observations of the physicochemical characteristics of the water column and biological sampling from the surface to hadal depth were performed. A large proportion of the work was based on autonomous hadal in situ technologies. Additional, traditional instruments (like MUC, gravity corer, CTD-Rosette and MOCNESS net) were used to collect samples from all water depth. The result will add to our database on microbial carbon mineralization in hadal settings and allow for comparison between hadal environments experiencing different regimes of organic carbon supply. Using this multidisciplinary, concerted and quantitative approach in comparing carbon and nutrient fluxes as well as the connection, composition and structure of hadal communities we will be able to get new knowledge on eutrophic trench ecosystems and deep sea ecosystems in general.

1.2 Zusammenfassung

Die wissenschaftlichen Arbeiten der Expedition SO261 tragen zur Untersuchung von hadalen Ökosystemen, einem der extremsten Lebensräume in unseren Ozeanen bei. Sie sind Teil des ERC Projekts HADES. Ziel ist es neue Erkenntnisse zu biogeochemischen Prozessen und Lebensgemeinschaften im Atacama Tiefseegraben zu erlangen, der in einem der produktivsten Ozeangebiete liegt. Die multidisziplinären Untersuchungen wurden an 6 Stationen am Meeresboden des Tiefseegrabens, entlang eines Transekts von 24° bis 20°S, durchgeführt und werden mit 3 benachbarten abyssalen Referenzstationen verglichen. Der Fokus der Forschungen lag bei der Zusammensetzung benthischer Lebensgemeinschaften aller Größenklassen von Organismen sowie auf ihren Ökosystemfunktionen (z.B. biogeochemsicher Prozesse und Stoffumsatz). Zusätzlich wurde die gesamte Wassersäule biologisch beprobt und ihre physikochemischen Merkmale charakterisiert. Ein großer Teil der Arbeiten wurde mit autonomen hadalen Messsystemen durchgeführt. Zusätzlich wurden traditionelle Technologien (wie MUC, Schwerelot, CTD/Rosette, MOCNESS Netz) eingesetzt, um in allen Wassertiefen Proben zu erhalten. Die Ergebnisse werden die Datenbasis für Mineralisationsprozesse in hadalen Ökosystem erweitern und den Vergleich mit anderen Tiefseegräben in unterschiedlichen biogeochemischen Provinzen ermöglichen. Die multidisziplinären Untersuchungen helfen die biogeochemischen Prozesse sowie die Zusammensetzung der Lebensgemeinschaften in hadalen Tiefseegräben sowie Tiefseeökosystemen im Allgemeinen besser zu verstehen.

2. PARTICIPANTS / FAHRTTEILNEHMER

2.1 Principal Investigator / Projektleiter

Frank Wenzhöfer	Fahrtleiter / Chief Scientist	MPI/AWI

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Figueroa Yanara	Observer	

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Maik Steep	Steward / Steward
Sven Kröger	Steward / Steward
Bernardo Carolino	Steward / Steward

3. NARRATIVE OF THE CRUISE / ABLAUF DER FORSCHUNGSFAHRT

F Wenzhöfer

The cruise SO261 started on the 2nd of March 2018 in San Antonio (Chile) with the goal to investigate the Atacama Trench, located off the coast of Chile (Fig. 3.1). It is one of the deepest ocean trenches in the world and has a maximum depth of 8065m.

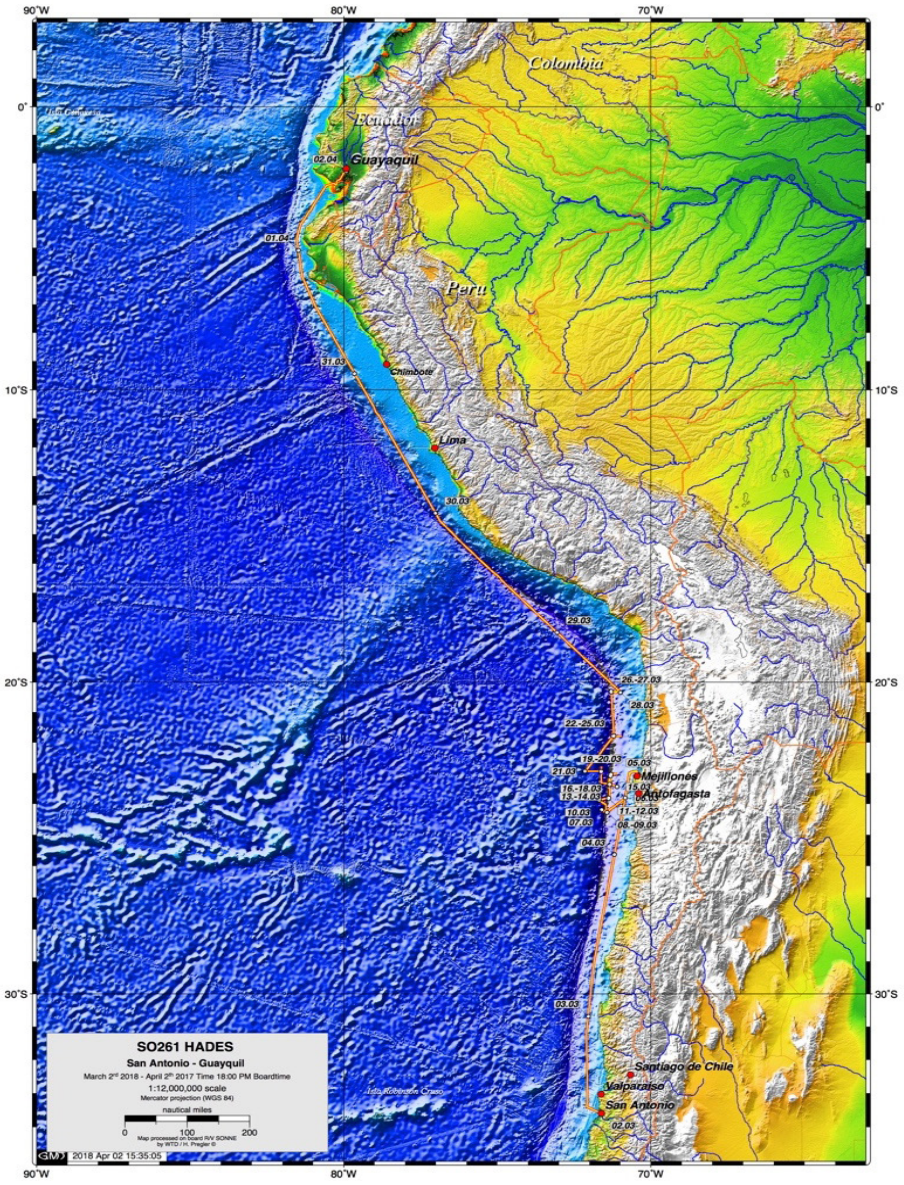

Figure 3.1 *Cruise track by RV SONNE during SO261*

An international team of 40 scientist from 17 different nations (Fig. 3.2) was on board to study the biogeochemical processes and biology from the water surface down to the seafloor of the trench system.

In the evening of March 4 we reached our first site at 2550m water depth, which we used as reference to compare to the later deep trench sites. We started the research program with the deployment of a bottom lander system ('Reiver') capable to take images of the seafloor. We used this information to get a fist impression of the seafloor and to decide if our other instruments can be deployed there. Images from this 2500-site showed a nice plain seafloor ideal to perform our further measurements. Our station work at the shallow site 1 was completed with sediment sampling and in situ flux measurements. We then moved to the first trench site (site 6; S 24° 15.96' W 71° 25.38'at 7830m water depth) at the southern end of our working area (Fig.3.1). At March 6 we started the sampling program with a camera-lander (Reiver) deployment to get some pictures of the seabed for evaluating lander configurations. During the lander deployment we collected water samples down to 6000m at intervals of 1000m for various analyses of geochemical and biological parameter. During the night, an OFOBS (Ocean Floor Observation and Bathymetry System) transect of the seaward trench slope was performed to get some impressions of the change in seafloor structure, habitats and fauna with depth. We observed several cliffs and areas of bare rock seafloor but also basins with sediment cover and abundant benthic organisms. The most abundant animal types included various holothurians, some of which were very colourful and also surprisingly good at rock climbing, with several spotted on narrow ledges on the sides of steep cliffs. During a second transect further north similar geological structures were observed, but also large fields of broken rock boulders were flown over, and sediments which were quite brown in appearance, perhaps indicting a different composition to those observed during the first dive. Our trench program was then continued with the deployment of several lander systems: Nano-Lander, Profiler-Lander and 2 Camera- /fish trap-Lander. During the time the lander systems performed their measurements at the trench bottom an intensive sediment sampling program was accomplished followed by water sampling from hadal depth (>6000m) using the Hadal-Rosette system, which is winched down to the trench bottom. The mounted Niskin bottles are triggered autonomously by a pressure sensor at defined water depth. The MOCNESS net was deployed during our transit from site 6 to site 5 (S 23° 49.02' W 71° 22.32'), our second trench site at 7890m water depth (Fig. 3.1). It collected a depth-integrated zooplankton and fish sample on its way down to a maximum depth of 4200m, but it failed to open and close on its way up. After arriving at site 5 on March 10 our general set up of instrument operations was performed: Reiver-Camera-Lander, CTD/Rosette water sampling 6000m, Nano-Lander, Profiler-Lander, Sediment-Lander, Camera/fish trap-Lander 1 & 2, Hadal-Rosette, MUC and gravity corer. We finished our Lander program at our second site at 7890m with the successful recovery of all our lander systems in the morning of Monday March 12. Some of these lander systems are used to perform measurements directly at the seafloor. They are part of our subproject to quantify and characterize the diagenesis along the trench axis versus the abyssal plain. Recent investigations have shown that hadal trenches act as hotspots for deposition and turnover of organic material and therefore are more important for regional element cycling than previously anticipated. The activity is presumably driven by specialized microbial communities that are adapted to the extreme hydrostatic pressures in the trench – communities that are unknown to science. The Atacama Trench is underlying one of the most productive water columns in the world and is situated in a very seismic active region - we thus hypothesize that this trench in particular, due to elevated delivery of food, will host enhanced diagenetic activity. Our next targeted site was Richards Deep (site 4), the deepest point in the Atacama Trench with a water depth of 8065m. Here we performed an intensive water column and seafloor program for almost three days. The last gears recovered were the two camera-baited-trap lander systems to study hadal fishes. During our transit from Richards Deep to our next trench station (site 3 at 7994m) further north we used the MOCNESS net

to collect zooplankton. In the morning of March 16, the 14-hour deployment brought huge amounts of samples to the surface. All nets worked perfectly and the samples will be used to discriminate the zooplankton communities collected in different water depth (5000-4000m, 4000-3000m, 3000-2000m, 2000-1000m, 1000-0m). On March 19 we started our usual station program at another reference site (4000m water depth) with the Reiver camera system to get pictures of the seafloor, subsequently the other instruments followed. After retrieving all instruments back on deck and checking the first data a clear difference between hadal and abyssal sites could be observed. This was most obvious when looking at the in situ oxygen microprofiles. Here an oxygen penetration depth of > 20 cm could be observed at the 4000m site which is 4-times deeper than at the hadal sites. So, this is the first evidence that sediments at the bottom of the Atacama Trench show elevated rates of organic matter mineralization. On our expedition along the Atacama Trench we continued the work with the fifth hadal station further north at 21° 46.86' S with our entire sampling program. Our sampling activities were finished with the third MOCCNESS net haul, sampling zooplankton at different water depth. We continued our station work with another hadal site further north to finish our transect of sampling sites along the trench axis. On Tuesday 26 we reached our northern most site. During the next two days we performed our water column and sediment sampling at this site and deployed our different lander system for the last time at hadal depth. In total we have investigated the Atacama-Trench axis along a ca 450 km long transect (Fig. 3.1). This allows us to assess the biological activity in the hadal Atacama Trench sediment and to evaluate local variability in the benthic mineralization activity and microbial processes in one of the deepest trenches on Earth. On March 28 we completed our work at the northern reference site at 4050m water depth with the recovery of our lander systems. In total we have managed to sample, besides the hadal sites, at three reference sites; two in the south of our transect and one in the north (Fig. 3.1). In the evening of March 28 we left our working area towards Guayaquil. During the four days of transit we were able to finalize all onboard analyses. In the morning of April 2 we entered the port in Guayaquil. Overall So261 was a very successful expedition bringing 40 scientists (Fig. 3.2) from 17 nations together to work concerted on the diversity and functioning of the Atacama Trench ecosystems. Using this multidisciplinary approach in comparing carbon and nutrient fluxes, the connection, composition and structure of communities from the water column to the seafloor using novel methods and technologies, we will provide novel insight on the Atacama trench and hadal ecosystems in general.

Figure 3.2 *Scientific party of SO261*

4. AIMS OF THE CRUISE / ZIELSETZUNG DER FORSCHUNGSFAHRT

RN Glud, F Wenzhöfer

Hadal trenches are some of the most remote, extreme, and scantly explored habitats on Earth – yet recent investigations have shown that trenched are hotspots for deposition and mineralization of organic material. The intensified biological activity in the trenches is believed to mainly be mediated by microbial communities adapted to the extreme hydrostatic pressure, but these largely remain unknown to science. In 2016 an advanced ERC grant – HADES-ERC – was awarded to among other things explore three large hadal trench systems in the Pacific; The Kermadec, the Japan and the Atacama trenches by the use of novel in situ instrumentation. These trenches were selected as they are underlying water columns of very different productivity - from the oligotrophic Kermadec trench to the eutrophic Atacama trench. Voyage So261 is the second large expedition in the HADES-ERC project and aimed to explore biogeochemistry, microbiology and biology of the Atacama trench. The multidisciplinary but integrated team of 40 scientist and technicians include biogeochemist, geologists, biologist, molecular biologists and oceanographers covering research topics from virology to fish ecology. The overall aim of the expedition is to understand material transport, particle deposition, benthic and pelagic biogeochemistry and ecology of the trench system but also to identify key organisms responsible for the processing of material in the trench. The insight will expand our present knowledge on deep sea biogeochemical functions, by including one of the most extreme and potentially most active hadal environments in our quantitative and conceptual understanding of the global ocean.

Specific questions addressed during this cruise were:

- What are the sedimentary processes sustaining the hadal community in the Atacama Trench?
- How do abundance, diversity and community structure of microorganisms, meio- and macrofauna organisms in the Atacama Trench differ from those in less productive trenches and nearby abyssal and shelf sites?
- What are the general biogeochemical characteristics of the surface and deep sediment, bottom water and water column in the euthrophic Atacama Trench?
- Which mineralization pathways are responsible for the organic matter break down in the eutrophic Atacama Trench?
- How efficient are microbial communities operating at extreme hydrostatic pressures in mineralizing organic material as compared to their shallower counterparts? And to what extent do specialized unknown extremophile microbial communities mediate these processes?

5. AGENDA OF THE CRUISE / PROGRAMM DER FORSCHUNGSFAHRT

F Wenzhöfer, RN Glud

The major goal of this expedition was to get a better understanding in biogeochemical processes and community structure of the Atacama trench system in highly productive surface waters. Detailed understanding of benthic biogeochemistry requires insight to the processes conveying sediment deposition, the nature of settling material, and the aerobic and anaerobic microbial-driven mineralization processes in the seafloor, all of which was explored during the cruise.

During the expedition, we performed lander deployments together with sediment and water sampling in the Atacama Trench system as well as adjacent abyssal and bathyal sites off Chile (Fig. 3.1 and 6.1). The sites were located within an area between 20° – 25° S and 70° - 73°W, and comprise a depth zone of 2500 – 8065m. The aim was to investigate several hadal stations along the Atacama Trench axis and 2 depth transects with stations at ca 6000 and 3000m. Originally it was also planned to visit 3 stations at 1000m at the continental shelf off Chile. However, it was not possible to get working permission to work in Chilean waters. For the visited sites the major aim was to address ecosystem functions such as benthic respiration, remineralization and nutrient transport, bacterial productivity, microbial as well as meio- and macrofauna biodiversity in the eutrophic Atacama Trench and to compare them with data from adjacent abyssal and bathyal sites.

We performed in situ measurements using a variety of autonomous lander systems (Fig. 5.1): Ultra-deep lander for in situ microprofiling and injection were used to investigate benthic fluxes and mineralization rates, a Nano-lander to study the bottom water microorganisms and camera lander systems to survey the faunal distribution. Preliminary inspections of photo and video footage from the stationary and towed camera systems provided a first characterization of the benthic fauna community and seafloor characteristics and were used to identify sites for further studies. The main focus of the cruise was to perform in situ studies on benthic process rates, including benthic fluxes and pore water concentration profiles of O_2, NO_3 and H_2S. Multicorer and gravity corer samples were used to investigate the biodiversity of all taxonomic size classes of the benthic communities. Sediment samples were analyzed for their porosity, vertical gradients of nutrients, C_{org} contents, C/N ratios, biomarker, phytodetrital pigments, carbonates, and other geochemical parameters, to characterize the geochemical environment of the upper sediment layers. Surface sediments were also examined under sedimentological criteria, in order to assess delivery areas of the sediments. Other sediment samples retrieved by the MUC will be used to analyze virus abundance, bacterial cell numbers, RNA, DNA, all to characterize the benthic communities. At selected sites we used the gravity core (GC) to retrieve longer sediment cores for pore water chemistry and deep biosphere community structure analyzes. A major component of our work was the evaluation of spatial distribution patterns in all size classes of benthic organisms including macro- and megafauna using video- and photo-footage. Towed and stationary camera systems were used for detailed characterizations of the seafloor habitat and quantitative fauna surveys. Combined CTD measurements and water sampling were carried out to characterize the hydrographic conditions and community structure in the study area. We deployed a deep water MOCNESS net (6500m maximum depth), equipped

with an Underwater Vision Profiler (UVP), sensors for conductivity, temperature, fluorescence, and 333µm nets for stratified samples. The UVP device will provide profiles of particle size distribution in the entire water column; while net samples will be split in fractions to examine live animals, animals for DNA analysis, and fixed samples for further taxonomic analysis.

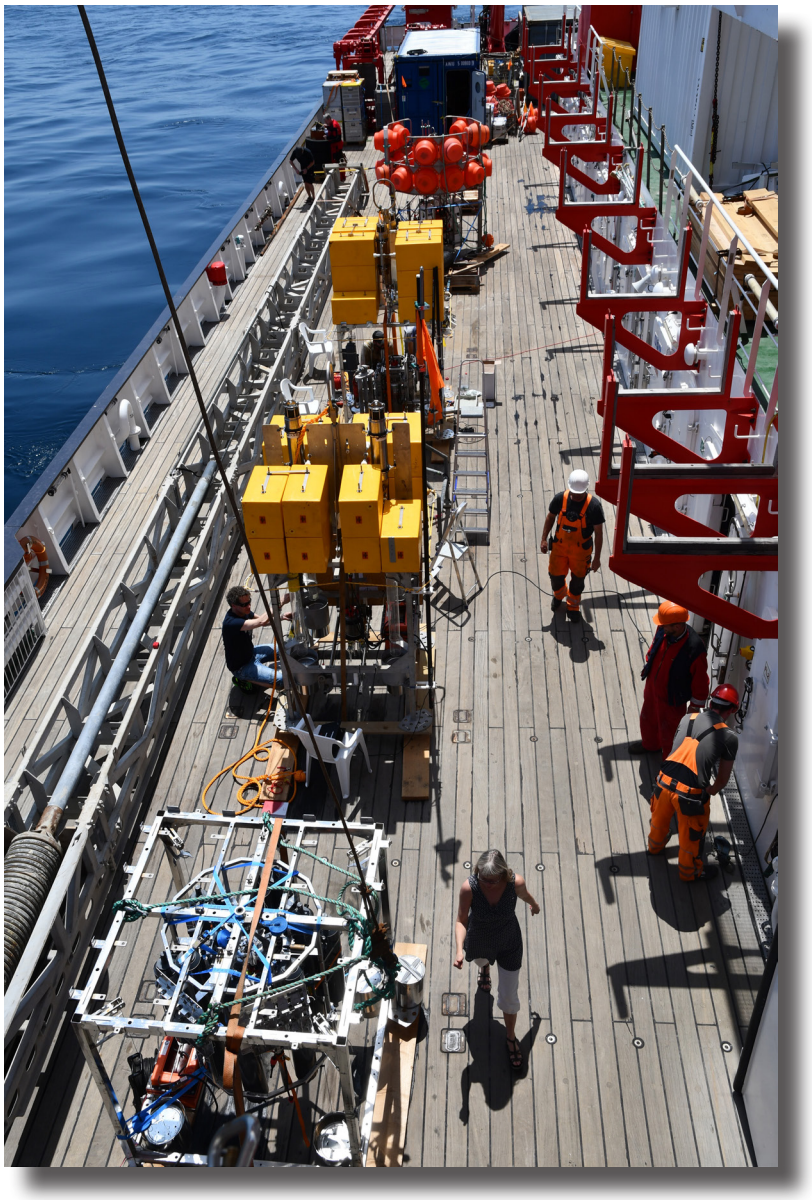

Figure 5.1 *Different lander systems on the deck of RV SONNE for investigating the Atacama trench system (Foto: F. Wenzhöfer)*

6. SETTINGS OF THE WORKING AREA / BESCHREIBUNG DES ARBEITSGEBIETES

F Wenzhöfer, RN Glud

The Atacama Trench (the southern part of the Peru–Chile Trench), is one of the 27 globally existing hadal trenches, located in the eastern Pacific Ocean, about 160 kilometers off the coast of Chile. It is approx. 3700 kilometers long (entire Peru-Chile Trench 5900km) with a mean width of 100 kilometers (covering an area of ca 590,000 square kilometers). The trench delineates the boundary between the subducting Nazca Plate and the overriding South American Plate. The Atacama Trench is underlying the most productive ocean in the world and therefore it represents an extreme end-member with massive deposition of material degraded at highly elevated pressure (Jamieson 2015; Danovaro et al 2003).

We investigated 6 hadal sites and 3 abyssal sites (reference sites) along a 444km long transect stretching from 23° 49.0' to 20° 19.1' S (Fig. 6.1 and 6.2; Tab. 6.1). Site 1 at 2560m water depth severed as test sites for the in situ instruments.

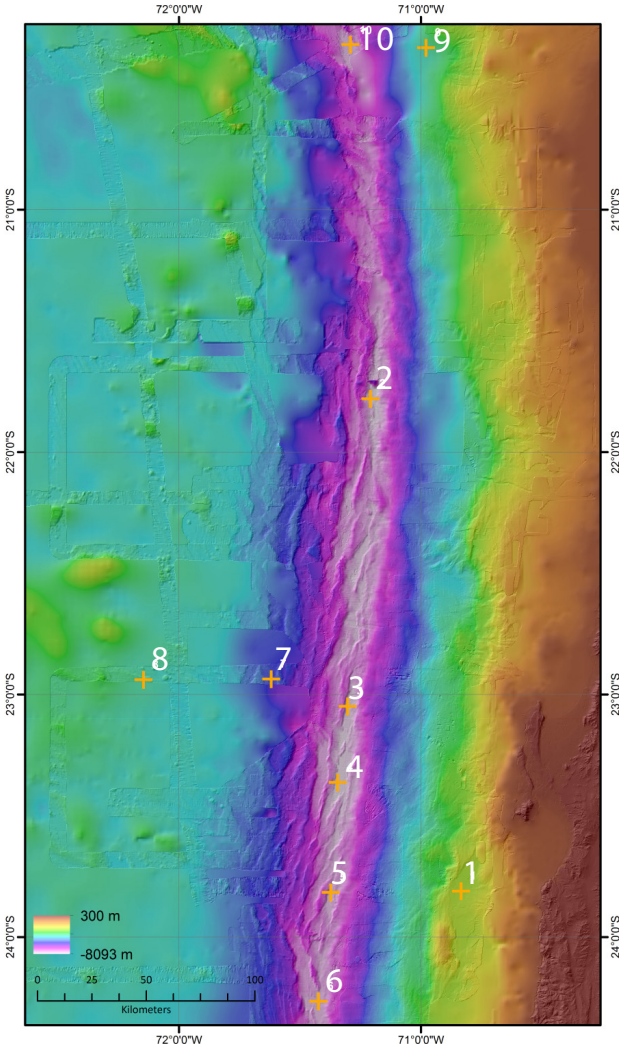

Figure 6.1 *Station map of the investigated sites*

Table 6.1 *Position and water depths of all sites*

Site	Lat	Long	Water depth (m)
1	23° 48.72' S	70° 50.04' W	2560
2	21° 46.86' S	71° 12.48' W	7994
3	23° 02.94' S	71° 18.12' W	7915
4	23° 21.78' S	71° 20.60' W	8085
5	23° 49.02' S	71° 22.32' W	7770
6	24° 15.96' S	71° 25.38' W	7720
7	22° 56.22' S	71° 37.08' W	5500
8	22° 56.40' S	72° 08.76' W	4000
9	20° 19.97' S	70° 58.70' W	4050
10	20° 19.14' S	71° 17.46' W	7770

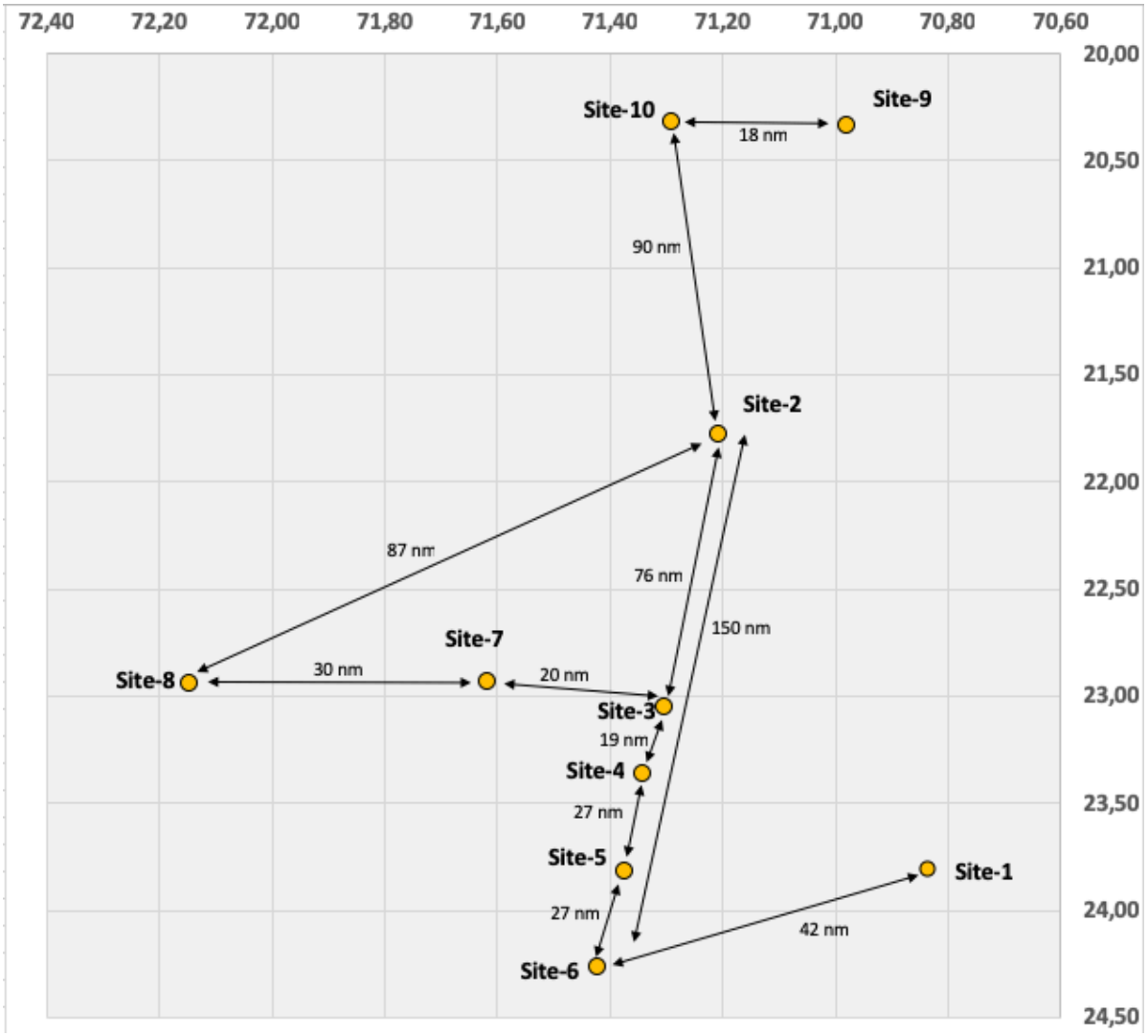

Figure 6.2 *Relative distance of the sites investigated*

7. WORK DETAILS AND FIRST RESULTS / BESCHREIBUNG DER ARBEITEN IM DETAIL EINSCHLIESSLICH ERSTER ERGEBNISSE

7.1 CTD-O/Rosette System

W Schneider

Gear description

The onboard CTD (Conductivity-Temperature-Depth) of RV *Sonne* is a Sea-Bird Electronics Inc. SBE 911plus system (Fig. 7.1.1). The unit is equipped with duplicate sensors for temperature (SBE3plus) and conductivity (SBE4C), a pressure sensor (Digiquartz 410K-134) and is connected to a SBE 32 carousel water sampler with 24 12-liter Niskin bottles. Additionally, an altimeter (Benthos PSA-916), Fluorescence/Turbidity sensor (WETLabs FLNTU), a PAR sensor (QCP2300-HP) and two dissolved oxygen sensors (SBE43) are mounted. The computation of oxygen concentration requires temperature, salinity and pressure which are measured by the CTD system.

Figure 7.1.1 *CTD deployment (Foto: L. Hehemann)*

Sampling/subsampling

During SO261 a total of 17 CTD casts (Tab. 7.1.1) were performed to collect water samples to monitor the distribution of the Oxygen-Minimum Zone (OMZ) in the investigation area.

Table 7.1.1 *List of CTD casts*

Site/St.	#Date (2018)	Filename	Depth/CTD	Comments
Site 1	S: 23° 48.72’	W: 70° 50.04‘		
01/002	05-03	SO261_01_002	2544/2500 m	Down only
01/007	06-03	SO261_01_007	2548/2400 m	
01/011	06-03	SO261_01_011	2567/1000 m	
Site 6	S: 24° 15.96’	W: 71° 25.38’		
06/013	06-03	SO261_06_013	7834/6000 m	
06/024	09-03	SO261_06_024	7835/6000 m	
Site 5	S: 23° 49.02’	W: 71° 22.32’		
05/028	10-03	SO261_05_028	7886/6000 m	
Site 4	S: 23° 21.78’	W: 71° 20.60’		
04/039	12-03	SO261_04_039	8062/6000 m	
04/041	13-03	SO261_04_041	8064/6000 m	
04/054	15-03	SO261_04_054	8065/6000 m	
Site 3	S: 23° 02.94’	W: 71° 18.12’		
03/057	16-03	SO261_03_057	7994/6000 m	
Site 7	S: 22° 56.22’	W: 71° 37.08’		
07/074	19-03	SO261_07_074	5539/5400 m	
Site 8	S: 22° 56.40’	W: 72° 08.76’		
08/080	21-03	SO261_08_080	4115/4000 m	
Site 2	S: 21° 46.86’	W: 71° 12.48’		
02/082	22-03	SO261_02_082	7848/6000 m	
02/089	22-03	SO261_02_089	7909/6000 m	
02/095	24-03	SO261_02_095	7883/6000 m	
Site 10	S: 20° 19.14’	W: 71° 17.46’		
10/100	26-03	SO261_10_100	7742/6000 m	
Site 9	S: 20° 19.97’	W: 70° 58.70’		
09/110	28-03	SO261_09_110	4020/3997 m	

7.2 Multi Corer (MUC)

M Zabel

Gear description

The coring device suited best for the sampling of undisturbed surface sediments including overlying bottom water is the multicorer (MUC; Fig. 7.2.1). The MUC used during the cruise was equipped with twelve large plastic tubes, each of 60 cm length and 9, 5 cm in diameter, respectively.

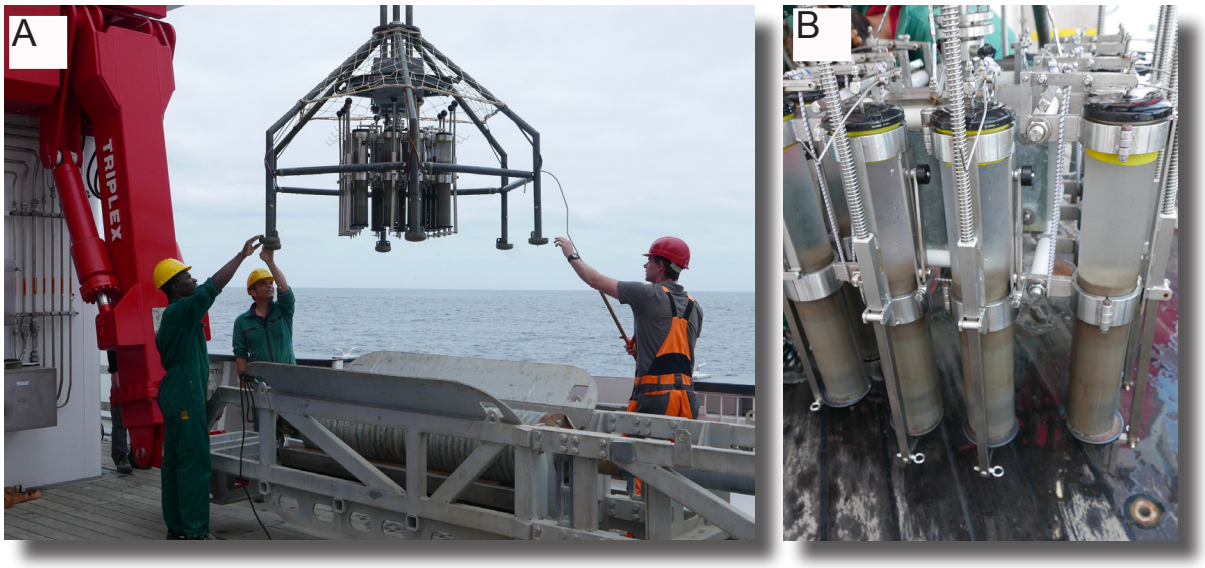

Figure 7.2.1 *Recovery of the MUC (A) and sediment cores from 8063m water depth (Fotos: M. Schlösser)*

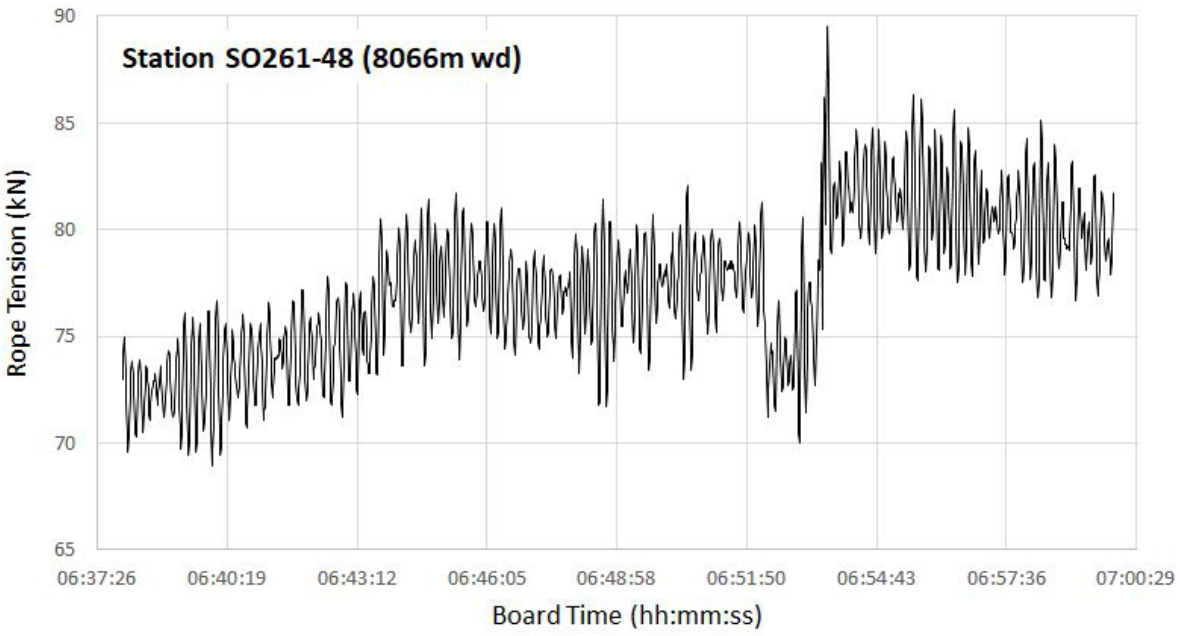

Figure 7.2.2 *Rope tension during first MUC deployment at Site 4 (Station SO261-48; 8066 m wd) when the device arrived at the sea floor.*

Sampling/subsampling

On each station the MUC was deployed twice to fulfill all scientific inquiries (*cf*. Tab. 7.9.1 and Station list). In total the MUC was deployed 18 times with great success. Depending on the sediment composition, the recovery of the multicorer cores varied between 25 and 48 cm. We finished the station work with 214 cores with surface sediments. Only two single tubes were lost due to a broken flap. Depending on the visual sediment characteristics (accessible through Reiver deployments; *cf*. section 7.5.5), the hive and veer velocities varied between 0,5–1,0 m/s. For details of subsampling, please see research specific sections from 7.9.

7.3 Gravity Corer (GC)

M Zabel

Gear description

During this cruise we used a classical gravity corer (GC; Fig. 7.3.1), which consists of an upper weight of 1,5 t, steel pipes of 6 – 12 m length with internal, exchangeable plastic tubes and a core catcher. The hive and veer velocities varied between 1,0–1,2 m/s. In total, the device was deployed 9 times. In the center of the trench (Sites 2-6 and 8) we could recover 7 sediment cores with lengths of 3,4–6,3 m. At the abyssal plain sites (7) a sediment core of 8,6 m lengths could be recovered. The total length of all sediment cores recovered during expedition SO261 is 38,5 m.

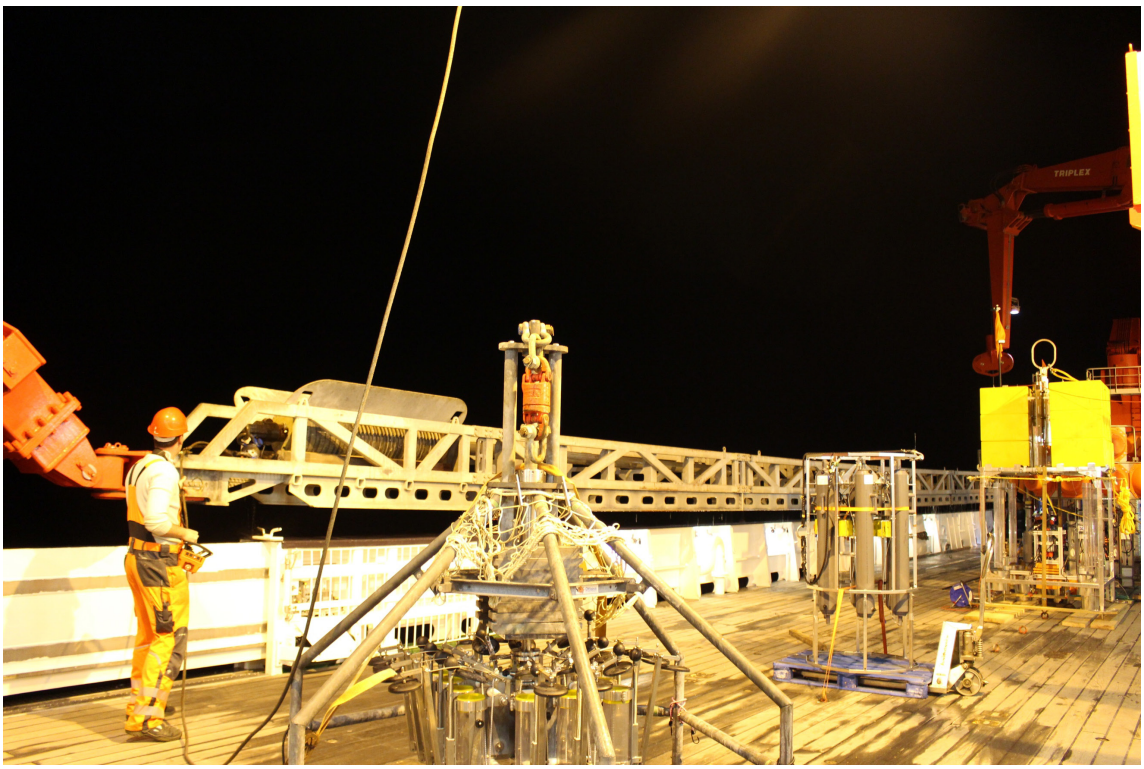

Figure 7.3.1 *Recovery of the Gravity Corer (GC) (Foto: N. Ramirez)*

Sampling/subsampling

Once on deck, the plastic liners were pulled out of the steel pipe, sliced into 1 m segments and transported to a cool lab until they were processed (cf. section 7.9). Already on deck, syringe (headspace) samples were taken from the bottom of each core and from the lower ends of all segments for analyses of methane at MARUM.

7.4 Hadal-Rosette

M Larsen, RN Glud, C Schauberger

The hadal rosette consist of 6 x12L Niskin-bottles and 4-6 x 7L Niskin-bottles mounted in an outer frame (Fig 7.4.1). The bottles are released pairwise when the instrument reach a pre-programmed hydrostatic pressure while being lowered by the oceanographic winch. The frame was loaded with additional ballast weights (ie ~ 400Kg) to enable fast lowering of the instrument by the winch system. Bottles can either be released on the descend or the ascend. At this cruise the targeted depth ranged from 6500m to 7700m water depth. Samples were shared and used for a wide range of analysis by different cruise participants (see sections below and the appendix on tabulated samples).

The instrument also hosted two sets of 50ml syringes – each set with five individual syringes. As for the bottles the syringes could be released and sample water once a given pre-programmed hydrostatic pressure was reached. Some syringes were pre-spiked with fixatives and the samples were used to assess the importance of in situ fixation versus on-board fixation when quantifying cell abundance and Virus Like Particle (VLP) abundance in water samples (see 7.13).

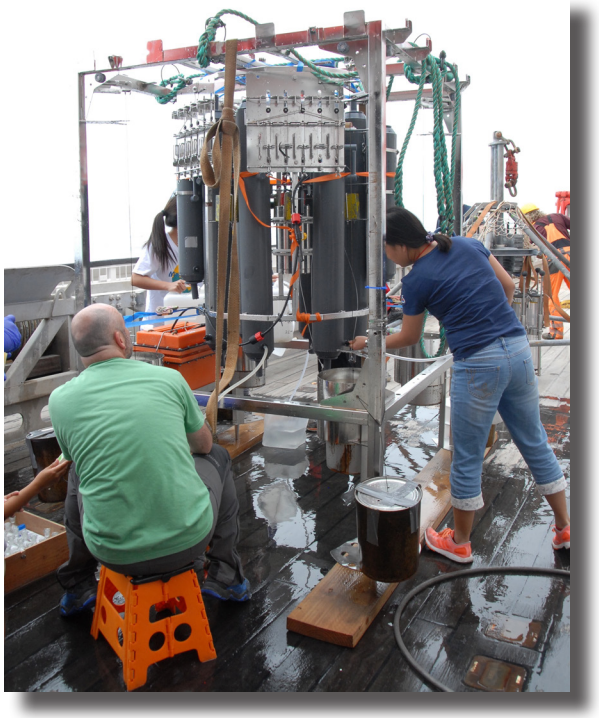

Figure 7.4.1 *Sampling water from the Hadal-Rosette (Foto: M. Gerringer)*

In addition, the frame of the rosette was used as a vehicle for different accessory equipment such as the hadal CTD (when the nano-lander not was deployed), hadal ranged O_2 sensing optodes (see section 7.5.5), pressure retaining water sampler (see section 7.13) and cameras to inspect instrument performance.

The hadal rosette was deployed 16 times during the cruise – 15 deployments were successful.

7.5 Lander Systems

7.5.1 Flux-Lander

F Wenzhöfer, A Nordhausen, V Asendorf, RN Glud

The MPI-Benthic-Lander-System (Fig. 7.5.1.1) was used to quantify benthic exchange and mineralization rates in situ at the reference sites. The Lander system was equipped with three benthic chamber modules and a two-axis Microprofiler (vertical profiling and lateral translation). The benthic chambers were used to measure total oxygen uptake (TOU) and dissolved inorganic carbon (DIC) as well as nutrient exchange of the sediment integrating all relevant solute transport processes (diffusion, advection and fauna-mediated transport) and an area of 400cm^2.

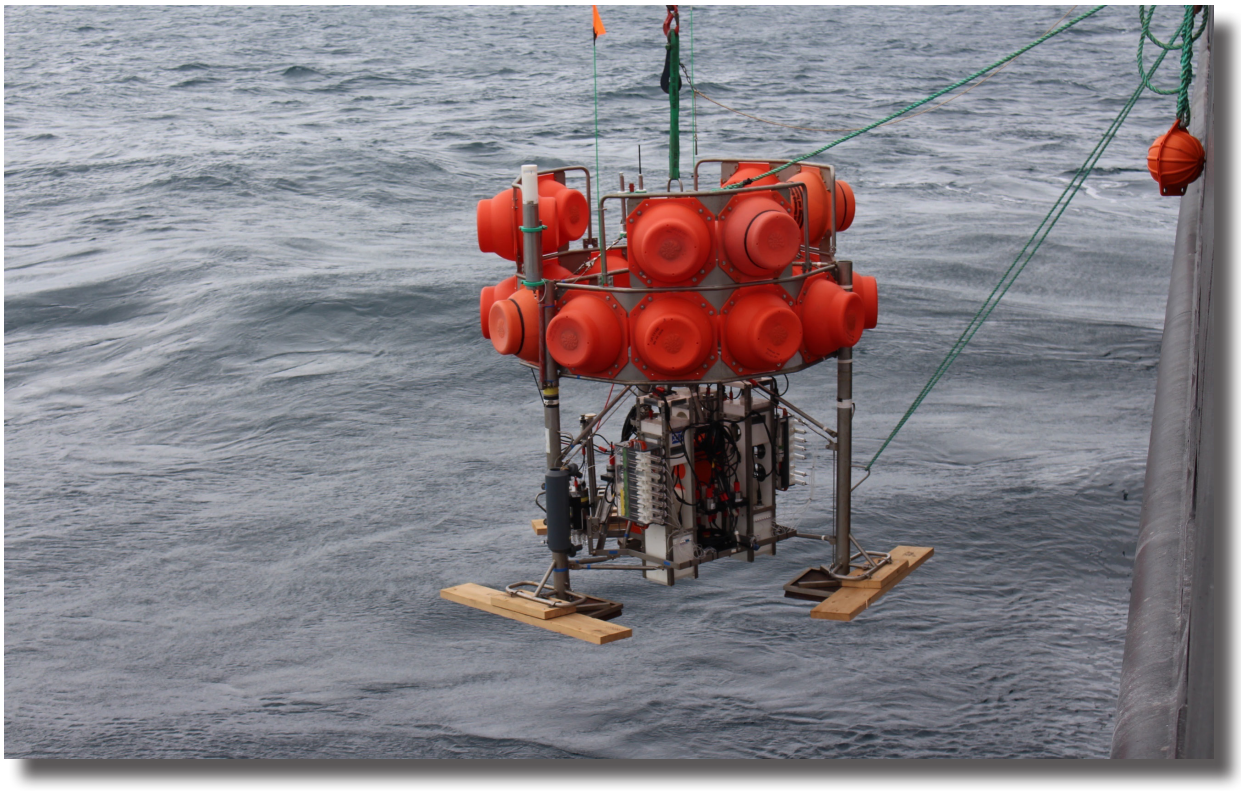

Figure 7.5.1.1 *Deployment of the Benthic-Lander-System at an abyssal site (Foto: N. Ramirez)*

During the deployment an oxygen optode measured changes in oxygen concentration and 7 syringes took water samples at pre-programmed time intervals for analyses of DIC and nutrients. Furthermore, the enclosed sediments were retrieved and sampled on board for total organic carbon (TOC) and photopigment content, and for abundances of microorganisms and fauna. The X-Y microprofiler was used to quantify diffusive oxygen uptake (DOU), which is generally assigned to microbial respiration. Each microprofiler was equipped with a total of eleven microsensors measuring vertical distributions of oxygen (6 sensors), pH (2), NOx (2), and resistivity (1). Measurements across the water-sediment interface and within the upper sediment layer were performed with a vertical resolution of 150µm and extending over a total length of 15-25cm. During the deployments the microprofiler performed five vertical profiles. The profiling unit was translated laterally by 9cm between replicate profiles to avoid profiling of the same sediment patch.

7.5.2 Hadal Profiler-Lander

RN Glud, M Larsen, F Wenzhöfer, A Glud, A Nordhausen, V Asendorf

The autonomous profiler-Lander is about 3.2 m high and has an overall weight of 1 ton in air (Fig. 7.5.2.1). The buoyancy (~-250kg) is ensured by syntactic foam while the ballast (~200kg) consists of small iron beads loaded in 4 metal buckets. The instrument is released from the ship by a “slip-hook” and sink to the seabed at roughly 45m min^{-1}. Once at the seabed the instrument completes a pre-programmed measuring cycle lasting 12-40 h depending on time availability, Once the program is completed, the ballast is released acoustically by a hydrophone from the surface or by a burn-wire system that is included in the lander design as a safety release mechanism. On average the instrument ascends by ~45m min^{-1} and once at the surface it can be tracked and located by radio and at night time by a blinking flash.

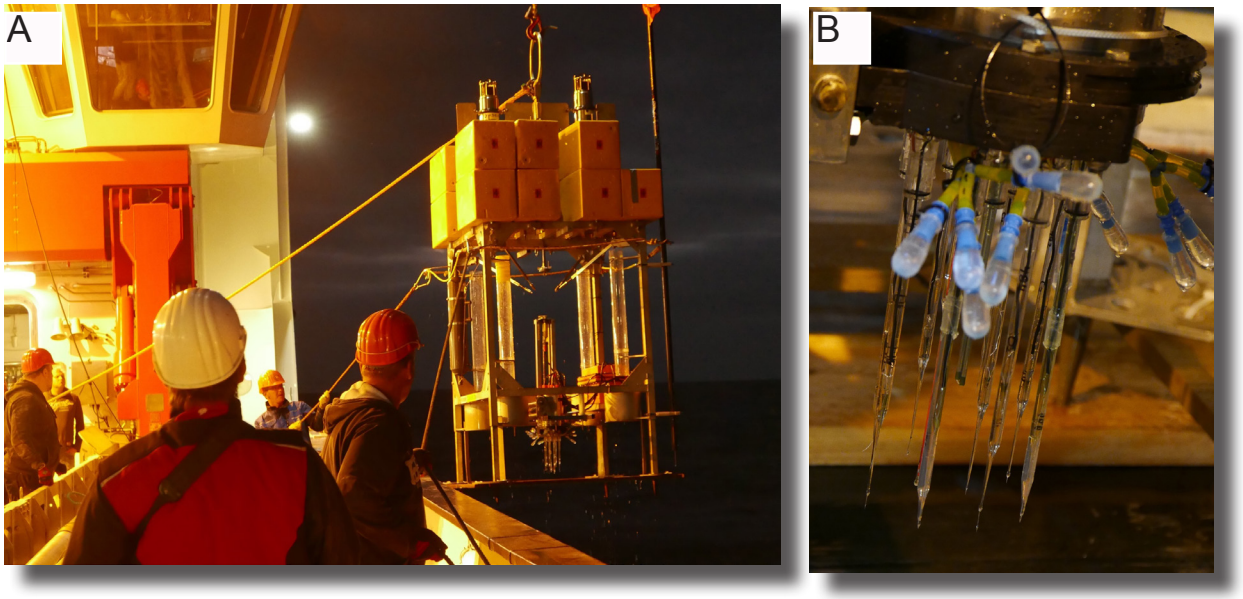

Figure 7.5.2.1 *Recovery of the hadal Profiler-Lander (A) and mounted electrodes (B) (Fotos: M. Schlösser)*

The central electronic cylinder contained 10 electrochemical microsensors. During this voyage we applied 1 resistivity sensor and 9 O_2 microsensors of which two occasionally where exchanged with NO_3^- biosensors. The central cylinder was mounted in an elevator that could be moved in small vertically steps and the elevator was mounted on a sledge that could be

moved horizontally in larger steps. During this campaign the electronic cylinder was typically moved vertically at 0.1mm resolution for 10cm, and subsequently an additional 10-20cm at 0.15mm resolution where after the sensors were moved back to the start position. The horizontal movement were either 12 or 6cm and initiated after each vertical profile. The number of vertical profiles ranged between 2 to 8 depending on available bottom time and if NO_3^- sensors were mounted or not (NO_3^- sensors have a longer response time and require a longer equilibration time at each depth). Data was stored in the central cylinder and downloaded after the instrument had been recovered. The lander was further more equipped with one Niskin bottle for sampling bottom water for sensor calibration and occasionally with a camera to monitor instrument performance.

The profling lander was deployed 8 times and provided between ~5 to ~70 profiles at each site depending on bottom time and the performance and breaking of individual sensors.

7.5.3 Hadal Sediment-Lander

M Larsen, B Thamdrup, RN Glud, F Wenzhöfer

The sediment lander is also autonomous and is equipped with syntactic foam, ballast and a ballast release system as the profiling lander – and roughly descend at the same speed (Fig. 7.5.3.1), However, this instrument is designed to i) collect six sediment cores and ii) to vertically inject various tracers in the sediment for in situ incubations. During this cruise we injected $^{15}NO_3^-$, $^{15}NO_2^-$ and $^{15}NH_4^+$ to quantify key processes in the benthic nitrogen cycle. At some stations we also injected Br^- as an inert tracer for documenting the ability to evenly inject tracers in the sediment and explore to what extent lander recovery and core handling could displace tracer. About 250ml was injected at the respective deployments.

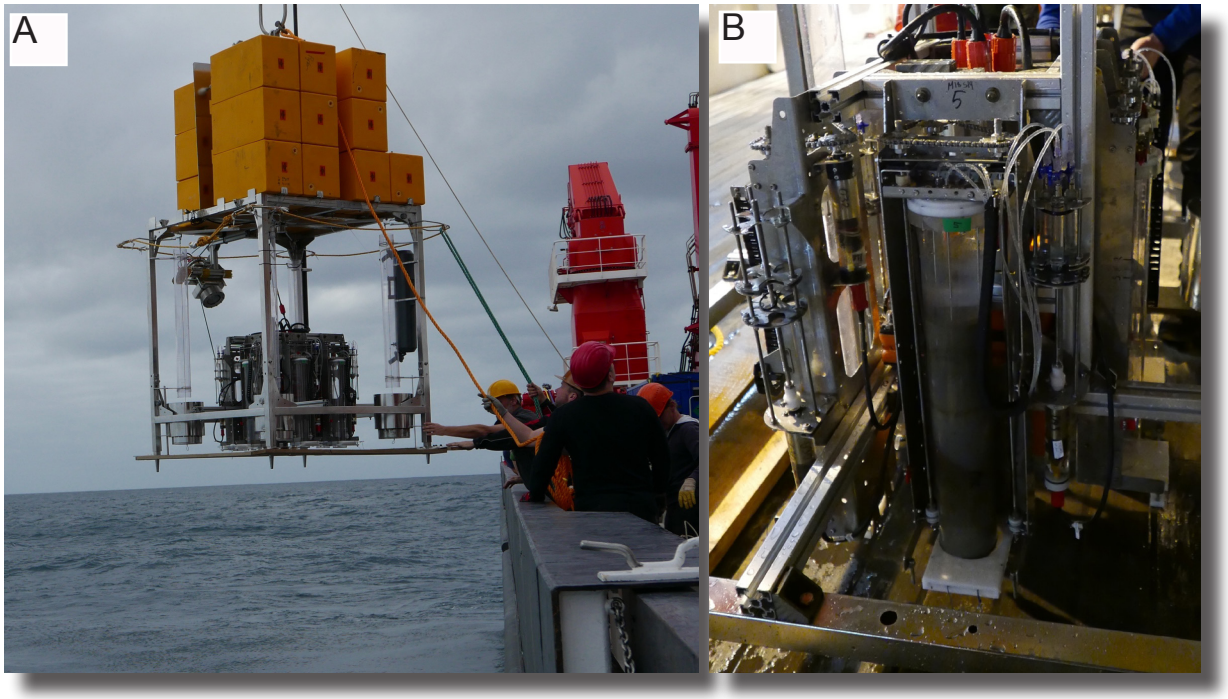

Figure 7.5.3.1 *Deployment of the hadal Sediment-Lander (A) and retrieved sediment core (B) (Fotos: M. Schlösser)*

During a successful deployment, the tracers are injected in each core at a regular time interval of 2-6 hours (depending on bottom time). The needles are fixed in the lid and a volume of 250ml is injected at a vertical resolution of 0.75cm. In each core we can apply 1 to 3 needles for vertical injection over 10-20cm depending on the sediment penetration depth of the core liners. After injection the sediment cores are retracted into the bottom water for incubation until the end of the program. At this point in time the ballast is released and after an ascend at ~50 m min^{-1} the instrument is recovered as for the profiling lander.

The overall idea of this measuring procedure is that all cores will be exposed to changes in hydrostatic pressure and transient heating and thus process measurements in the respective cores will be affected in the same way by any potential recovery artefacts. However, any gradual increase in labelled products during the in situ incubation will reflect the actual in situ process rate. Upon recovery the sediment cores are taken into the cool lab to be sections at in situ temperature. Subsamples and pore water is extracted and fixed for later analysis.

The sediment lander was deployed at seven sites but on most initial trials only a few or none of the liners retracted the sediment when driven out of the seabed. At the last two deployments core catchers were installed in all liners and sediment recovery was 100% successful for these two deployments. The surface of the sediment appeared disturbed by the catchers but the subsurface sediment appeared intact. The recovered sediment was sectioned and fixed and now await analysis at SDU.

7.5.4 Camera Lander

A Jamieson, T Linley, H Stewart, M Gerringer

Gear description

The camera landers (Fig. 7.5.4.1) are two identical hadal-rated baited camera system that comprise a delivery system of one acoustic release (Oceano 2500 Ti-Deep; IXSEA France), seven 17” glass spheres (Vitrovex; Nautilus Marine, Germany) on 50 m long mooring, and a 120kg steel ballast weight. The scientific payload comprised a bespoke HD video and still camera with LED illumination, powered by a 12V lead acid battery (SeaBattery; DSPL, US). The landers also recorded pressure and temperature (RBR Duet; RBR Ltd, UK). Physical samples were recovered using two different types of traps. The first was a large fish trap, 1 x 0.4 x 0.4m in size, fitted with 1 cm gauge netting. The seconds was a 1m long by 180mm diameter polycarbonate funnel trap. Both traps were set to sit directly on the seafloor and were baited with locally sourced fish (Scombridae). The landers were deployed from the aft and descended at ~45 m/min and once ballast was released by acoustic command, surfaced at ~50m/min.

Sampling/subsampling

The camera landers were deployed 18 times across the entire depth range of the trench (2500-8052m; Tab. 7.5.4.1). Every deployment was successful and ~335 gigabytes of video and image data were collected. These data were downloaded and backed up after every dive.

The physical samples were immediately put on ice and transported to the cold room where the majority of amphipod samples were preserved in Ethanol while some were preserved and frozen in RNA later for genetic work. The fish were preserved in formalin.

Table 7.5.4.1 *Camera lander deployments.*

Station	Date	Gear	Latitude	Longitude	Depth (m)
05	05-Mar	C-1	-23.816	-70.835	2543
06	05-Mar	C-2	-23.821	-70.8361	2537
17	07-Mar	C-1	-24.275	-71.4231	7782
18	07-Mar	C-2	-24.28	-71.4232	7834
31	10-Mar	C-1	-23.829	-71.3463	7608
32	10-Mar	C-2	-23.833	-71.3439	7493
45	13-Mar	C-2	-23.3796	-71.3447	8052
46	13-Mar	C-1	-23.3731	-71.393	7204
60	16-Mar	C-1	-23.05	-71.2507	7139
61	16-Mar	C-2	-23.0503	-71.2332	6974
72	19-Mar	C-1	-22.9491	-71.62	5563
73	19-Mar	C-2	-22.938	-71.6781	4974
87	22-Mar	C-1	-21.7416	-71.2578	6714
88	22-Mar	C-2	-21.7203	-71.2636	6520
103	25-Mar	C-1	-20.3435	-71.1214	5920
104	25-Mar	C-2	-20.3435	-71.1304	6025
113	27-Mar	C-1	-20.3424	-70.9901	4051
114	27-Mar	C-2	-20.3469	-70.9901	4100

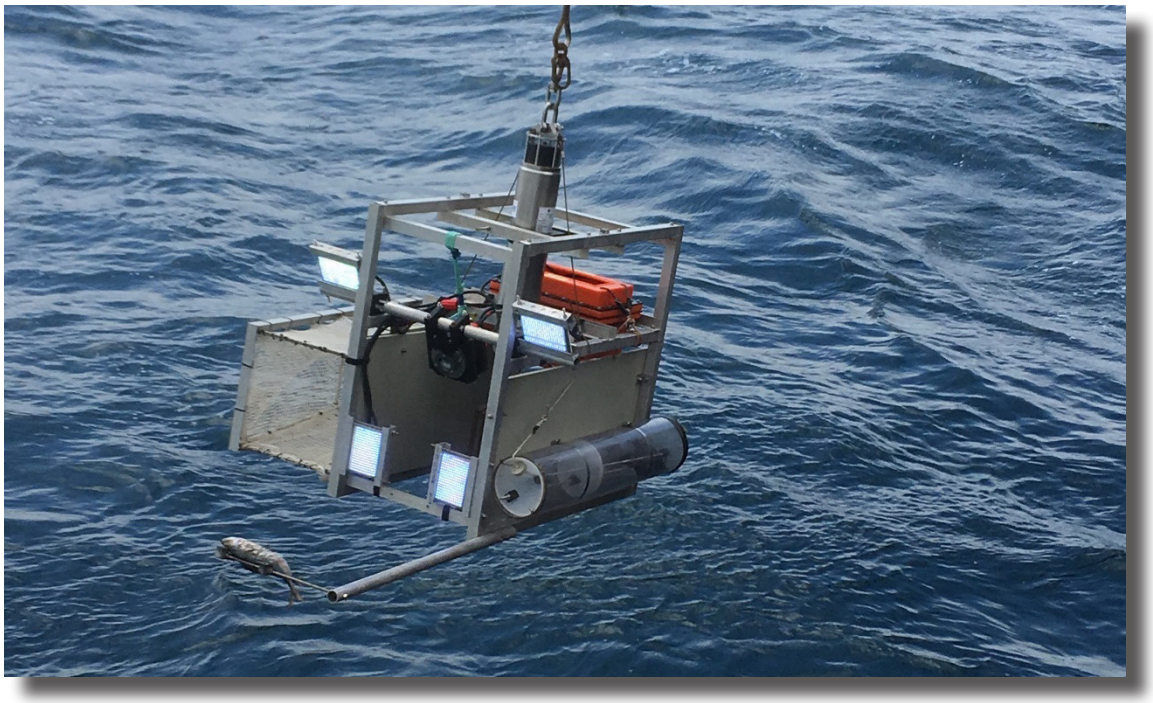

Figure 7.5.4.1 *One of the camera landers being deployment from the stern of Sonne on SO261 (Foto: T. Linley)*

7.5.5 Reiver

A Jamieson, K Oguri, T Linley

Gear description

The Reiver is a system that free falls to the seafloor to capture a rapid assessment of the seafloor substrate prior to the deployment of the larger profiling and sediment landers. The objective is assessed whether the seafloor is suitable for these more substrate sensitive systems. The Reiver therefore often only remains on the seafloor for <1h prior to release by acoustic command. As the substrate and geological complexity of the trench is unknown, the Reiver was rigged in such a way that a 120kg ballast weight was suspended below the camera, just maintaining the system above any uneven ground.

The Reiver was typically the first system to deployed at each site and soon as the cameras were back on board, the imagery was downloaded, viewed and decision was made whether or not continue at that locations. In all but one site, the seafloor was considered suitable and work began (Fig. 7.5.5.3).

There were two types of Reiver used on SO261, at depths less than 6000m an abyssal system (Reiver 1) was used and at depth >6000m, a hadal system was used (Reiver 2; see Table 7.5.5.1)

Abyssal camera

On the abyssal stations the Reiver was equipped with an HD video camera of a bespoke design mounted in such a way that the ballast weight was suspended 2m below the camera (Fig. 7.5.5.1). The abyssal system also included a current meter with CTD sensors (SeaGuard; Aanderaa, Norway). The abyssal system descended at 55 m/min and surface at ~65 m/min. It was programmed to film for 30 seconds every minute.

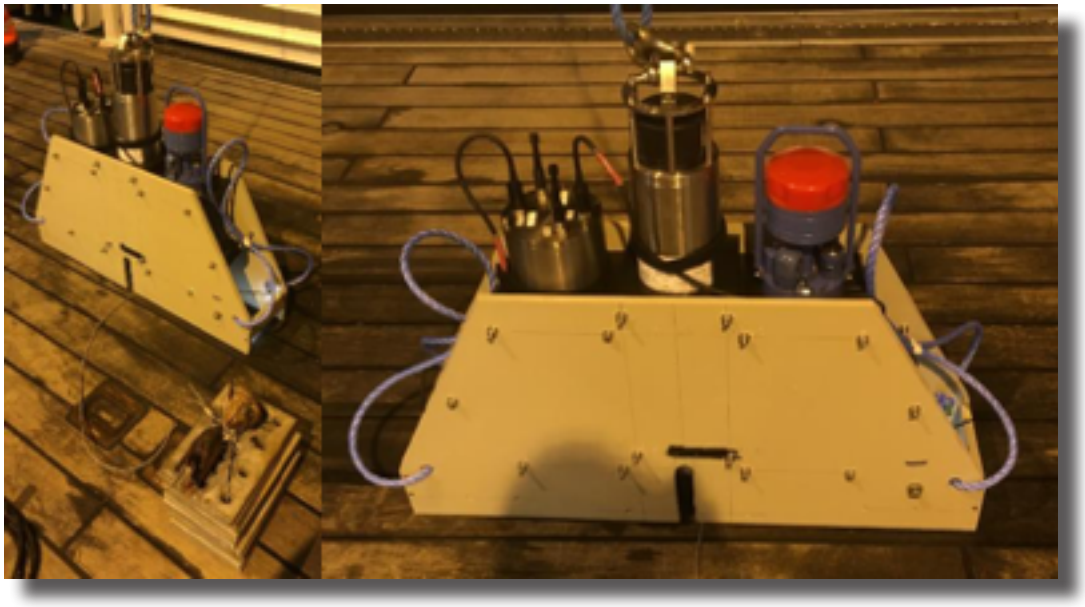

Figure 7.5.5.1 *The Abyssal Reiver 1 (Fotos: A. Jamieson)*

Table 7.5.5.1 *Reiver 1 and 2 deployments*

Station	Date	Gear	Latitude	Longitude	Depth (m)
01	05-Mar	Reiver 1	-23.812	-70.8342	2552
12	06-Mar	Reiver 2	-24.266	-71.423	7842
27	10-Mar	Reiver 2	-23.817	-71.372	7893
38	13-Mar	Reiver 2	-23.3627	-71.3433	8064
56	16-Mar	Reiver 2	-23.0494	-71.3021	7990
68	19-Mar	Reiver 1	-22.9378	-71.618	5476
79	21-Mar	Reiver 1	-22.9413	-72.1459	3995
81	21-Mar	Reiver 2	-21.781	-71.2079	7915
99	25-Mar	Reiver 2	-20.3191	-71.291	7741

Hadal Camera

A hadal camera and a LED light were mounted in Reiver to observe sea floor and benthic organisms. This camera is consisted of 11000m–rated titanium pressure cylinder incorporated with a commercialized HDTV digital video camera (GZ-V590C modified, JVC Kenwood, Japan), eight Li-ion batteries (NCR18650B, Panasonic, Japan) and a handmade programmable timer circuit. The LED light is constructed to plasticize a print circuit board mounted sixteen 3W white LEDs and four resisters for current regulation in epoxy resin (Oguri et al., 2015). The power consumption of the light is ca. 15 W (14.8V, >1A). Fig. 7.5.5.2 shows the Hadal camera system mounted in the Reiver frame.

The timer programming was made by connecting the timer board with a PC via serial communication. The date/time of starting video recording, recording time, sting time and the repeat cycles were configured (Table 7.5.4.2).

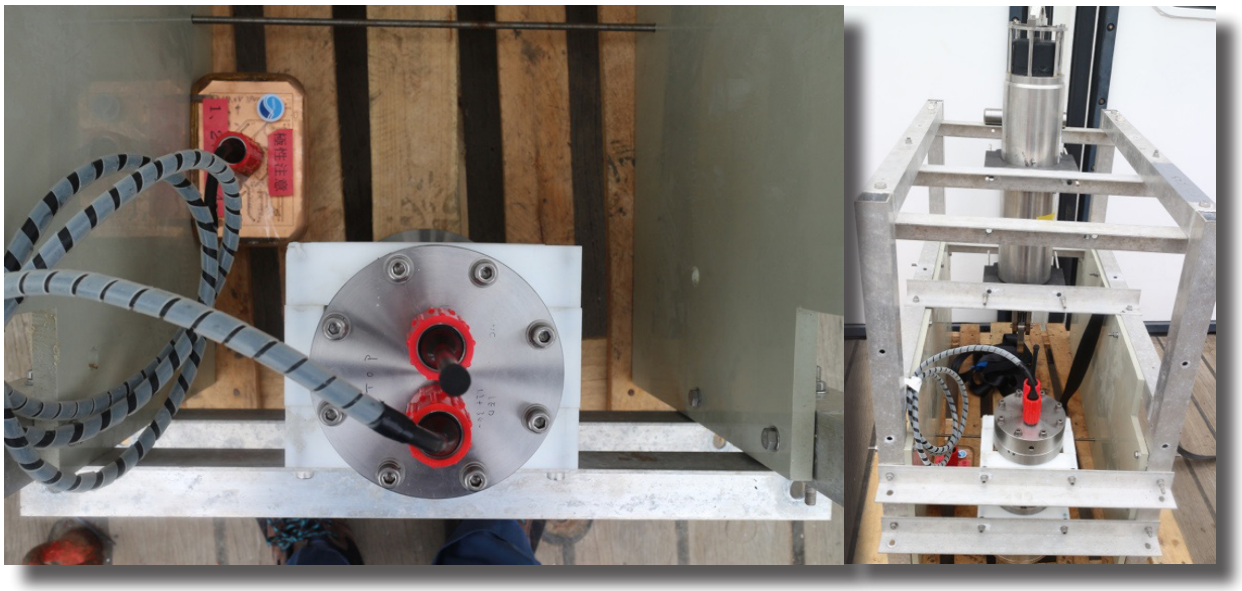

Figure 7.5.5.2 *The hadal camera and the LED light mounted on Reiver (Fotos: (T. Linley)*

Table 7.5.5.2 *Recording configurations of the hadal camera. Each cycle was set to 00:03:00.*

Deployment	Site	From (UTC-4)	To (UTC-4)	Rec./ each	Cycles
SO261_27	5	10/Mar/2018 13:01	10/Mar/2018 17:58	00:01:37	100
SO261_38	4	12/Mar/2018 17:31	12/Mar/2018 22:28	00:01:37	100
SO261_56	3	16/Mar/2018 11:01	16/Mar/2018 17:57	00:01:38	100
SO261_81	2	21/Mar/2018 23:31	22/Mar/2018 4:28	00:02:00	100
SO261_99	10	25/Mar/2018 22:01	26/Mar/2018 3:30	00:02:00	111

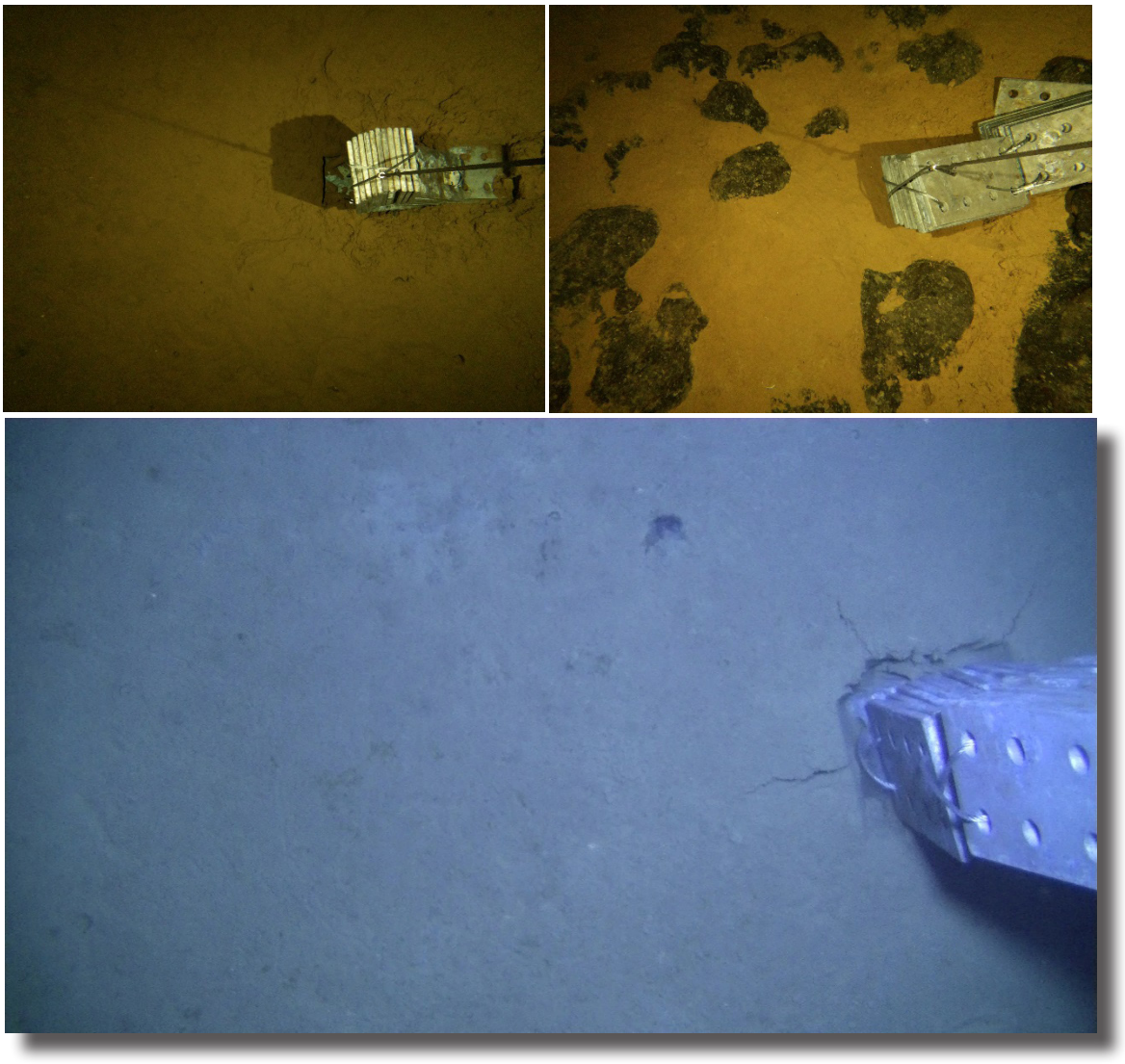

Figure 7.5.5.3 *Examples of Reiver imagery. The top left shows a typical (and suitable for sampling) abyssal sedimented seafloor. The top right shows a geological complexity considered not suitable for sampling. The bottom image, from the hadal-camera, shows a typical seafloor from the trench axis >8000m (Fotos: A. Jamieson)*

7.5.6 Nano-Lander

N Ramirez, G Alarcon, E Flores, L Arias, O Ulloa

Gear description

The Nano-lander “Audacia” from the Instituto Milenio de Oceanografía, Universidad de Concepción (IMO-UdeC, Chile) is 244cm tall x 64cm wide (125mm wide with the side variable flotation pods) x 53cm deep, with and weight of approximately 182kg (Fig. 7.5.6.1). An expendable anchor weighing 40 kg takes the lander to the bottom at about 1 m/s. This compact ocean lander was designed and built by Kevin Hardy, Global Ocean Design (San Diego, CA). A hadal SeaBird SBE19 plus CTD-O (Sea-Bird Scientific, Bellevue, WA) is its primary sensor package. The dissolved oxygen sensor was not available for the *Sonne* SO261 cruise on time, so a hadal Aanderaa optode sensor (www.aanderaa.com), provided by Kazumaza Oguri (Jamstec, see below), was successfully mounted on the lander. The Nano-lander also has a drop arm with a baited trap, a self-recording underwater video camera, and two 30-L Niskin bottles. For *Sonne* SO261, a pressure-compensated LED light for the camera was kindly provided by Kazumaza Oguri.

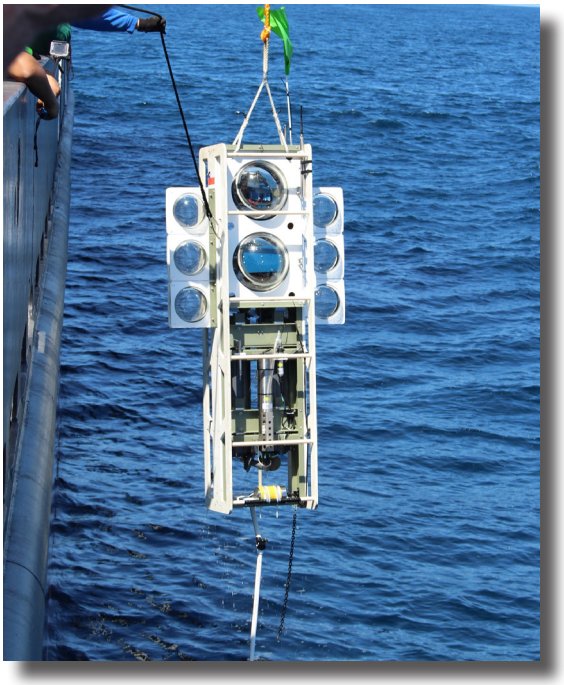

Figure 7.5.6.1 *Recovery of the Nano-Lander (Foto: N. Ramirez)*

Sampling/subsampling

The Nano-lander was deployed 5 times (one at Sites 6, 5, and 2, and two at Site 4). The geographical location and maximum depth reached for the CTD records are given in Table 7.5.6.1.

Table 7.5.6.1 *CTD SBE 19 plus deployments on Nano-lander.*

File name	Operation	Date	Latitude	Longitude	Max Depth [m]
SBE19plus_01907824_2018_03_08_HADES_06	SO261_15-1	07/03/18	24º 15.963‘ S	071º 25.385‘ W	7856.2
SBE19plus_01907824_2018_03_12_HADES_05	SO261_33-1	10/03/18	23º 49.023‘ S	071º 22.314‘ W	7906.7
SBE19plus_01907824_2018_03_15_HADES_04	SO261_51-1	14/03/18	23º 23.118‘ S	071º 20.722‘ W	8079.2

File name	Operation	Date	Latitude	Longitude	Max Depth [m]
SBE19plus_01907824_2018_03_23_HADES_02	SO261_86-1	22/03/18	21º 47.051‘ S	071º 12.256‘ W	7953.2

* Bottom depth is ~1.2 m deeper than the CTD pressure sensor.

Additionally, the CTD SBE 19 plus was mounted on the Hadal Rosette at Sites 3 and 10. The details are given in Table 7.5.6.2.

Table 7.5.6.2 *CTD SBE 19plus deployments on Hadal Rosette.*

File name	Operation	Date	Latitude	Longitude	Max Depth [m]
SBE19plus_01907824_2018_03_17_HADALR_03	SO261_62-1	16/03/18	23º 03.136‘ S	071º 18.180‘ W	7674.6
SBE19plus_01907824_2018_03_27_HADALR_10	SO261_108-1	27/03/18	20º 18.305‘ S	071º 17.534‘ W	7673.0

Seawater samples were taken from the Niskin bottles for microbial cell abundance, DNA, chlorophyll, and chemical variables (dissolved oxygen, nutrients, DIC, DOC, alkalinity, pH, $PO^{13}C$, $PO^{15}N$, ^{14}C-DIC). To complement measurements from the Nano-lander, seawater samples for the same variables were taken from the ship´s Rosette and the Hadal Rosette. A summary is given in Table 7.5.6.3.

Table 7.5.6.3 *Summary table for sampling of chemical and biological discrete samples.*

Operation	Site	Equipment
SO261_02	1	CTD/Rosett
SO261_07	1	CTD/Rosette
SO261_11	1	CTD/Rosette
SO261_13	6	CTD/Rosette
SO261_06_19	6	Hadal Rosette
SO261_06_023	6	CTD/Rosette
SO261_06_024	6	Hadal Rosette
SO261_28	5	CTD/Rosette
SO261_34	5	Hadal Rosette
SO261_33	5	NanoLander
SO261_29	5	Sediment Lander
SO261_30	5	Profiler Lander
SO261_39	4	CTD/Rosette
SO261_40	4	Hadal Rosette
SO261_04_42	4	Nano Lander
SO261_41	4	CTD/Rosette
SO261_47	4	Hadal Rosette
SO261_51	4	NanoLander
SO261_54	4	CTD/Rosette
SO261_57	3	CTD/Rosette
SO261_62	3	Hadal Rosette

Operation	Site	Equipment
SO261_07_74	7	CTD/Rosette
SO261_08_80	8	CTD/Rosette
SO261_02_82	2	CTD/Rosette
SO261__02_89	2	CTD/Rosette
SO261_02_91	2	Hadal Rosette
SO261_02_86	2	NanoLander
SO261_02_96	2	Hadal Rosette
SO261_10_100	10	CTD/Rosette
SO261_10_108	10	Hadal Rosette
SO261_09_110	9	CTD/Rosette

O_2 sensor and the O_2 profiles in water column

To obtain O_2 profiles in water column, a hadal optical O_2 sensor (Optode 5331, Xyrem, Norway) and a serial data logger (Handmade equipped with a Raspberry Pi Zero, England) in a titanium pressure cylinder were installed in the Nano Lander (Fig. 7.5.6.2). The O_2 data were obtained every 5 seconds interval (Fig. 7.5.6.3). The raw data were corrected to refer temperature, salinity and water depth acquired in parallel with a CTD (SBE19 plus, Seabird Electronics, USA) following the formula and the constants shown in the manual.

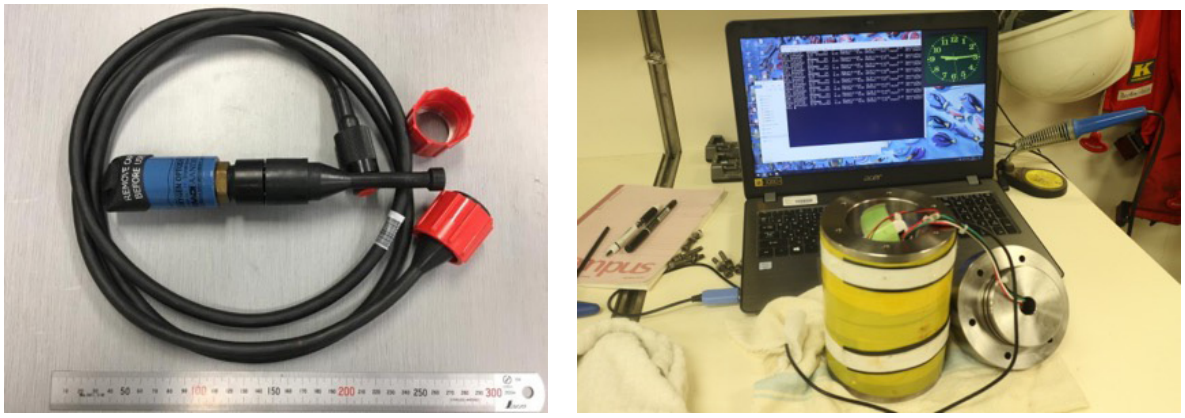

Figure 7.5.6.2 *O_2 sensor (left) and the data logger (right) used for measuring the O_2 profiles.*

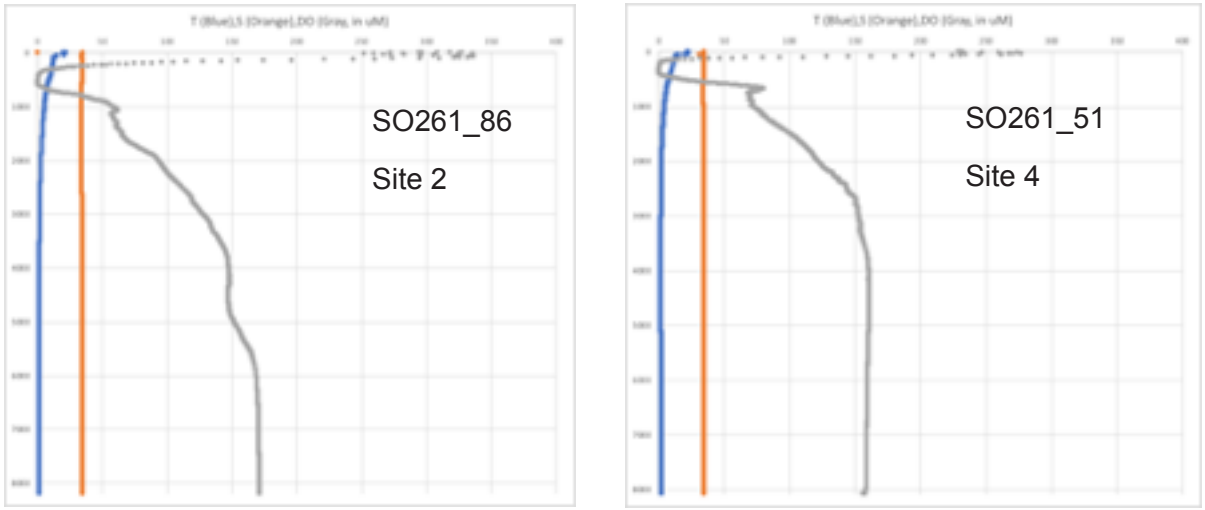

Figure 7.5.6.3 *Profiles of temperature (ºC), salinity and dissolved O_2* (µM) in water column. Vertical axis in each graph represents water depth (m).

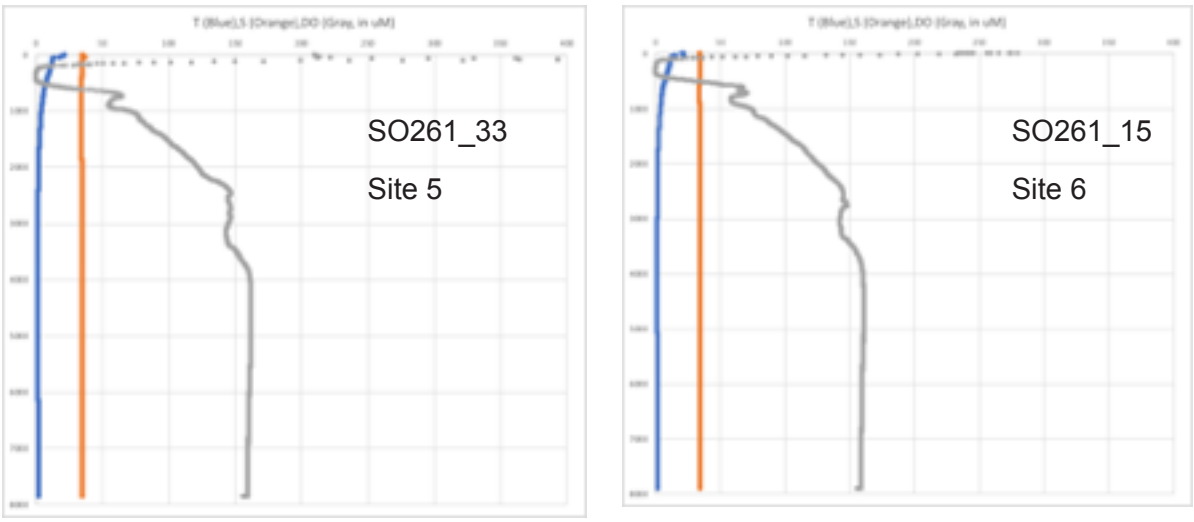

Figure 7.5.6.3 *continued Profiles of temperature (ºC), salinity and dissolved O_2 (µM) in water column. Vertical axis in each graph represents water depth (m).*

7.6 Ocean Floor Observation and Bathymetry System (OFOBS)

A Purser, U Hoge, L Hehemann

Gear description

The Ocean Floor Observation and Bathymetry System (OFOBS) is a recently developed 6000m depth rated, towed imaging and acoustic system, integrating a high-resolution photo-camera (iSiTEC, CANON EOS 5D Mark III), high definition video-camera (iSiTEC, Sony FCB-H11), forward facing acoustic camera and EdgeTech 2205 AUV/ROV MPES (multiphase echosounder) with two sidescan frequencies (low/LF: 230 kHz and high/HF: 540kHz) for different range and resolution achievements (Fig.7.6.1). The cameras and acoustic devices are mounted on a steel frame (140L x 92W x 135H cm), together with two strobe lights (iSiTEC UW-Blitz 250, TTL driven), three laser pointers at a distance of 50cm from each other that were used to estimate the size of seafloor structures, four LED lights, a USBL positioning system (Posidonia) coupled with a IXUS 6000 G3 Inertial Navigation System with integrated Nortek N3015 DVL to track the position of the OFOS during deployments. For a more detailed description of the system see Purser et al. (2018).

OFOBS survey tracks

The 6000m depth rating of the OFOBS prevented its use in the central regions of the Atacma Trench. During SO261 seven scientific deployments were made on the overriding and subducting flanks of the Atacama Trench, of various duration (Table 7.6.1). Commonly these deployments were planned to survey in greater detail topographical features such as ridges and trenches previously mapped during ship based bathymetric surveys. Problems with the fibre connection to the RV *Sonne* resulted in the early termination of several dives, but in all cases the seafloor was at least imaged by the system, providing information of seafloor type (muddy, rocky, cliffs etc) and a brief impression of the fauna.

Figure 7.6.1 *OFOBS, deployed during SO261 (Foto A Purser)*

Due to the high interest in water column activities and processes at the sites visited by the cruise, and effort was made to also image zooplankton, detritus and megafauna during OFOBS deployments and recoveries.

Table 7.6.1 *List of OFOBS deployments during SO261.*

Station Number SO261	Date (UTC)	At Bottom (UTC)	Off Bottom (UTC)	Seafloor distance Imaged (m)	Number of collected seafloor images	Approximate still image coverage (m^2)
3	05/3/2018	N.A.	N.A.	N.A	N.A.	N.A.
14	07/3/2018	10:32:16	13:58:46	6000	952	4570
26	10/3/2018	08:49:20	11:13:51	4000	627	3010
53	15/3/2018	11:03:39	11:11:12	5	37	178
66	18/3/2018	03:56:42	04:05:13	5	37	178
78	21/3/2018	05:16:14	05:18:50	5	9	20
90	24/3/2018	02:40:59	03:48:36	700	327	1570
109	27/3/2018	22:23:16	02:31:43	3700	1035	5400
TOTAL COUNTS AND COVERAGES:					3024	14515

Results and Fauna

With the exceptions of deployments SO261-14 and SO261-26, all OFOBS deployments filmed seafloor comprised of primarily soft sediments. The dive tracks and example images of the seafloor from each dive are provided below (Fig. 7.6.2 to 7.6.8):

Station SO261-14

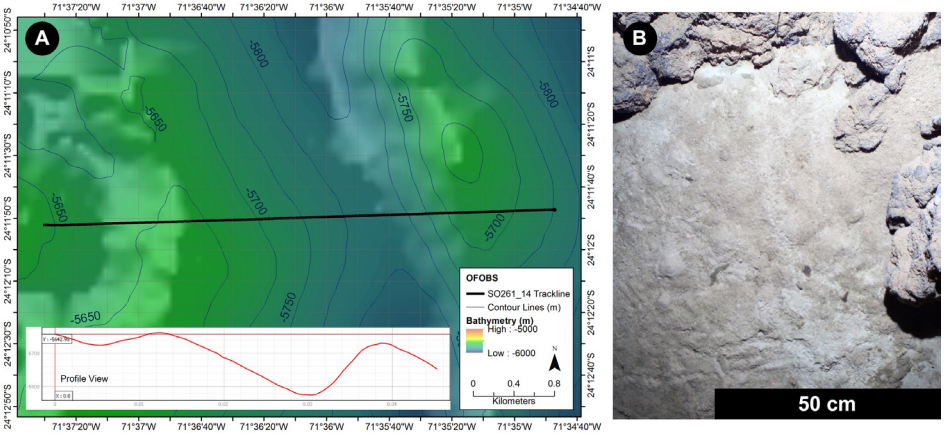

Figure 7.6.2 *LEFT: Seafloor track for OFOBS deployment SO261-14. RIGHT: Typical seafloor imaged during deployment. Soft sediments with occasional compacted sediment ridges (Fotos: L Hehemann)*

Station SO261-26

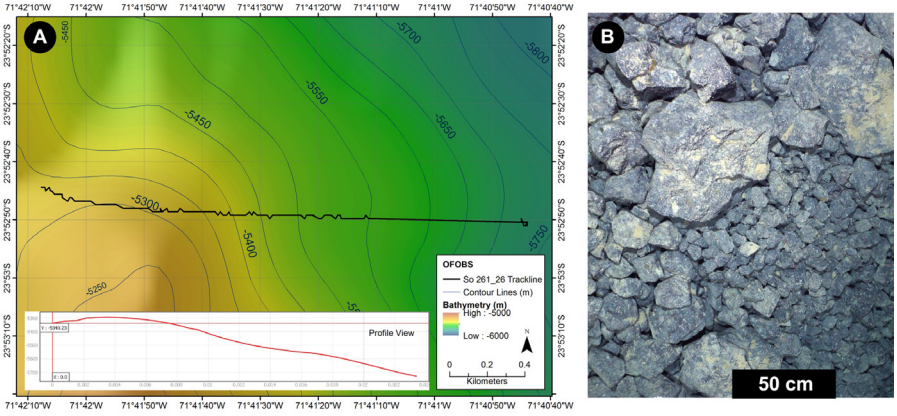

Figure 7.6.3 LEFT: *Seafloor track for OFOBS deployment SO261-26. RIGHT: One example of the two typical seafloor types imaged during deployment. Here, a steep slope of hard sediment / rock blocks is shown. Throughout the deployment, such exposures were intermixed with soft sediment areas (Fotos: L. Hehemann)*

Station SO261-53

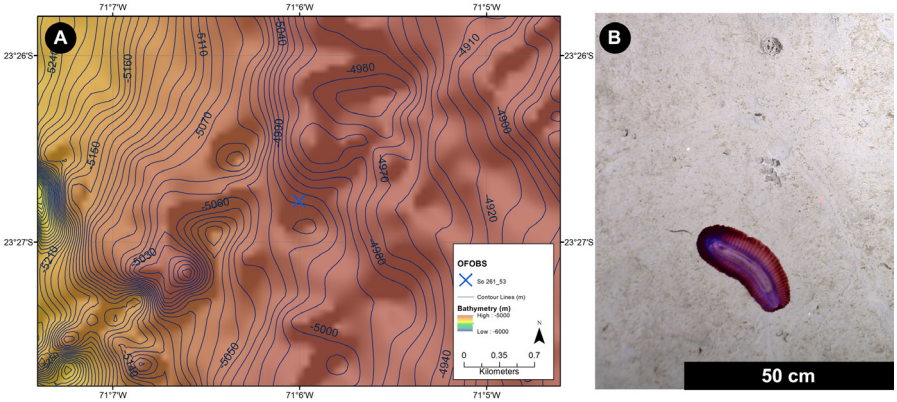

Figure 7.6.4 *LEFT: Location of brief OFOBS deployment SO261-55. RIGHT: Typical seafloor imaged during deployment. Soft sediments observed at the location (Fotos: L. Hehemann)*

Station SO261-66

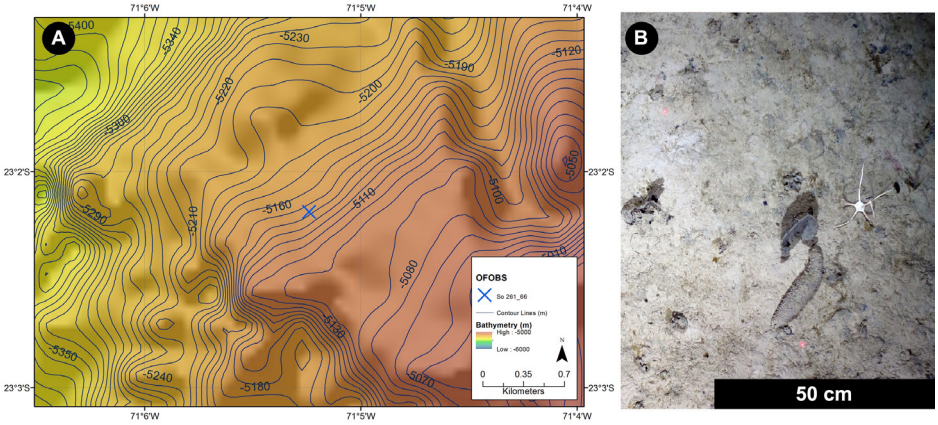

Figure 7.6.5 *LEFT: Location of brief OFOBS deployment SO261-66. RIGHT: Typical seafloor imaged during deployment. Soft sediments with heavy bioturbation observed (Fotos: L. Hehemann)*

Station SO261-78

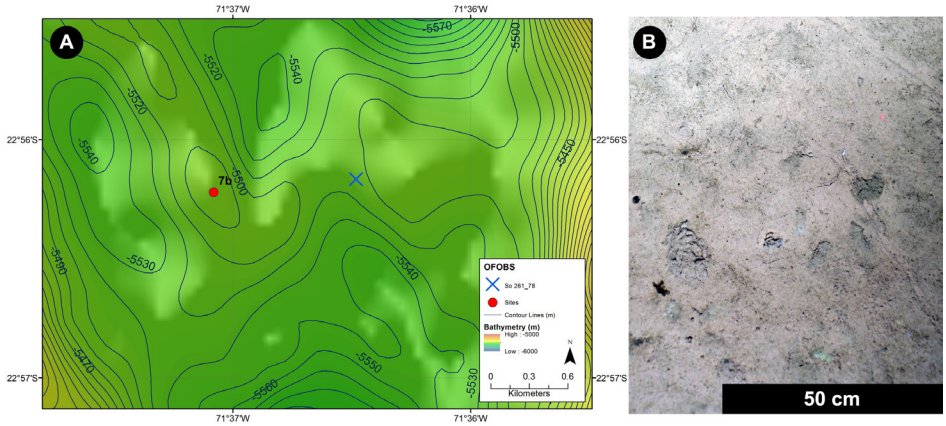

Figure 7.6.6 *LEFT: Location of brief OFOBS deployment SO261-78. RIGHT: Typical seafloor imaged during deployment. Soft sediments observed (Fotos: L. Hehemann)*

Station SO261-90

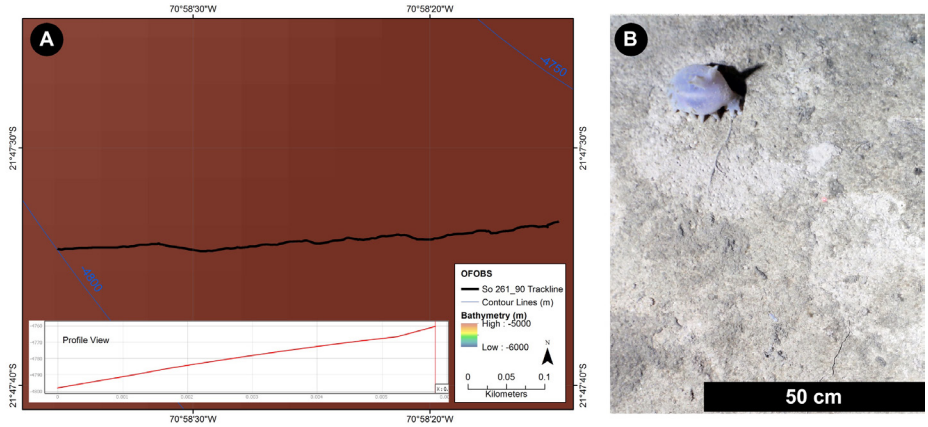

Figure 7.6.7 *LEFT: Seafloor track for OFOBS deployment SO261-90. RIGHT: Typical seafloor imaged during deployment. Soft sediments observed throughout the dive transect (Fotos: L. Hehemann)*

Station So261-109

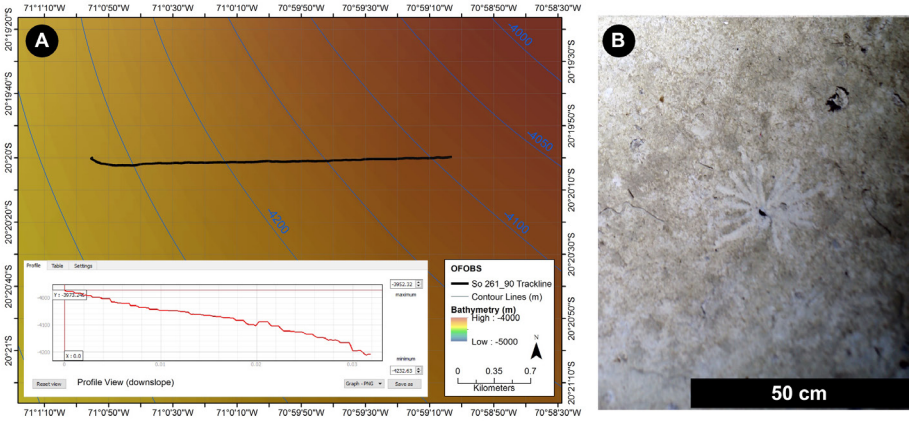

Figure 7.6.8 *LEFT: Seafloor track for OFOBS deployment SO261-109. RIGHT: Typical seafloor imaged during deployment. Soft sediments observed throughout the dive transect (Fotos: L. Hehemann)*

Fauna

The seafloor imaged during SO261 was rather abundant in mobile and sessile fauna. Numerous amphipods, ophiuroids, starfish, holothurians, isopods and polychaetes were observed across all surveyed regions (Fig. 7.6.9). The hard outcrops imaged during SO261-14 and So261-26 supported communities of encrusting and stalked sponges not observed in any abundance elsewhere during the cruise. Few fish were observed at the deeper surveyed sites, though during SO261-109 a number of fish and fish species were present. Cephalopods, though present in the water column throughout many deployments, with octopods only observed on the seafloor during SO261-109, with two individuals highly reminiscent of the species' observed in the Peru Basin at comparable depths (Purser et al., 2016). One of these individuals seemed to have been attracted to a recent dead fish food fall, or to prey upon crabs feeding on the fish remains. Despite a general similarity in species richness to that observed in the Peru Basin (Boetius, 2015) and the apparently near uniform seafloor structure, for each OFOBS deployment the dominant species differed, indicating a potentially complex mix of microhabitats not immediately distinguishable in imagery or bathymetry.

7.6.4 Acoustics

Forward facing acoustic camera and sidescan data were collected throughout each dive. The forward facing acoustic camera was extremely useful for OFOBS height correction in the rockier surveyed regions, such as those observed during SO261-26. The side scan data will be processed in forthcoming months.

7.6.5 Data availability

All acoustic and image data collected during SO261 by the OFOBS system was provided during the cruise to the onboard scientific party, and will be made publically available via the PANGAEA archive within 6 months of cruise completion. High resolution georeferenced bathymetric products derived from video frames and still images will be available via PANGAEA within two years of cruise completion.

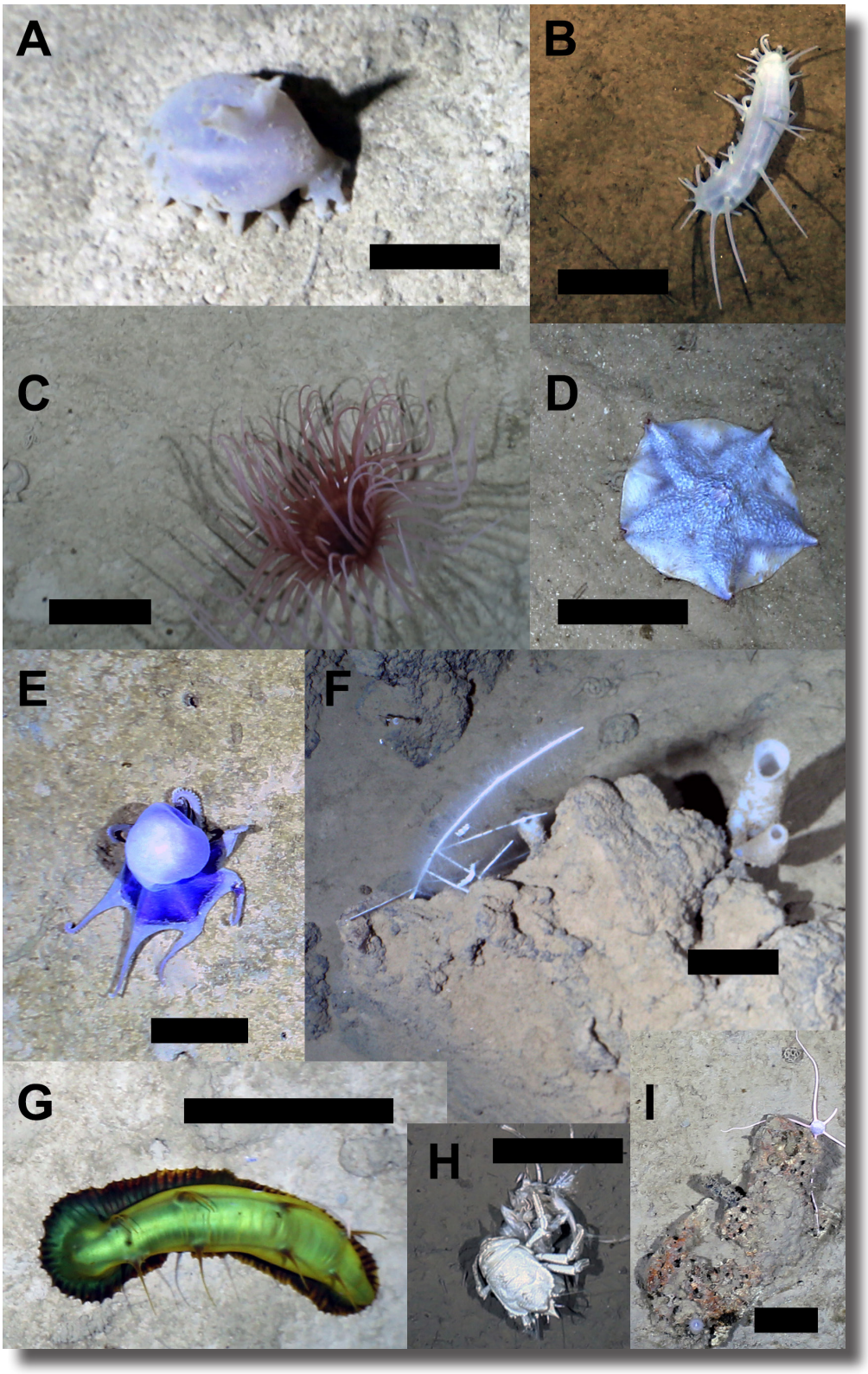

Figure 7.6.9 *Selected images of charismatic megafauna observed during the SO261 OFOBS deployments. Black bar represents 10 cm. A – holothurian, B – holthurian, C – burrowing anemone?, D – cushion star, E – Octopod, F – several sponge species, G – holothurian, H – galatheid crab on dead fish food fall, I – colonised litter. Wood? (Fotos: A Purser)*

7.7 MOCNESS

R Escribano, D Toledo, I Fernandez

The MOCNESS (Multiple Opening-Closing Net and Environmental Sensing System) is a zooplankton net designed to obtain stratified samples at deep waters (Fig. 7.7.1). The MOCNESS-10 is designed with an opening frame of 10m^2 hosting six 333µm mesh-size nets of 25m length. It is also equipped with Seabird sensors for temperature, salinity, dissolved oxygen and fluorescence.

Figure 7.7.1 *MOCNESS net being deployed via the A-frame (Foto: F. Wenzhöfer)*

MOCNESS works on real time by means of the conductive cable and a deck unit. Upon deployment the net can be monitored at real-time for net depth, vertical and horizontal speed, angle, water volume being filtered and all environmental parameters. Nets can be closed and opened at desirable depths. The equipment is operated by trawling at about 2 knots to a maximum depth of 6500m.

7.8 Multinet

R Escribano, D Toledo, I Fernandez

Gear description

The multinet is a smaller zooplankton sampler, compared to MOCNESS, designed to obtain stratified samples to a maximum depth of 1000 m. It has an opening area of 0.25 m^2 and is equipped with five 200 µm mesh-size nets. It is equipped with a pressure sensor and a flowmeter and it works after being programmed to close and open nets at pre-fixed depths. It can be towed vertically and horizontally but mostly used to catch meso-zooplankton.

7.9 Bio-Geochemical Analyses

M Zabel, B Thamdrup

Objectives

The aim of bio-geochemical investigations on this cruise was to get the first information on microbially mediated, benthic transformation rates in hadal sediments of the Atacama Trench. Due to the strong attenuation to the input of organic debris typically observed at great water depth, the reactivity of hadal deposits and therefore their potential role for the global carbon cycle were long assumed to be very small, based on extrapolation from abyssal depth. Using state-of-the-art deep-sea technology, however, it has more recently been shown that lateral particle transport and landslides from the steep flanks of the deep-sea trenches can lead to high levels of input even at water depths beyond 6000 m and consequently high biological activity. High productivity in nearby Chilean coastal waters let assume, that this also applies to the Atacama Trench.

Work at sea

To prevent warming of the sediments on board, immediately after recovery all cores were stored in a cooling lab at a temperature of about 4°C. The cores from the MUC were processed within a few hours for pore water analysis while the gravity cores were subsampled within 1 day after recovery.

We used different methods to determine the probably most significant bio-geochemical processes in surface and deep buried sediments after the respiration of oxygen (e.g. iron and sulfate reduction, anammox). The main subject of our investigations was pore waters, but also sediment samples were taken for subsequent analyses in our home labs.

On one MUC core from the first deployment at each station pore waters were sucked out by Rhizon micro suction samplers (RSS, 5 cm, 0.2 µm porous polymer, Rhizosphere Research). The same method was applied to the GCs. On two additional MUC cores (one of each deployment) pore waters were gained by centrifugation of sediment samples and subsequent filtration (25 mm 0.2 µm cellulose acetate filters) with sectioning and filtration taking place in a N_2-filled glove bag. During the sectioning, approx. 5 cm^3 of sediment was taken for solid phase analysis on land. These samples were frozen immediately after sectioning. The resolution of the subsampling varies between 1 and 5 cm in MUC cores and 10 to 20 cm in GCs. Information on which core from which station which examinations were performed is given in Table 7.9.1.

Prior to using RSSs on MUC cores, a sample was taken from the supernatant bottom waters. After that, the remaining bottom waters were carefully removed by means of a siphon before pore water extractions started. RSSs were carefully inserted through the already prepared sampling holes. The first 0.1 mL was always discarded to avoid contamination, dissolution and oxidation. The next 0,2-2,0 mL (depending on the concentration of the constituents) were instantly analyzed for dissolved iron and phosphate (s. below). The RSSs were left connected until about 10 mL of pore water has been retrieved, which took up to 60 min. The same procedure of pore water collection was applied to the GCs. Some few sediment samples for radio carbon dating and sequential extraction of mineral phases were taken out of the GCs. The latter were stored in a glass bottle under nitrogen atmosphere. Otherwise, the whole round segments were not opened.

Beside the aliquots used in onboard analyses of the parameters mentioned below, we collected the following sample splits for onshore laboratory analyses: 1,8 mL of sample each for DIC and NPOC, 0,1 mL diluted with 1,9 ml for onshore anion analysis, 0,5 mL of sample diluted with 4,5 mL of 1M HNO_3 for cation analysis, and 2 mL of sample preserved with Zn acetate solution for onshore H_2S analysis. The rest of the sample was kept without addition of preservatives.

Alkalinity was determined on a 1 mL split of the plain sample by titration with 0,01 M HCl. To allow accurate pH measurements, a pH electrode was used together with a special stirring device that magnetically rotates a 1,5 mL Eppendorf vial around the electrode without the need of a magnetic stirring bar. The acid was added using a 0,3 mm ID PTFE tube. The samples were titrated with a digital burette to a pH well below pH 3,9 and both titration volume and final pH were recorded. The alkalinity was calculated using a modified equation from Grasshoff et al. (1999).

Ammonium (NH_4^+) was detected onboard with a flow injection teflon tape gas separator technique after Hall & Aller (1992). About 200 – 300 µL of plain sample were injected into the analytical line by an auto sampler, there mixed with an alkaline solution (0,01 M NaOH + 0,2 M Na citrate) to form gaseous NH_3 which passed a PTFE membrane to cause a conductivity signal in a receiving acid solution (0,001 M HCl, 34 µS cm^1). The conductivity was determined using a temperature compensated conductivity meter with flow-through-cell (Amber Science 1056 and 529) and recorded electronically.

Dissolved iron (Fe^{2+}) and phosphate (PO_4^{3-}) were detected photometrically (Hach Lange DR 5000 photometer) at 565 nm and 880 nm wavelengths. An iron sensitive color complex was formed by adding 1 mL of plain sample to 50 µL of a ferrospectral receiver in disposable polystyrene cuvettes. Phosphate concentrations were determined by application of the Molybdenum Blue method (Grasshoff et al. 1999). About 1 mL of sample was mixed with 50 µL of an ammonium molybdate solution in a disposable polysterene cuvette and spiked with 50 µL of an ascorbic acid solution. The phosphomolybdate complex was thus reduced to molybdenum blue. In case of high iron concentrations, the original sample was diluted with oxygen free pure water to match the respective calibration range.

Table 7.9.1 *Pore water geochemistry on cruise SO261*

Station	Site	GeoB No.	Device	Core No.	Fe^{2+}	PO_4^{3-}	NH_4^+	Alk	NO_3^{2-}	NO_2^{2-}	H_2S	Aliquots*
SO261_8	1	22901-1	MUC	1	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_9		---	MUC	4	---	---	---	---	X	X	X	X
SO261_10		22901-2	GC	---	X	X	X	X	---	---	---	X
SO261_21	6	22901-1	GC	---	X	X	X	X	---	---	---	X
SO261_22		22902-2	MUC	7	X	X	X	X	X	X	X	X
		---		4	---	---	---	---	X	X	X	X
SO261_23		---	MUC	4	---	---	---	---	X	X	X	X
SO261_35	5	22903-1	MUC	7	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_36		---	MUC	4	---	---	---	---	X	X	X	X
SO261_37		22903-2	GC	---	X	X	X	X	---	---	---	X
SO261_48	4	22904-1	MUC	7	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_49		---	MUC	4	---	---	---	---	X	X	X	X
SO261_50		22904-2	GC	---	X	X	X	X	---	---	---	X
SO261_63	3	22905-1	MUC	7	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_64		---	MUC	4	---	---	---	---	X	X	X	X
SO261_65		22905-2	GC	---	X	X	X	X	---	---	---	X
SO261_75	7	22906-1	MUC	7	X	X	X	X	---	---	---	X
SO261_76		---	MUC	4	---	---	---	---	---	---	---	X
SO261_77		22906-2	GC	---	X	X	X	X	---	---	---	X
SO261_92	2	22907-1	MUC	7	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_93		---	MUC	4	---	---	---	---	X	X	X	X
SO261_94		22907-2	GC	---	X	X	X	X	---	---	---	X
SO261_105	10	22908-1	MUC	7	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_106		---	MUC	4		---	---	---	X	X	---	X
SO261_107		22908-2	GC	---	X	X	X	X	---	---	---	X
SO261_115	9	22909-1	GC	---	X	X	X	X	---	---	---	X
SO261_116		22909-2	MUC	7	X	X	X	X	---	---	---	X
		---		4	---	---	---	---	X	X	X	X
SO261_117		---	MUC	4		---	---	---	X	X	---	X

(* subsamples were stored for further analyses in home labs at MARUM and SDU)

Pore water obtained by centrifugation was analysed for nitrite (NO_2^-) and nitrate (NO_3^-) shortly after the sectioning of the two cores. These species were quantified photometrically on 0,5 mL aliquots diluted 1:1 in water using the Griess reagent according to Grasshoff et al. (1999) and with NO_3^- reduction to NO_2^- achieved through heating in the presence of vanadium chloride (1% VCl_3 in 1 M HCl; García-Robledo et al. 2014). Pore water from Sites 1, 3, 4, 5, and 6 in mL aliquots was additionally analysed photometrically for hydrogen sulphide (H_2S) by means of the methylene blue method (Cline 1970) after preservation with zinc acetate ($Zn(CH_3COO)_2 \cdot 2H_2O$; 10 µL of 20% wt/vol per mL). Aliquots of the pore water obtained by centrifugation were saved for further analysis on land. These include 1.5 mL for analysis of ammonium and confirmatory analysis of nitrate and 2 mL acidified with 20 µL 6N HCl for analysis of manganese and iron.

First results

Bottom water nitrate concentrations, as measured in the supernatant of the MUC cores, decreased markedly along the trench axis from ≥ 35 µM in the South to < 25 µM in the North, which suggests the presence of different water masses at either end of the transect. Within the hadal sediment pore water, nitrate, being the preferred electron acceptor for microbial respiration after the depletion of oxygen, reached a depth of 6 – 10 cm with lower penetration depth in the North than in the South. Nitrate penetrated to ~6 cm at the continental slope Site 1 while no depletion was observed to 25 cm depth at Site 7 on the oceanic slope of the trench. Nitrite concentrations were < 2 µM and typically exhibited two peaks, one at the oxic sediment surface (0-1 cm) and a second just below the oxic/anoxic interface. The difference in the associated oxygen concentration suggests that the peaks are related to ammonium oxidation and nitrate reduction, respectively. The nitrate and nitrite profiles in the two cores from the same station were generally very similar, indicating low heterogeneity in redox zonation at each site at the scale of tens of metres, the likely distance between the two MUC coring stations.
In contrast to Site 1 on the continental slope, where the first appearance of iron in pore water fits quite well with the penetration depth of oxygen, this is not the case in the hadal trench. As already indicated by clear and relatively sharp colour changes from brownish to greyish within the surface layers, first low iron concentrations were only detectable significantly below the oxic zone in depth between 10 and 15 cm. As to be assumed, phosphate concentrations almost parallel the iron profiles, but also ammonium and alkalinity show prominent changes in gradients in the respective depths. Together with the results from the much deeper-reaching gravity cores (s. below), this observation let assume different composition of layered surface sediments. Perhaps the uppermost parts of the deposits have been accumulated very fast in form of debris flows. Further, more detailed investigations in our home labs will pursue this hypothesis. Taken iron, phosphate, ammonium or alkalinity as indicators for the intensity of microbial activity, respectively iron reduction or organic matter degradation, no systematic trend(s) could be observed along the trench axes.

Hydrogen sulphide was not detected at any of the sites where it was analysed. Based on this result and the general similarity in redox zonation of MUC cores across sites, hydrogen sulphide analyses were not carried out at all the sites sampled later during the cruise.

The assumption that the hadal sediments in the Atacama Trench are deposited rather in form of lateral mass transport (e.g. submarine landslides, debris flows) than by continuous vertical sedimentation, is strongly supported by both, first visually distinguishable changes in the grain size composition along all gravity cores and striking fluctuations in iron and (to a somewhat lesser extent) phosphate concentrations down to 3,4 – 6,30 m below the sea floor. Especially several local maxima in iron release indicate different layers with a significant amount of reducible oxihydroxides. The preliminary most logical explanation for this phenomenon are changing input rates of terrestrial minerals, which may have been deposited first in shallower waters and were remobilized later either naturally due to the steepness of the slope or triggered by earthquakes. The different reactive layers are separated by intercalated “normal”, hemipelagic sediments.

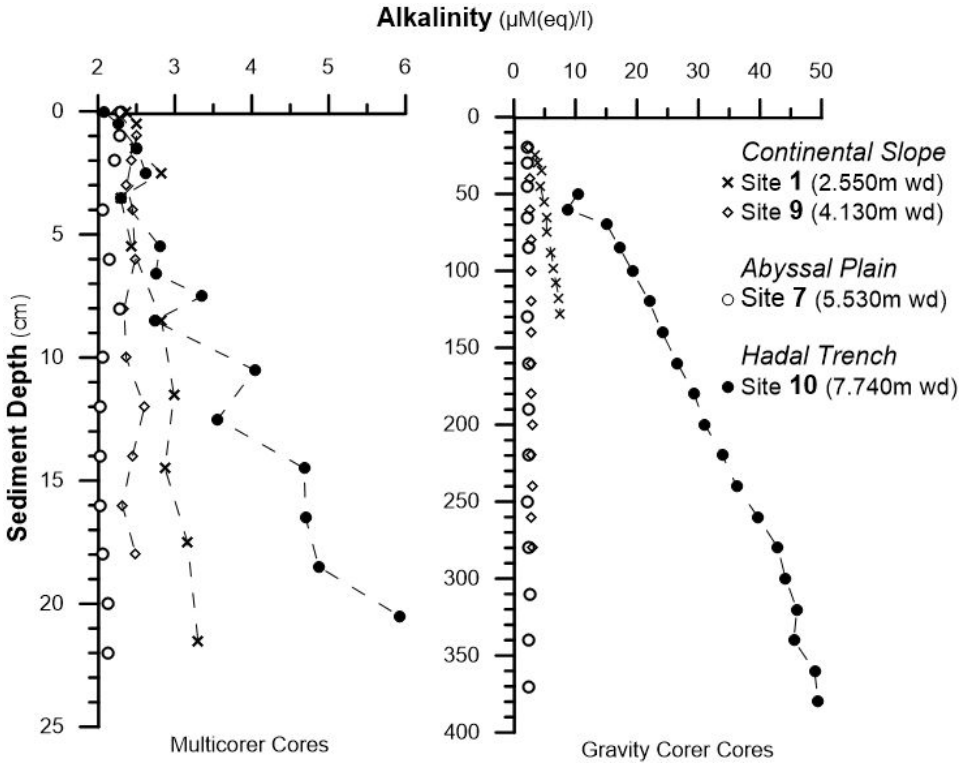

Figure 7.9.1 *Alkalinity profiles in pore waters from four different sites. By far the highest values could be measured in the sediments from hadal depths.*

The comparison between pore water results from the slope Sites (1 and 9), the abyssal plain (Site 7) and the hadal Sites (2-6 and 10) clearly support our previous assumption that Atacama Trench is a sink for organic material. Figure 7.9.1 shows the alkalinities from surface as well as deeper sediments recovered at Sites 1, 7, 9 and 10. Although subsequent, more specific analyses in our home labs have to confirm this, we assume that values represent mostly dissolved inorganic carbon (DIC) concentrations and profiles can be seen as indicators for the local intensities of early diagenesis. It is obvious, that by far the highest concentrations are archived in hadal deep-sea sediments.

7.10 Organic Biogeochemistry / Chemosynthesis in water column

X Li, X Zhao

7.10.1 Objectives

As the most complete representative of water layers, trench becomes a natural environment to evaluate pelagic organic carbon budget. However, besides the occasional input of organic carbon by geological activities such as earthquakes, landslides etc, extraordinarily high organic

carbon content in the trench sediment mediated by microbes in overlying water columns are still poorly known. We propose to apply elemental analysis, light spectrometry and mass spectrometry to study the composition and characteristics of POC/DOC in the pelagic realm of the trench; combining with measurement on microbial chemoautotrophic carbon fixation and respiration rate, we aim to first quantitatively assess the carbon input from microbial activities. The investigation aim to study organic carbon cycling from diverse information including physical, chemical and biological parameters. The exploit of the project will provide basic understanding of processes in trench storage of organic carbon and organic carbon cycling in extreme environment.

Work at sea

At the biogeochemical stations, discrete samples were obtained at selected depths from surface to hadal trench (eg. 5, 1000, 3000, 6000, 6500, 7500m), by means of a CTD-rosette sampler and special designed hadal rosette sampler (Tab. 7.10.1 and 7.10.2).

Physicochemical parameters

DOC and nutrient samples have been taken for CDOM, FDOM and FT-ICR. MS analysis on land.

Microbial community structure and abundance

Size fractionated microbes have been collected by 2.7 µm, 0.7 µm (Whatman) and 0.3 µm (Advantec, Japan) GF filters and stored at -80 °C until further analysis. Later in the lab, quantitative PCR and MiSeq sequencing targeting the bacterial and archaeal 16S rRNA gene will be performed on these filters to study the microbial community abundance and structure.

Chemoautotrophic carbon fixation rate

Seawater samples from each depth were spiked with a $^{13}C–NaHCO_3$ (99 atm% ^{13}C; Shoko Corporation) solution with about 10% of the total inorganic carbon in the ambient water. The samples were incubated in dark in a climate room. Immediately following incubation, the samples were filtered directly through pre-combusted (450°C for 4 h) Whatman GF/F filters under vacuum. The filtered samples were kept frozen and stored at -80 °C until isotope analysis performed on land.

Microbial community respiration rate

In vivo INT method was applied on board to measure the microbial community respiration rate. Immediately following incubation, the samples were filtered directly through size fractionated PC filters (3.0 µm, 0.8 µm, 0.2 µm) and stored at -80°C for land analysis. Size fractionated microbial community respiration rate will be derived.

First results

All analysis will be analyzed at Southern University of Science and Technology in China. Meanwhile, sediment multi-cores have been collected and sectioned on board. Biogeochemistry work such as organic biomarkers and stable and radiocarbon isotopes will be conducted. See details in “7.21.6 Characterization of deposited organic material”.

Table 7.10.1 *Water biogeochemistry on cruise SO261*

Station	Analysis	No. of bottle
S0261_10	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	1,3,14,15,19,20,21,22
S0261_13	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	2,10,16,22
S0261_19	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	5,6. 2
S0261_25	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	1
S0261_28	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC;FT-ICR-MS	2,10,16,24
S0261_34	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC; FT-ICR-MS	1,3,4,5,6
S0261_39	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC; FT-ICR-MS	2,11,17,24
S0261_40	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC; FT-ICR-MS	1,6,3
S0261_44	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	sediment lander
S0261_57	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	2,11,17,24
S0261_63	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	5
S0261_74	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC; FT-ICR-MS	4,11,17,24
S0261_80	Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	8,14, 19, 20, 23
S0261_82	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC; FT-ICR-MS	1, 10, 16, 24

Station	Analysis	No. of bottle
S0261_91	Respiration rate;Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC; FT-ICR-MS	1,2(7L),3(7L),4(7L),5(7L),6
S0261_100	Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	1, 10, 16, 24
S0261_108	Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	1,2(7L),3(7L),4(7L),5(7L),6
S0261_110	Carbon fixation rate;Microbial community structure and abundance;Nutrients;DOC	2,7,14,19,20,23

Table 7.10.2 *Sediment biogeochemistry on cruise SO261*

Station	Analysis	Research group	No of cores
S0261_8	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_23	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_36	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_49	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_64	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_76	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_93	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_106	Elemental analysis; Organic biomarkers	SUSTech; SOU	3
S0261_116	Elemental analysis; Organic biomarkers	SUSTech; SOU	3

7.11 *In situ* and lab flux and process measurements

RN Glud, M Larsen, B Thamdrup, A Glud, F Wenzhöfer

Objectives

The main objectives of this subtask is to a) quantify the total benthic carbon mineralization rate from O_2 microprofile measurements, b) compare *in situ* versus laboratory based microprofile measurements to explore potential recovery artefacts, c) quantify sulphate reductions rates (SRR) and asses the relative importance of SRR for the total carbon mineralization, d) resolve the benthic N turn over in the surface sediments with particular focus on anammox and denitrification through laboratory and *in situ* assessments.

Work at sea & first results

For objective a)

As described in section 7.5.2 the profiling lander performed well during all deployment. This has provided us with approximately 300 *in situ* microprofiles to be processed, including microprofiles for resistivity, O_2 and to lesser extent NO_3^-. It is a major effort to – in detail - analyse every profile to derive transport coefficients, concentration profiles and process rates. This will be realized in the coming year. However, preliminary analysis of a few selected profiles shows considerable variation in the O_2 penetration depth between the respective sites; from 1.88 cm

at site 1 to 22.00 cm at site 7 (Fig. 7.11.1). It is not too surprising that site 1 at the continental slope with a water depth of 2560 m display the highest mineralization (or biological) activity with an O_2 penetration depth of only 1.88 cm. However, the two other sites outside the trench; site 7 and site 9 at depths of 6033m and 4022m both have significantly lower mineralization activity (deeper O_2 penetration depth) than all stations along the trench axis residing at a depth range from ~7500m to ~8100m. This clearly reflects intensified biological activity at the trench axis as compared to the ambient seafloor. It further more appears that sites to the south exhibit lower activity than the northern stations which might reflect the general increase in surface productivity above the trench towards the north.

Preliminary inspection of the many profiles do, however, show some variation in activity at the respective sites and that relatively few profiles (~2-3%) are affected by irrigation or macrofauna activity. However, full appreciation of microscale variation in mineralization activity at the respective sites awaits further analysis.

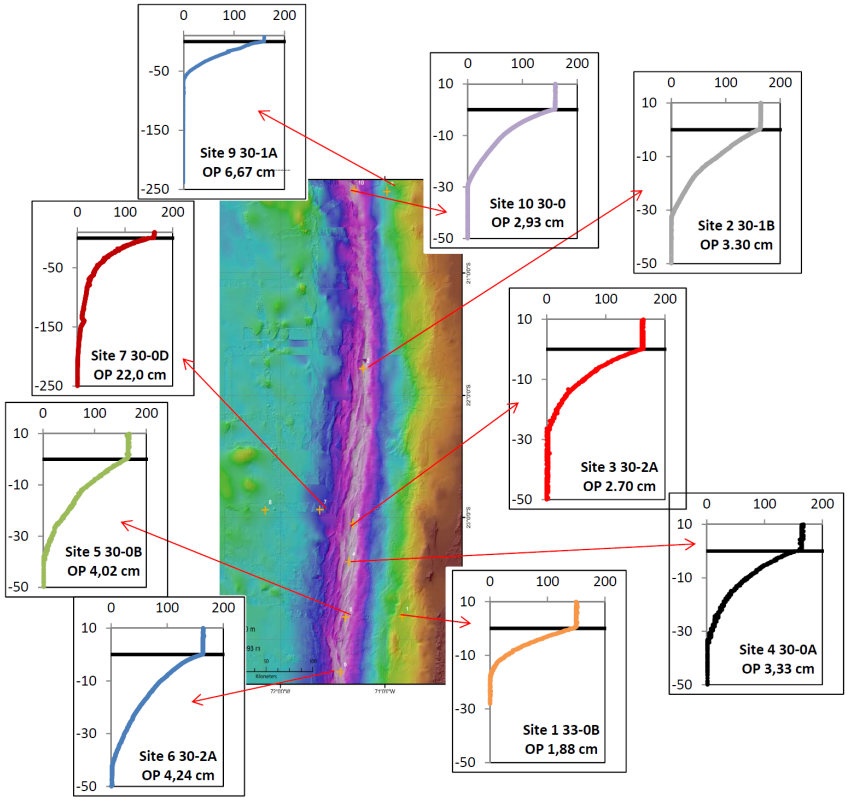

Figure 7.11.1 *Selected in situ O_2 microprofiles measure at the respective sites targeted during So261*

For objective b)

O_2 and NO_3^- microprofiles were measured in the laboratory in apparently undisturbed sediment as recovered by the MUC from seven sites. The data are of relatively good quality despite the fact that it was difficult maintaining the O_2 in the overlying water at the *in situ* level. However, any direct comparison between profiles obtained in the laboratory versus *in situ* will have to await more detailed analysis.

For objective c) (*liaise with section 7.9)*

Microbial sulphate reduction rates were determined by the ^{35}S radiotracer technique (Jørgensen 1979) in two cores subsampled from a MUC core from the 1st deployment at all sites except Site 7. These cores, in 2,8 cm i.d. acrylic core liners equipped with silicone-sealed injection ports at 1 cm vertical intervals, were brought to the radiotracer laboratory container and there injected with 5 µL of carrier-free $^{35}SO_4^{2-}$ (1 kBq μL^{-1}) per centimetre through the entire length of the core. The cores were incubated for 24 h at 3 °C and then sectioned in 2-cm intervals, which were fixed in 10 mL of 20% wt/vol zinc acetate and stored frozen for later analysis. The data will enable direct assessment of the importance of SRR for total carbon mineralization.

For objective d) (*liaise with section 7.9)*

Rates of anaerobic microbial nitrogen transformations (denitrification, anammox, nitrate reduction to nitrite, nitrate/nitrite reduction to ammonium) were determined at all sites by addition of ^{15}N-labeled substrates to anoxic sediment slurries following the principles of Dalsgaard and Thamdrup (2002). For this, a core from the 2nd MUC was sectioned and processed in the N_2-filled glovebag into four to eight depth intervals of 2 or 2,5 cm thickness reaching from above the oxic/anoxic interface to below the depth of nitrate depletion as determined just prior to the start of incubations. From each section 40 – 80 cm^3 of sediment was suspended in 1,5 times the volume of artificial seawater (S = 35), which had been purged with N_2. The resulting slurries were dispensed into 6-mL glass vials (Exetainers, Labco, UK) previously amended with ^{15}N-labeled substrates as specified below. The vials were sealed with butyl rubber septa leaving no headspace and incubated at 3 °C. Incubations were terminated by addition of 100 µL 50% wt/wt zinc chloride ($ZnCl_2$) solution. Standard incubation time was 48 h with vials sacrificed in triplicate per depth and treatment at the beginning and end of the incubation, respectively. At selected sites and depths additional vials were incubated for 24 – 120 h to test linearity in product accumulation rates. The substrate additions (final concentrations in parentheses) included $^{15}NO_3^-$ (100 µM), $^{15}NH_4^+$ (200 µM), $^{15}NH_4^+ + {}^{14}NO_3^-$ (200 + 100 µM), and $^{15}NO_2^-$ (50 µM). The samples will be analysed by mass spectrometry on land. The sediment sections used for these incubations were additionally subsampled for quantification of anammox bacteria and potentially other functional guilds of the nitrogen cycle. For this three samples of 1 mL form each section were stored at -80°C.

Ultimately the laboratory determined proses rates will be compared to the *in situ* measurements derived from the incubation of the sediment lander.

7.12 Biodiversity

S Arnaud-Hoand*, M Brandt, B Trouche*

Objectives

Oceans cover 70% of the surface of our planet and in its three vast dimensions the marine biome represents 90% of the Earth biome. Thus far we have explored less than 5% of the oceans (Costello et al. 2010). Of around 1.8 million species described to date, fewer than 250,000 are marine. However, major taxonomic and ecological compartments of the Earth system haven't been explored yet, and recent holistic survey of surface world oceans' plankton have shown for instance that unicellular eukaryotes (protists) account for >85% of total eukaryotic diversity (de Vargas et al. 2015). The knowledge and understanding of the ecology and evolution of the marine realm requires an enhanced appraisal of marine biodiversity and of the biotic and abiotic drivers of its distribution and evolution. Yet the very first step, that of inventory, appears

stumbled: considering the pace of taxonomic description in 2015, an estimated 10,000 years would be required to complete the taxonomic descriptions and inventory of the majority of the existing biodiversity, provided it would be accessed and sampled.

In this context, the contribution of the team occurs in the framework of the project "*Pourquoi Pas les Abysses*" (*ABYSS*) launched by Ifremer with the sequencing support of France Génomique through "*eDNAbyss*". Our objective in *ABYSS* project is to contribute to a new census of marine biodiversity through molecular inventories based on metabarcoding (eukaryotes –including metazoans-, and prokaryotes) and metagenomics (mostly prokaryotes) on environmental DNA (eDNA) sampled from sediments and the layer of water just above the sea floor). Finally, we expect then to explore, based on those inventories, the biotic and abiotic interactions detectable within and among the main taxonomic compartments, and that may play a role in shaping the distribution, dynamics and evolution of marine biodiversity from genes to communities. This is the topic of the PhD thesis of Miriam Brandt and Blandine Trouche.

Specific objectives on hadal trenches: the bridge between HADES and ABYSS

The participation of the team to the cruise is embedded in a collaboration with the HADES project. More than providing unique data, adding the hadal trenches of Kermadec and Atacama to the ABYSS project, this collaboration allows a synergy between the characterization of biogeochemical processes and that of living communities characteristics of hadal trenches compared to abyssal plains. We will focus on specific questions related to the workings and specificity of the hadal trenches.

- How biogeochemistry relates with the diversity and composition of microbial + metazoans assemblages at local and global scales?
- What is the role of biogeochemical parameters as drivers of the community composition, and can it be disentangled from the role of some biotic compartments in the biogeochemical processes measured?
- What are the functional trends?
- What are the emerging biogeographic patterns for the biotic and the abiotic parameters and do they coincide?

Work at sea

We sampled three cores from two consecutive multicorer (MUC) deployments on each site. Two cores were collected from the first deployment, and one from the second. Cores were between 20-42 cm long (Tab. 7.12.1). For each core, we retrieved the supernatant water and filtered it on 0.2 µm polycarbonate filters that were flash frozen in liquid nitrogen and preserved at - 80°C.

Table 7.12.1 Overview of cores sampled for eDNA during the SO261 cruise.

Site	Lat_DM	Long_DM	Water Depth	ID of eDNA cores	Core length
1	23° 48.72‘ S	70° 50.04‘ W	2560	1.8; 1.9; 2.8	25-27.5 cm
6	24° 15.96‘ S	71° 25.38‘ W	7720	1.8; 1.9; 2.8	25-28.5 cm
5	23° 49.02‘ S	71° 22.32‘ W	7770	1.8; 1.9; 2.8	32.5 cm
4	23° 21.78‘ S	71° 20.6‘ W	8085	1.8; 1.9; 2.8	32.5-37.5 cm
3	23° 2.94‘ S	71° 18.12‘ W	7915	1.8; 1.9; 2.5	32.5 cm
7	22° 56.22 , S	71° 37.08‘ W	5500	1.8; 1.9; 2.9	30-32.5 cm
2	21° 46.86‘ S	71° 12.48‘ W	7994	1.8; 1.9; 2.8	29-35 cm
8	22° 56.4‘ S	72° 8.76‘ W	4000	NA	NA
9	20° 19.971‘ S	70° 58.704‘ W	4050	1.8; 1.9; 2.8	20 cm
10	20° 19.14‘ S	71° 17.46‘ W	7770	1.8; 1.9; 2.8	40-42 cm

Each core was sliced into horizons following the HADES sampling scheme and slices homogenised and preserved in zip lock bags at -80°C (Fig. 7.12.1). The HADES samples were taken as follows:

- each cm for the first 10 cm
- every 2.5 cm for the rest of the core up to the end of it (20 to 42 cm, depending on site, see Table 7.12.1).

From each of these horizons, three subsamples (1 mL, 2 mL, 2 mL) were taken and preserved in cryotubes for further molecular biology analyses.

Then, a subsample was extracted from each HADES horizon and mixed according to the ABYSS scheme (Fig. 7.12.1), to compile two 10 g subsamples for DNA extraction in the lab after the cruise. From these ABYSS horizons, two subsamples were also taken for preliminary treatment on board:

- 0.5 mL for FISH fixation using paraformaldehyde 4%
- 0.75 mL for pyrophosphate treatment in order to separate soluble DNA (assimilated to extracellular DNA) and non-soluble DNA (assimilated to intracellular DNA).

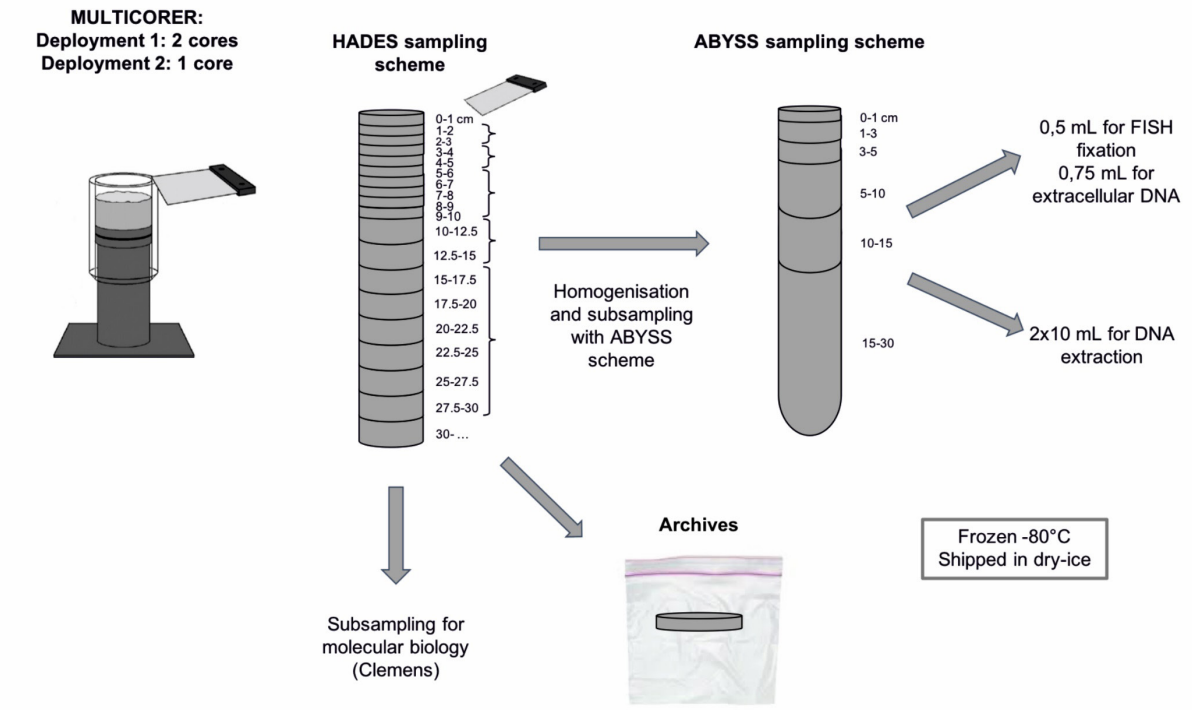

Figure 7.12.1 *Sampling procedure of sediment samples for eDNA metabarcoding, following the HADES and ABYSS schemes To fit the ABYSS scheme, subsamples from HADES samples were pooled, their left-over was archived following HADES scheme.*

First results

No results could be directly obtained on-board as DNA has to be extracted first, but the summary of samples and horizons prepared is detailed in the Appendix. We expect the DNA to be extracted during the following weeks for data processing during summer.

7.13 Microbiology and Virology

L Peoples, C Schauberger, M Larsen, RN Glud

Objectives

Accurate rates of microbial activity in the deep-sea are important for estimating carbon sequestration in the ocean. However, most estimates of deep-ocean microbial activity have been conducted under atmospheric pressure conditions. Microbial activity may be higher under *in situ* pressures as these communities might be expected to be adapted to their *in situ* conditions. Such measurements are lacking, especially from hadal locations that contain distinct communities from those at abyssal sites. Therefore pelagic water samples will be evaluated for microbial activity under atmospheric, *in situ*, and full-ocean depth pressures using the methionine analog homopropargylglycine (HPG). HPG is incorporated into newly synthesized protein and can be detected using fluorescence microscopy or fluorescence activated cell sorting. This will allow us to 1) determine the active fraction of the microbial community down the water column 2) determine within samples the effects of hydrostatic pressure on rates of microbial activity 3) compare across water column depths to see if communities are increasingly pressure-adapted with depth 4) taxonomically and genomically characterize the active members of these communities.

Deep-ocean samples are typically collected with Niskin bottles under decompressed conditions. What influence this has on microbial abundances or activity is relatively unknown. Therefore we have developed a pressure-retaining sampler (PRS) capable of collecting hadal water and maintaining *in situ* pressure (Fig. 7.13.1 and 7.13.2). This device has been deployed at hadal depths one time previously; therefore this will be the first shakedown cruise of this instrument. The PRS will be deployed pre-loaded with HPG or formaldehyde to address whether cell abundances and activity vary when collected with and without decompression.

Microbes that show optimum growth under hydrostatic pressures greater than 0.1 MPa are known as piezophiles. The majority of piezophiles belong to a narrow group of Gammaproteobacteria, including members of the genera *Colwellia*, *Shewanella*, *Moritella*, *Psychromonas*, and *Photobacterium*. This is in part due to the nutrient-rich, facultatively-anoxic conditions that are typically used when culturing in pressure vessels. In order to culture novel piezophiles we have developed a flow through system for maintaining oxygen and nutrient concentrations. Water, sediment, and amphipod samples will be collected to isolate novel piezophiles using this device and within pressure vessels back at our home institution.

Work at sea

To estimate microbial activity water samples were collected from 14 deployments at 22 discrete depths. These depths included 50m, 500m, 2500m, 5000m, and 7000-8000m to evaluate different oceanographic regimes (surficial, mesopelagic, bathypelagic, abyssopelagic, and hadopelagic) for their pressure response. 50 mL aliquots were amended with 5 uM HPG and incubated at 2-4°C at 0.1 MPa, *in situ* pressure of collection, and 80 MPa (full trench depth). Samples were incubated for two days prior to fixation with formaldehyde. Hadal samples were also preserved without fixation in glycerol-TE. Hadal samples were also concomitantly incubated at room temperature and the aforementioned conditions for two and five days to determine how the pressure sensitivity of these samples changes as a function of temperature and length of incubation.

Figure 7.13.1 *The PRS mounted to the hadal rosette with a spring system (Foto: L Peoples)*

Eleven deployments of the pressure-retaining sampler were attempted. Each build of the PRS took approximately 6 hours, not including sample processing, disassembly, or cleaning of the device. Five deployments were performed using the hadal rosette where a spring system was used to trigger the opening and closing of the valve on the PRS. The spring system was operated at depth using the same pressure-triggered sensor that was used to close the Niskin bottles on the rosette. Six subsequent deployments were performed using the CTD rosette. The PRS was mounted on the bottom of the rosette with a motor system from MPI to open the device 720°, remain open for 15 minutes, and close. After all recoveries the PRS was dismounted from the rosette and checked to make sure it opened properly by pressure release in the rear compartment. The retained pressure was then checked using a high-pressure pump. The PRS was deployed loaded with either HPG or formaldehyde.

Water, sediment, and amphipod samples were collected for culturing under high hydrostatic pressure and for single-cell genomics. Water samples from 14 deployments were preserved in glycerol and glycerol-TE. High volume filtration of water samples from 9 deployments was also performed to concentrate cells prior to preservation. 0-1 cm sediment samples from 8 multicore deployments were preserved in glycerol and glycerol-TE. Amphipod samples from two camera lander deployments were homogenized in sterile 0.2 um filtered abyssal or hadal seawater and preserved in glycerol and glycerol-TE.

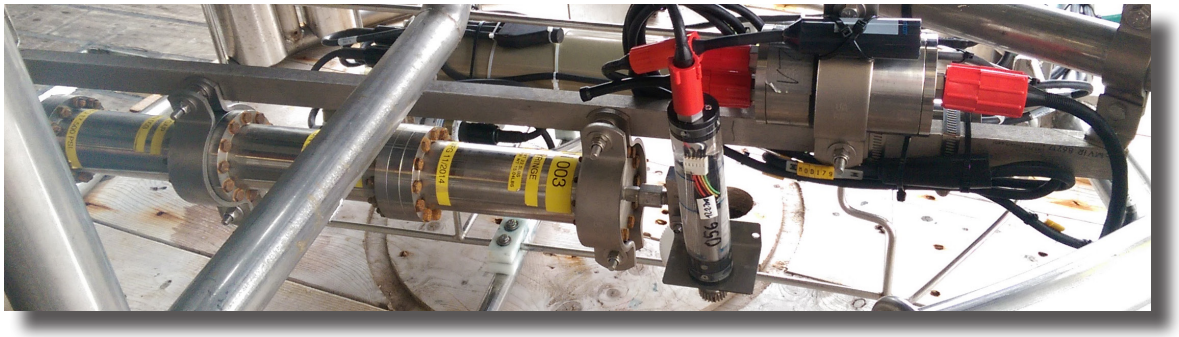

Figure 7.13.2 *The PRS mounted to the CTD rosette with a motor (Foto: L Peoples)*

First results

Estimates of microbial activity will be evaluated using fluorescence microscopy and FACS-based single-cell genomics to identify active populations under different pressure conditions. Culturing will be performed back at SIO.

Eleven total deployments were attempted using the PRS: 3 successful deployments that held pressure, 3 failures of the motor to open the sampler, 1 burn wire failure to open the sampler, 1 spring failure to open the sampler, 1 burn wire failure to close the sampler, 1 failure of the spring to close the sampler completely (valve ajar), 1 aborted deployment due to a set screw issue during pre-deployment testing. Of the three successful deployments the PRS held 62%, 70%, and 69% of the *in situ* pressure. While the number of samples collected under *in situ* conditions was less than hoped for, the cruise still showed that the sampler is functional and capable of maintaining between 60-70% of the *in situ* pressure upon recovery. The drop in pressure is likely due to thermal expansion of the system (only a ~7 mL loss is needed to fully decompress the system at 60 MPa), as the temperature on recovery was between 7-16°C, while abyssal and hadal Niskin water was between 3-4°C. The sampler works when the needle valve is reliably opened and closed at depth.

7.14 Meiofauna

7.14.1 Metazoans meiofauna

D Zeppilli

Objectives

The Atacama Trench, belonging to the Peru–Chile trench system, is the most southern and deepest trench of the eastern Pacific Ocean. The trench receives substantial inputs of organic fallout from the richly productive surface waters and it represents an extreme end- member with massive deposition of material degraded at highly elevated pressure. An early study, based on the analysis of three cores obtained from a single location in the Atacama Trench at 7800 m depth, revealed an extraordinarily high meiofaunal density, dominated by nematodes. Following this study, hadal faunal communities of the Peru-Chile Trench were investigated revealing various families of fish, amphipods and snails between 4000 and 8000m depth.

In order to investigate abundance, diversity and community structure of benthic organisms in the Atacama we collected sediment samples during the cruise So-261. Benthic organisms coming from a less productive trench, Kermadec Trench in Southwest Pacific, and nearby abyssal and shelf sites will be compared to achieve a better understanding in biogeochemical processes, community structure and biodiversity and ecosystem functioning (BEF) relationships.

Specific objectives are:

1) investigate abundance, biomass and diversity of benthic organisms in the Atacama and Kermadec Trenches and adjacent abyssal and bathyal sediments, testing whether the Atacama Trench is indeed a « hotspot » of benthic biomass and including environmental factors responsible for potential observed patterns;

2) unveil connectivity of benthic organisms between the Atacama and Kermadec Trenches and adjacent abyssal-bathyal sediments;

3) identify biodiversity and ecosystems functioning patterns in the Atacama and Kermadec Trenches;

4) investigate the presence of the nematode parasite *Trophomera* in hadal amphipods.

Work at sea

During the So-261 cruise, we sampled sediments from six hadal sites within the Atacama trench (sites 2, 3, 4, 5, 6, 10), 2 abyssal sites (sites 7 and 9) and 1 station at 2550 m at the continental shelf off Chile (Tab. 7.14.1.1). Sediment samples were collected with the MUC. Two independent deployments were made for each site. For each deployment, one corer was dedicated to benthic sampling. Immediately after collection, sediment cores were transported to the cold room. Each MUC corer was subsampled in four cores (29 mm diameter): three subcores were dedicated to meiofauna abundance, biomass and diversity and one subcore for barcoding and isotopes. Samples were sliced in cold into 1 cm up to 10 cm and immediately stored in formalin 4 % or frozen at -80°C. Extra corers available were fixed at -80°C for further molecular analyses (barcoding) and isotope analyses.

In order to investigate the presence of the nematode parasite *Trophomera* in hadal amphipods, amphipod traps were deployed at the site 6 (Tab. 7.14.1.2).

First results

Table 7.14.1.1 *List of cores sampled.*

STATION	SITE	DEVICE	DEPLOYMENT	CORER	ANALYSIS
SO261_8	1	MC	DEP1	10	Meiofauna/Macrofauna
SO261_9	1	MC	DEP2	10	Meiofauna/Macrofauna
SO261_21	6	MC	DEP1	10	Meiofauna/Macrofauna
SO261_22	6	MC	DEP2	10	Meiofauna/Macrofauna
SO261_35-1	5	MC	DEP1	10	Meiofauna/Macrofauna
SO261_36-1	5	MC	DEP2	9	Meiofauna/Macrofauna
SO261_36-1	5	MC	DEP2	7	Barcoding/Isotopes
SO261_48-1	4	MC	DEP1	10	Meiofauna/Macrofauna
SO261_49-1	4	MC	DEP2	9	Meiofauna/Macrofauna
SO261_63-1	3	MC	DEP1	10	Meiofauna/Macrofauna
SO261_64-1	3	MC	DEP2	6	Meiofauna/Macrofauna
SO261_64-1	3	MC	DEP2	9	Barcoding//Isotopes
SO261_75-1	7	MC	DEP1	10	Meiofauna/Macrofauna
SO261_76-1	7	MC	DEP2	8	Meiofauna/Macrofauna
SO261_76-1	7	MC	DEP2	6	Barcoding/Isotopes
SO261_76-1	7	MC	DEP2	9	Barcoding/Isotopes
SO261_92-1	2	MC	DEP1	9	Meiofauna/Macrofauna
SO261_93-1	2	MC	DEP2	9	Meiofauna/Macrofauna
SO261_93-1	2	MC	DEP2	7	Barcoding/Isotopes
SO261_105-1	10	MC	DEP1	10	Meiofauna/Macrofauna
SO261_106-1	10	MC	DEP2	7	Meiofauna/Macrofauna
SO261_106-1	10	MC	DEP2	9	Barcoding/Isotopes
SO261_116-1	9	MC	DEP1	10	Meiofauna/Macrofauna
SO261_117-1	9	MC	DEP2	9	Meiofauna/Macrofauna
SO261_106-1	10	MC	DEP2	7	Barcoding/Isotopes

Table 7.14.1.2 *List of amphipod trap samples (no parasite observed).*

STATION	SITE	DEVICE	DEPLOYMENT	FIXATION	ANALYSIS
SO261_16	6	LANDER	AMPHIPOD TRAP 1	Ethanol	9 amphipods
SO261_16	6	LANDER	AMPHIPOD TRAP 1	-80°C	8 amphipods
SO261_16	6	LANDER	AMPHIPOD TRAP 2	Ethanol	3 amphipod
SO261_16	6	LANDER	AMPHIPOD TRAP 1	-80°C	13 amphipods

7.14.2 Foraminifera

D Romero

Objectives

The Atacama Trench, situated in the upwelling zone off Chile, has become attractive for researches about organisms adapted to particular extreme conditions at the seafloor in this depth. Among benthic communities, some meiofauna groups have been well-characterized,

but only one observation recorded the presence of soft-shelled foraminifera. This group was composed by organic-walled allogromiids and agglutinated saccamminids from a single core at 7800 m depth in this area.

The objective is to assess the biodiversity of benthic foraminifera in sediment samples from hadal sites in the Atacama Trench and surrounded areas during the cruise So 261. In addition, we investigate the presence of foraminiferal species/morphotypes which can potentially store nitrate in their cells in order to understand its ecological function in deep-sea sediments.

Specific objectives are:

1) Assess the abundance and diversity of benthic foraminifera in the survey area.
2) Study the spatial and vertical distribution of foraminifera related to environmental/ sedimentary parameters.
3) Estimate the intracellular nitrate in some species sorting onboard during the cruise.

Work at sea

Sediment samples were collected using the multicorer (MUC) in nine sites off Atacama (Chile). Six of them are located within the Atacama trench (sites 2, 3, 4, 5, 6, 10), two in the abyssal (sites 7 and 9) and one in the bathyal zone (site1), close to the continental margin. For objectives 1 and 2, samples were collected directly from the MUC tube (= 29 mm) which corresponded to the second deployment. The cores were sliced at one centimeter intervals for the upper 5 cm. Only for site 1, slices were cut for the 10 cm with the same resolution (Tab. 7.14.2.1). The slices of sediment were immediately preserved in plastic jars with 100 ml of 4 % buffered formalin. This samples will be stained with Rose Bengal in land (IMARPE).

Table 7.14.2.1 *List of sediment samples for foraminifera.*

STATION	SITE	CORER	LEVEL	FIXATION	ANALYSIS
9	1	10	0-10	Buffered Formalin	Foraminifera
93	2	10	0-5	Buffered Formalin	Foraminifera
64	3	10	0-5	Buffered Formalin	Foraminifera
49	4	10	0-5	Buffered Formalin	Foraminifera
36	5	10	0-5	Buffered Formalin	Foraminifera
22	6	10	0-5	Buffered Formalin	Foraminifera
76	7	10	0-5	Buffered Formalin	Foraminifera
117	9	10	0-5	Buffered Formalin	Foraminifera
106	10	10	0-5	Buffered Formalin	Foraminifera

For objective 3, the remaining sediment from every replicate core for meiofauna sampling (IFREMER) was collected for the upper 3 cm at each site. Samples were wet-sieved with filtered sea water using a 20 µm mesh and put into small Petri dish. Samples were observed with a binocular microscope. Species/morphotypes were hand sorted into artificial sea water (ASW) and photographed with a camera Zeiss AxioCam for biovolume measurements. Lastly, they were stored in small vials and frozen at -20 °C until the analyses in SDU.

Additionally, some specimens of xenophyophores were recovered from the surface of core samples at site 2 and preserved with formalin for further identification.

First results

Preliminary observations in hadal sites indicated that most of the specimens recorded were allogromiids with different forms (predominately spherical and elongate) and agglutinated groups like saccamminids and psammosphaerids were very frequent. A *Resigella-like* form and *Chitinosiphon* spp. were very common on the trench sites as well other chain-like monothalamids. A tubular agglutinated form resembling the genus *Bathysiphon* was observed, too. It probably has been recorded as some specie of *Hyperammina* in the literature. A few Komokiaceans were observed but not classified yet. At bathyal and abyssal sites, the number of agglutinated species increased recording some taxa like Ammodiscids, Hormosinids, Trochamminids and even Robertinids (see also Tab. 7.14.2.2).

Table 7.14.2.2 *List of species picked for intracellular nitrate analysis.*

Vial	Specie	Number	Site	Level (cm)	Replicate
1	*Saccammina spp.*	14	1	0-1	-
2	*Saccammina spp.*	37	1	0-1	-
3	*Saccammina spp.*	36	1	0-1	-
4	*Saccammina spp.*	32	1	0-1	-
5	*Chitinosiphon spp.*	19	6	0-1	1
7	*Saccammina sp1*	8	6	1-2	1
8	*Saccammina sp2*	4	6	1-2	1
9	*Resigella ps2*	2	6	1-2	1
12	*Saccammina sp1*	2	6	2-3	1
13	*Saccammina sp2*	3	6	2-3	1
14	*Psamosphaera sp1*	2	6	2-3	1
6	*Chitinosiphon spp.*	9	6	0-1	2
10	*Psamosphaera sp1*	3	6	1-2	2
11	*Saccammina sp2*	5	6	1-2	2
15	*Saccammina sp2*	18	6	2-3	2
16	*Psamosphaera sp1*	2	6	2-3	2
18	*Saccammina spp.*	4	5	0-1	1
17	*Saccammina spp.*	12	5	0-1	2
20	*Resigella ps2*	3	5	1-2	1
19	*Saccammina spp.*	6	5	1-2	2
21	*Saccammina sp2*	20	5	2-3	1
22	*Saccammina sp2*	11	5	2-3	2
23	*Saccammina spp.*	3	5	2-3	2
24	*Gromiid sp1*	7	4	0-1	2
25	*Psamosphaera sp2*	5	4	0-1	2
26	*Ammoscalaria*	3	4	0-1	2
27	*Bathysiphon-like*	3	4	0-1	2
28	*Bathysiphon-like*	7	4	0-1	1
29	*Gromiid sp1*	2	4	0-1	1
30	*Ammoscalaria*	1	4	0-1	1
31	blank	-	4	0-1	1
32	*Bathysiphon-like*	4	4	1-2	2

Vial	Specie	Number	Site	Level (cm)	Replicate
33	*Saccammina sp2*	13	4	1-2	2
34	*Bathysiphon-like*	8	4	1-2	1
35	*Saccammina sp2*	13	4	1-2	1
36	*Bathysiphon-like*	3	4	2-3	1
37	*Saccammina sp2*	10	4	2-3	1
38	*Saccammina sp2*	10	4	2-3	2
39	blank	-	4	2-3	2
40	*Bathysiphon-like*	5	3	0-1	1
41	*Saccammina sp2*	12	3	0-1	1
42	*Bathysiphon-like*	5	3	0-1	2
45	*Saccammina sp2*	7	3	1-2	1
43	*Bathysiphon-like*	2	3	1-2	2
44	*Saccammina sp2*	8	3	1-2	2
46	*Saccammina sp2*	9	3	2-3	1
47	*Saccammina sp2*	7	3	2-3	2
48	*Saccammina sp2*	15	7	0-1	1
49	*Saccammina sp2*	19	7	0-1	2
50	*Allogromiid undefined*	3	7	0-1	2
51	*Saccammina sp2*	12	7	1-2	1
52	*Saccammina sp2*	18	7	1-2	2
53	*Saccammina sp2*	12	7	2-3	1
54	*Saccammina sp2*	15	7	2-3	2
55	*Allogrommiidae sp.1*	18	2	0-1	1
55	*Chitinosiphon spp.*	14	2	0-1	1
55	*Allogrommiidae sp.2*	3	2	0-1	1
55	*Allogrommiidae sp.3*	1	2	0-1	1
55	*Resigella ps2*	1	2	0-1	1
56	*Allogrommiidae sp.1*	11	2	1-2	1
56	*Chitinosiphon spp.*	6	2	1-2	1
57	*Allogrommiidae sp.1*	5	2	2-3	1
57	*Chitinosiphon spp.*	10	2	2-3	1
58	*Allogrommiidae sp.1*	21	2	0-1	2
58	*Chitinosiphon spp.*	4	2	0-1	2
58	*Resigella ps2*	3	2	0-1	2
58	*Gromiid sp1*	1	2	0-1	2
59	*Allogrommiidae sp.1*	16	2	1-2	2
59	*Chitinosiphon spp.*	8	2	1-2	2
60	*Allogrommiidae sp.1*	9	2	2-3	2
60	*Chitinosiphon spp.*	6	2	2-3	2
61	*Chitinosiphon spp.*	15	10	0-1	1
62	*Saccammina sp2*	9	10	1-2	1
63	*Chitinosiphon spp.*	3	10	1-2	1
63	*Saccammina sp2*	9	10	2-3	1

Vial	Specie	Number	Site	Level (cm)	Replicate
64	Mixed soft-shelled	7	10	0-1	2
65	*Saccammina sp2*	5	10	1-2	2
66	*Saccammina sp2*	6	10	2-3	2
67	Mix of soft-shelled	14	9	0-1	1
68	Mix of soft-shelled	4	9	1-2	1
69	Mix of soft-shelled	4	9	2-3	1
70	Mix of soft-shelled	13	9	0-1	2
71	Mix of soft-shelled	12	9	1-2	2
72	Mix of soft-shelled	6	9	2-3	2

7.15 Megafauna

A Jamieson, T Linley, M Gerringer

First results

Imaging lander deployments were sufficient to identify depth related faunal boundaries. While there is some variation in specific species the fish fauna broadly falls into four groups. A bathyal group, an abyssal group, an abyssal-hadal transition group and a hadal group. The bathyal group was most species rich with six fish species identified on preliminary analysis (Fig. 7.15.1)

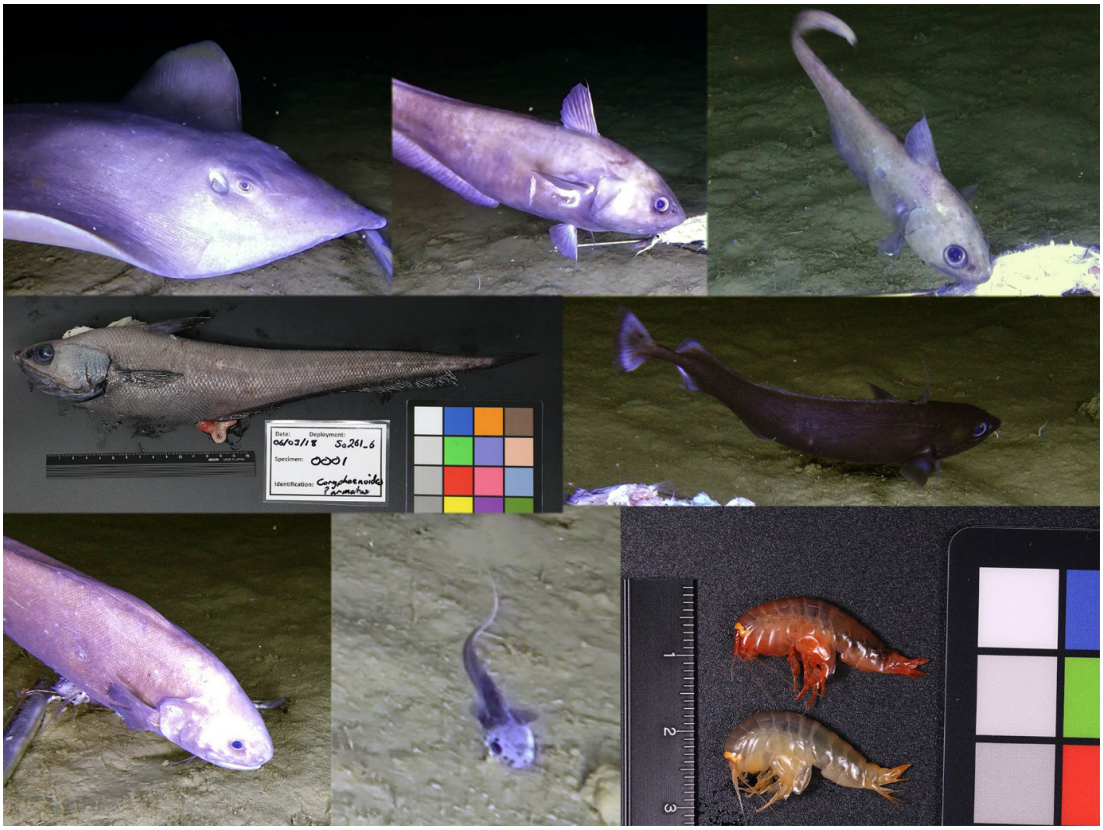

Figure 7.15.1 *Bathyal fish species observed. Left to right, top to bottom: Bathyraja ?eatonii, Coryphaenoides ?rudis, unknown rattail, Nezumia convergens - Peruvian grenadier, Antimora rostrata – blue hake, Spectrunculus crassus, unknown fish, Eurythenes gryllus (Fotos: T Linley)*

At abyssal depths from ~4000-5500 m depth the deployments were dominated by large numbers of grenadiers which rapidly consumed the bait (Fig. 7.15.2). Most appear to be *Coryphaenoides armatus* with solitary *C. yaquinae* and potentially additional macrurid species.

Figure 7.15.2 *Large numbers of grenadiers gathering at the bait. (Foto: T Linley)*

An abyssal-hadal transition group was found between ~5900-6500 m depth. Some grenadiers were still observed but the deployments were dominated by *Bassozetus* cusk eels and eelpouts (Fig. 7.15.3). *Barathrites iris* was the deepest species seen to feed on the bait directly. Most other species appeared to be feeding on the scavenging amphipods attracted to the bait.

Figure 7.15.3 *Bassozetus cusk eels gathering around the bait to feed on passing amphipods. Barathrities iris (centre) feeds directly on the bait. Eelpouts are also gathering around the bait. (Foto: T Linley)*

At hadal depths three species of snailfish were observed, sometimes in the same image. A purple snailfish, resembling a more typical abyssal snailfish, a pink snailfish resembling a more typical hadal snailfish and a white snailfish who's elongate fins and prominent snout resembles the ethereal snailfish observed in the Mariana Trench (Fig. 7.15.4).

Figure 7.15.4 *From left to right, the purple, pink and white snailfish observed. All images are from the same deployment: So261_87 at 6738 m depth. (Fotos: T Linley)*

Samples

Megafaunal samples were collected by baited trap from nine stations in and around the Atacama Trench, at depths 2,548–8,064 meters. The majority of collected specimens were amphipods which were found in almost every deployment (Fig. 7.15.5). Nearly ten thousand amphipods of at least five different genera were collected. Stations (6,700 m) and four (7,200 and 8,000 m) yielded the highest amphipod abundances, with more than one thousand *Hirondellea c.f. thurstoni* collected in each trap. Full species identification and sex and life stage analyses will be conducted at Newcastle University. In addition to population studies, amphipod samples were collected for age estimation (M. Gerringer, University of Washington), food web stable isotope analyses (J. Drazen, University of Hawaii), transcriptomics and genomics (S. Piertney, University of Aberdeen), and analysis of persistant organic pollutants (R. Glud, University of Southern Denmark). Six decapod crustaceans identified as *Hymenopenaus nereus* were collected from abyssal depths 4,900–6,000 m. Tissue samples were taken for food web stable isotope analyses and specimens were preserved in ethanol for population studies. Three fishes were collected, one bathyal, one abyssal, and one hadal. Two of these belong to the family Macrouridae, the rattails—one *Nezumia convergens* from 2,548 m and one *Coryphaenoides armatus* from 4,053 m. The deepest fish collection was from a depth of 6,738 m, the purple hadal snailfishe seen in video (Fig.7.15.6). It is small (standard length 87 mm) and may be a juvenile. It likely belongs to the genus *Careproctus*, however complete taxonomic identification will be undertaken back onshore. Fish collections were preserved in 4% buffered formaldehyde solution for further study. Tissue samples and fin clips were taken for genetic studies and white muscle samples were taken from the macrourids for food web analyses, studies of pressure adaptation, and archival purposes. Full details on megafauna collected by the two Camera Landers, preservation, and all subsamples taken can be found in the SO261_Megafauna_ Samples spreadsheet.

Figure 7.15.5 *Amphipods collected by baited trap from 8,604 m in the Atacama Trench (Deployment SO261_45, Camera Lander 1, 14 March 2018). (Foto: M. Gerringer)*

Figure 7.15.6 *Hadal snailfish collected by baited trap from 6,738 m in the Atacama Trench (Deployment SO261_87, Camera Lander 1, 24 March 2018). (Foto T. Linley)*

7.16 Zooplankton

R Escribano

MOCNESS/MULTINET SAMPLES

In the SONNE-261 Expedition zooplankton studies were planned aiming at the following scientific objectives:

- Identify the species and their vertical distribution of mesozooplankton, macrozooplankton and micronekton in the water column down to bathypelagic depths (>4000 m) inhabiting the water masses over the Atacama trench. Samples were thus obtained for taxonomic analysis as preserved in 10% formalin and also in ethanol for DNA analysis as a complementary.
- Study the contribution of zooplankton respiration to particle remineralization down to the abyssal zone by analyzing the electron transport system activity a proxy for respiration. Measurements will be made on size-fractionated zooplankton in order to attribute specific roles among the different components of the deep zooplankton communities. The collected zooplankton from the different depth strata (MOCNESS and Multinet samplings) were therefore size fractionated and immediately frozen in liquid nitrogen (-190 °C) for subsequent laboratory analyses on land. Using the water samples obtained with the Rosette, the microplankton respiration will be also assessed following the same enzymatic approach. Incubation experiments from the surface seawater were additionally used to measure actual respiratory rates in live mesozooplankton, which will allow to calibrate the potential respiratory rates obtained from the enzymatic measurements.
- Model sinking particle flux and calculate both export transfer and nutrient retention efficiencies throughout the entire water column over the Atacama trench from measurements of plankton respiration (explained above).
- Assessing the sources of C and N and studying trophic relationships of zooplankton from surface to deep waters, using C and N stable isotopes composition. Size-fractioned zooplankton from different depth strata were frozen in liquid nitrogen for biochemical measurements. Samples will be analyzed for protein, C and N contents and their isotopic signature. Furthermore, some of the samples will be selected to carry out a more exhaustive isotopic analysis based on individual amino acids. This approach will allow to accurately determine the trophic position for the different size fractions of zooplankton, and the production history of the particulate material. Biogeochemical studies of zooplankton are complemented with isotopic measurements of Particulate Organic Carbon (POC) and Particulate Organic Nitrogen (PON) that was obtained by filtering seawater collected by the oceanographic Rosette at the same stations.

Sampling with MOCNESS included three sites (2, 4 and 6). At site 2 the MOCNESS could sample down to 5000m, although some nets did not close properly, so that no stratified samples could be obtained. However, the collected samples was used to sort large animals, such as crustacean (shrimps and euphausiids) and fishes (mainly myctophids). At site 4 the MOCNESS sampled down to 4000m for 4 depth strata. Samples were all processed for the analyses described above. At this site the MULTINET was also operated to obtain samples of mesozooplankton for 5 depth strata from 800 m to surface and samples. At site 6 both MOCNESS and MULTINET were deployed. MOCNESS could sample to a maximum depth of 5158 m, which is the deepest zooplankton sampling ever done. 5 depth strata were thus obtained and all samples were processed while the MULTINET could sample the same as in site 4. Both sampling processing and experimental work were done as planned at the three sites.

7.17 Physical Oceanography

W Schneider

Objectives

To determine the geometry of the Oxygen Minimum Zone (< 0.5 mL/L) along the Atacama Trench and the potential temperature, salinity and dissolved oxygen concentration of the waters of the deep Atacama Trench (5000 – 8000 m) within in the work area of SO261.

Work at sea

The Atacama Trench stations 6, 5, 4, 3, 2, 10 (listed from south to north) were sampled with the Rosette/CTDO unit of RV *Sonne* from surface to 6000m depth. A SBE19 CTD with titanium housing was employed either on the Nano Lander or on the Hadal rosette at stations 6, 5, 4, 3, 2 and 10 to measure temperature and salinity from surface to bottom close to 8100 m depth. Dissolved oxygen content was determined by means of the Winkler method from ocean water provided by the ship's rosette, the Hadal rosette, the Nano Lander, the Profile Lander and the Sediment Lander.

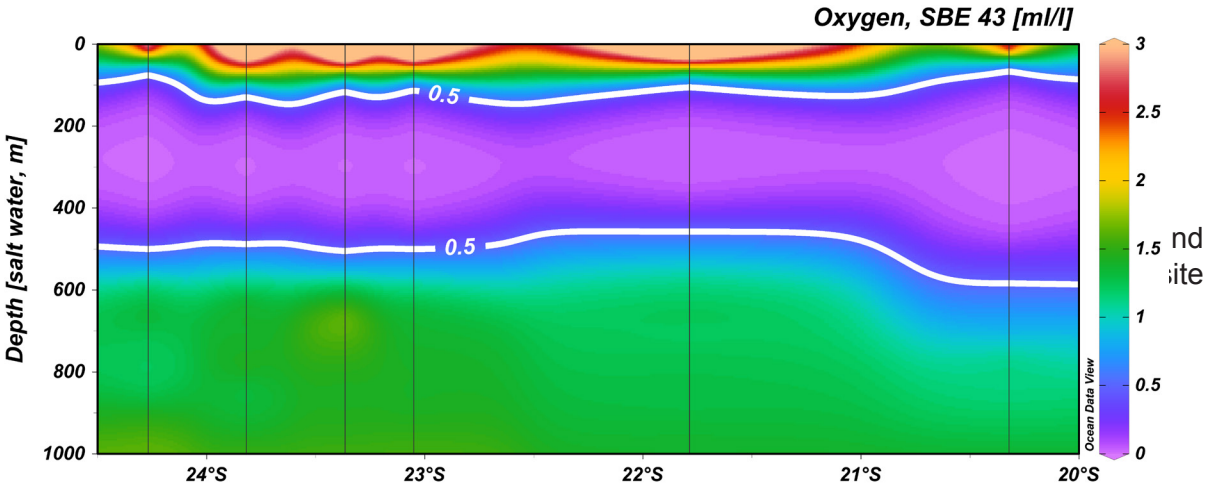

Figure 7.17.1 *Atacama Trench Water. The deep Atacama Trench (6000 – 8000 m) surprisingly was filled at all sites with abyssal water of the Chilean Basin. Only slight differences existed between the more southern site (S: 24° 15.96') and the most northern site (S: 20° 19.14') sampled. The potential temperature and salinity characteristics were 1.318 °C and 34.681 PSU in the south with potential temperature being warmer by 0.001 °C and saltier by 0.003 PSU which however could be attributed to sensor drifts. Dissolved oxygen concentration in hadal depth of the trench were around 3.78 ml/L.*

7.18 Pelagic Microbiology

O Ulloa

Objectives

The main objective was to investigate the abundance, phylogenetic diversity, and metabolic potential of planktonic microbial communities.

Work at sea

Samples were collected for flow cytometry (cell abundance), metagenomics, and single-cell genomics. For metagenomics, up to 40 L of seawater per depth were pre-filtered through 3.0-µm and then filtered onto Sterivex filters. Filters were flash frozen in liquid nitrogen (Tab. 7.18.1)

First results

Cell abundance in hadal waters of the Atacama Trench are in the order of 4-7 10^7 (cell L^{-1}). Samples for genomic studies will be analysed in the near future.

Table 7.18.1 *Summary of samples collected for metagenomics*

Site	Station	Sample ID	Depth (m)	Size fraction 0.2 -3.0 um	Size fraction 3.0-20 um
4	SO261_04_39	SO_046	7906,7	x	x
4	SO261_04_41	SO_067	6000	x	x
4	SO261_04_47	SO_068	7000	x	x
4	SO261_04_51	SO_078	8079	x	x
2	SO261_02_89	SO_131	5000	x	x
2	SO261_02_89	SO_132	6000	x	x
2	SO261_02_86	SO_136	7928,3	x	x
2	SO261_02_96	SO_137	7000	x	x

7.19 Pelagic Carbon Geochemistry

O Ulloa

Objectives

In order to constrain multiple sources and cycling of carbon in hadal waters, the main objective was to characterize the radiocarbon ($\delta^{14}C$), stable isotopic composition ($\delta^{13}C$) and carbonate parameters of the dissolved inorganic carbon pool, as well as the concentration and isotopic signal ($\delta^{13}C$, $\delta^{15}N$) of the particulate organic matter (POM).

Work at sea

Seawater samples were collected using the standard CTD/Rosette, the Hadal Rosette and the Nano-Lander from the surface to the 1.5 m above the sea floor about every 1000 m. Samples were fixed and store for analysis on land.

For POM, up to 40 L of seawater per depth was filtered onto pre-combusted glass-fiver filters. Filters were dried at sea and stored for analysis on land (Tab. 7.19.1).

First results

Samples are currently being analysed.

Table 7.19.1 *Summary of samples collected for carbon geochemistry*

Site	Depth	POC/PON	δ15N/ δ13C POM	∆14C DIC
1	5	x	x	-
1	20	x	x	-
1	60	x	x	-
1	200	x	x	-
1	500	x	x	-
1	1000	x	x	-
2	5	x	x	x
2	20	x	x	-
2	60	x	x	x
2	200	x	x	-
2	500	x	x	x
2	1000	x	x	x
2	2000	x	x	x
2	3000	x	x	x
2	4000	x	x	x
2	5000	x	x	x
2	6000	x	x	x
2	7000	x	x	x
2	7928	x	x	x
4	5	x	x	x
4	20	x	x	-
4	60	x	x	x
4	200	x	x	-
4	500	x	x	x
4	1000	x	x	x
4	2000	x	x	x
4	3000	x	x	x
4	4000	x	x	x
4	5000	x	x	x
4	7000	x	x	x
4	7000	x	x	x
4	8079	x	x	x
6	5	x	x	-
6	1000	x	x	-
6	2000	x	x	-
6	3000	x	x	-

Site	Depth	POC/PON	δ15N/ δ13C POM	∆14C DIC
6	4000	x	x	-
6	5000	x	x	-
6	6000	x	x	-
6	7000	x	x	-
10	6500	-	-	x
10	7000	-	-	x
10	7600	-	-	x

7.20 Particle and deposition dynamics

R Turnewitsch, K Oguri

Objectives

In deep-sea regions that are structured by relatively steep topographic features, supply of particulate matter to a given sea floor location could occur via more continuous pelagic or hemipelagic sedimentation and/or by rarer but more disruptive mass wasting events. Hadal trenches are topographic features for which mass wasting events are particularly important (Oguri et al., 2013). But between these transient events, pelagic sedimentation of fresher material must also be an important factor for the functioning of the biogeochemistry and biology of these deep-sea systems. Recent work suggested that pelagic sedimentation is not necessarily a simple gravitational process, but that fluid-dynamic features such as internal tides may modulate the downward flux of particulate matter and, therefore, potentially also the food supply to hadal organisms (Turnewitsch et al., 2014).

On this cruise, the first aim was to scrutinize the thickness of the bioturbated layer in the surface sediments and identify unusual sediment layers as evidence of 'recent' mass-wasting events that would have occurred during the last few decades. The second task was to compare sampling sites in terms of the amount of 'recently' deposited particulate matter. These two objectives are addressed by interpreting down-core profiles of excess ^{210}Pb ($^{210}Pb_{xs}$; half-life: 22.3 years) and total $^{210}Pb_{xs}$ inventories. The third objective was to search for evidence of particulate-matter redistribution both in the water column and surface sediments on time scales up to only a couple of months, time scales that include semidiurnal and diurnal tides as well as neap-spring tidal cycles. This latter objective was tackled by sampling the vertical distribution of the naturally occurring particle tracer thorium-234 (^{234}Th; half-life: 24.1 days) in the water column (as total ^{234}Th) and surface sediments (as excess ^{234}Th: $^{234}Th_{xs}$).

Work at sea

Sediment samples were collected by the multiple corer. All main Sites were sampled, except Site 8. At each Site, one core (#2) was sub-sampled for both $^{210}Pb_{xs}$ and $^{234}Th_{xs}$ from the first MUC deployment at each Site. For $^{210}Pb_{xs}$, the topmost 10cm of the sediment column were sliced in 1cm intervals; below 10cm, the cores were sliced at 2cm intervals (Table 7.20.1). These samples were packed in plastic cubes (6 cm^3) for constant volume sampling. For $^{234}Th_{xs}$, only the topmost 10cm were sliced at 1cm intervals. Sub-samples for $^{210}Pb_{xs}$ were sent to the shore lab at JAMSTEC and analysed by gamma-spectrometry with a HPGe detector, together with determination of dry bulk densities.

For $^{234}Th_{xs}$, sediment sub-samples of a known wet volume were suspended in thorium- and particle seawater, followed by splitting of a sub-sample of the suspension of known volume, dilution, and filtration onto a polycarbonate filter with 0.4mm pore width. The filters were air-dried, folded in a reproducible way and wrapped up in Mylar foil. These filter packages were then inserted in a low-level betacounter where the beta radioactivity was measured non-destructively. To find out whether there was $^{234}Th_{xs}$ in the surface sediments, measurements need to be continued at the shore lab at SAMS to see how the beta activity changes over time and to determine backgrounds due to long-lived beta-emitters. These measurements will be completed in about 6 months' time.

Table 7.20.1 *Deployment of MUC, Core number, Site, Location, Water depth, Depth sampled and number of samples.*

Deployment, Core	Site	Latitude Longitude	Water depth (m)	Depth sampled (cm)	Number of samples
SO261_8_ MUC1_2	1	23º49,242' S 70º50,282' W	2548	0-10 ($^{234}Th_{xs}$) 0-20 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 15 ($^{210}Pb_{xs}$)
SO261_21_ MUC1_2	6	24º17,099' S 71º25,440' W	7831	0-10 ($^{234}Th_{xs}$) 0-22 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 16 ($^{210}Pb_{xs}$)
SO261_35_ MUC1_2	5	23º49,834' S 71º22,521' W	7890	0-10 ($^{234}Th_{xs}$) 0-30 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 20 ($^{210}Pb_{xs}$)
SO261_48_ MUC1_2	4	23º23,012' S 71º20,703' W	8063(1)	0-10 ($^{234}Th_{xs}$) 0-34 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 22 ($^{210}Pb_{xs}$)
SO261_63_ MUC1_2	3	23º03,131' S 71º18,180' W	7995	0-10 ($^{234}Th_{xs}$) 0-26 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 18 ($^{210}Pb_{xs}$)
SO261_75_ MUC1_2	7	22º57,266' S 71º37,246' W	6064	0-10 ($^{234}Th_{xs}$) 0-24 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 17 ($^{210}Pb_{xs}$)
SO261_92_ MUC1_2	2	21º47,317' S 71º12,259' W	7928	0-10 ($^{234}Th_{xs}$) 0-32 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 21 ($^{210}Pb_{xs}$)
SO261_105_ MUC1_2	10	20º19,572' S 71º17,549' W	7734	0-10 ($^{234}Th_{xs}$) 0-38 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 24 ($^{210}Pb_{xs}$)
SO261_116_ MUC1_2	9	20º21,089' S 70º59,401' W	4134	0-10 ($^{234}Th_{xs}$) 0-18 ($^{210}Pb_{xs}$)	10 ($^{234}Th_{xs}$) 14 ($^{210}Pb_{xs}$)

(1) Water depth is unavailable from the ship log and the depth shown is from the second deployment, SO261_49.

Water samples for total ^{234}Th were collected by a CTD bottle rosette (down to 6000m), the Hadal Rosette (deeper than 6000m), and by the Profiler Lander (1.2 mab). Samples were collected at all Sites, except Site 8 (Table 7.20.2). To extract total thorium from the water samples, a MnO_2 precipitation was carried out. The samples were filtered through polycarbonate filters with a pore width of 1.0mm. Filters were air dried, folded in a reproducible way, wrapped

in Mylar foil and measured non-destructively in the low-level betacounter. Measurements will be continued in the shore-based lab at SAMS to follow the decrease of the beta radioactivity and determine backgrounds due to long-lived beta-emitters.

As none of the $^{210}Pb_{xs}$ and $^{234}Th_{xs}$ measurements have been completed, we cannot report results yet.

Table 7.20.2 *Compilation of Sites that were sampled and their nominal sampling depths. Sample IDs consist of the cruise number, station number, sampling device and Niskin bottle number.*

Site #	Sample ID	Nominal depth (m)		Site #	Sample ID	Nominal depth (m)
1	SO261_007_CTD_NB04	2400		7	SO261_074_CTD_NB22	50
	SO261_007_CTD_NB06	2300			SO261_074_CTD_NB20	500
	SO261_007_CTD_NB07	2000			SO261_074_CTD_NB18	1000
	SO261_007_CTD_NB08	1700			SO261_074_CTD_NB15	2000
	SO261_007_CTD_NB09	1400			SO261_074_CTD_NB12	3000
	SO261_007_CTD_NB10	1100			SO261_074_CTD_NB10	3500
	SO261_007_CTD_NB16	800			SO261_074_CTD_NB08	4000
	SO261_007_CTD_NB17	500			SO261_074_CTD_NB07	4500
	SO261_007_CTD_NB18	250			SO261_074_CTD_NB05	5000
	SO261_007_CTD_NB23	50			SO261_074_CTD_NB03	5200
6	SO261_013_CTD_NB03	6000			SO261_074_CTD_NB02	5400
	SO261_013_CTD_NB05	5500			SO261_074_CTD_NB14	2500
	SO261_013_CTD_NB06	5000			SO261_069_PL_NB	5500
	SO261_013_CTD_NB07	4500			SO261_071_SL_NB	5500
	SO261_013_CTD_NB08	4000		2	SO261_082_CTD_NB21	50
	SO261_013_CTD_NB11	3000			SO261_082_CTD_NB19	500
	SO261_013_CTD_NB14	2000			SO261_082_CTD_NB17	1000
	SO261_013_CTD_NB17	1000			SO261_082_CTD_NB14	2000
	SO261_013_CTD_NB19	500			SO261_082_CTD_NB12	3000
	SO261_013_CTD_NB21	50			SO261_082_CTD_NB08	4000
	SO261_019_HR_NB01	6500			SO261_082_CTD_NB07	4500
	SO261_019_HR_NB03	7000			SO261_082_CTD_NB05	5000
	SO261_019_HR_NB05	7500			SO261_082_CTD_NB04	5500
5	SO261_028_CTD_NB05	5500			SO261_082_CTD_NB02	6000
	SO261_028_CTD_NB03	6000			SO261_082_CTD_NB13	2500
	SO261_034_HR_NB05	6500			SO261_091_HR_NB03	6500
	SO261_034_HR_NB03	7000			SO261_091_HR_NB04	7000
	SO261_034_HR_NB06	7500			SO261_091_HR_NB06	7700
	SO261_028_CTD_NB06	5000		10	SO261_100_CTD_NB21	50
	SO261_028_CTD_NB08	4000			SO261_100_CTD_NB19	500
	SO261_028_CTD_NB11	3000			SO261_100_CTD_NB17	1000
	SO261_028_CTD_NB14	2000			SO261_100_CTD_NB14	2000
	SO261_028_CTD_NB17	1000			SO261_100_CTD_NB13	2500
	SO261_028_CTD_NB19	500			SO261_100_CTD_NB11	3000

Site #	Sample ID	Nominal depth (m)		Site #	Sample ID	Nominal depth (m)
	SO261_028_CTD_NB21	50			SO261_100_CTD_NB08	4000
	SO261_028_CTD_NB13	2500			SO261_100_CTD_NB07	4500
	SO261_029_PL_NB	7880			SO261_100_CTD_NB05	5000
	SO261_030_SL_NB	7880			SO261_100_CTD_NB04	5500
4	SO261_039_CTD_NB03	6000			SO261_100_CTD_NB02	6000
	SO261_039_CTD_NB05	5500			SO261_108_HR_NB02	6500
	SO261_039_CTD_NB06	5000			SO261_108_HR_NB04	7000
	SO261_039_CTD_NB08	4500			SO261_108_HR_NB06	7500
	SO261_039_CTD_NB09	4000		9	SO261_110_CTD_NB21	50
	SO261_039_CTD_NB12	3000			SO261_110_CTD_NB17	500
	SO261_039_CTD_NB15	2000			SO261_110_CTD_NB15	1000
	SO261_039_CTD_NB18	1000			SO261_110_CTD_NB13	1500
	SO261_039_CTD_NB20	500			SO261_110_CTD_NB11	2000
	SO261_039_CTD_NB22	50			SO261_110_CTD_NB10	2500
	SO261_039_CTD_NB14	2500			SO261_110_CTD_NB08	3000
	SO261_040_HR_NB03	6500			SO261_110_CTD_NB06	3500
	SO261_040_HR_NB04	7000			SO261_110_CTD_NB04	4000
	SO261_040_HR_NB06	7700			SO261_111_PL_NB	4050
	SO261_043_PL_NB	8060				
3	SO261_057_CTD_NB22	50				
	SO261_057_CTD_NB20	500				
	SO261_057_CTD_NB18	1000				
	SO261_057_CTD_NB15	2000				
	SO261_057_CTD_NB12	3000				
	SO261_057_CTD_NB09	4000				
	SO261_057_CTD_NB08	4500				
	SO261_057_CTD_NB06	5000				
	SO261_057_CTD_NB05	5500				
	SO261_057_CTD_NB03	6000				
	SO261_057_CTD_NB14	2500				
	SO261_063_HR_NB03	6500				
	SO261_063_HR_NB04	7000				
	SO261_063_HR_NB01	7500				
	SO261_058_PL_NB	7995				
	SO261_059_SL_NB	7995				

7.21 Sediment and geological characterization

HA Stewart, RN Glud, L Hehemann

Objectives

7.21.1 Multibeam echosounder and sub-bottom profiler

Multibeam echosounder data underpins geoscientific investigations at sea, creating the platform from which multi-disciplinary marine science is conducted. In addition to providing the main tool for contextualising and selecting stations for scientific operations, multibeam bathymetry data are utilised to interpret the geomorphology and geological structure of the seafloor. Backscatter intensity data, acquired concurrently with the multibeam bathymetry data, give an indication of the roughness, hardness and composition of the sea floor (Lurton and Lamarche, 2015). Areal sediment distribution, sediment thickness and depositional facies are visualised with the hull mounted ATLAS PARASOUND P70 parametric sub-bottom profiler.

As more detailed deep-water bathymetry becomes available [e.g. Stewart and Jamieson, 2018], the morphology of the Atacama Trench interior is revealed to exhibit significant topographic variation. For example, bathymetry data show an extensive network of elongate ridges and troughs: the seafloor expression of normal fault scarps on the subducting plate with near-vertical seafloor offsets frequently in excess of 600m. This is hypothesized to result in areas of high sedimentation within the fault-bounded grabens and low sedimentation rates along the escarpments, therefore influencing the benthic community regardless of depth. Furthermore the influence of potentially infrequent, catastrophic mass-wasting events; and sedimentation via continuous transport through gravitational processes (rain-out of material from overlying water column and from down-slope transport) must be considered.

In summary, the primary objectives for the SO261 acoustic data acquisition programme was 1) to map the geomorphology and shallow sedimentary architecture of the Atacama Trench study area, and 2) to provide the geological context for the other sampling equipment (suite of landers, multicore and gravity core stations).

7.21.2 Geological characterization of recovered surface sediment

There continues to be a lack of sediment samples from hadal zones available to “ground-truth” best available bathymetry data (acquired both during Expedition SO261 or sourced from public databases e.g. Ryan *et al.* 2009) and video and photographic imaging data acquired using free-falling imaging landers and the OFOBS System (see sections 7.5.4., 7.5.5. and 7.6).

The objective is to use sediment samples acquired by the MUC to ground-truth photographic and video datasets thus providing unprecedented insight into spatial and temporal variation in habitat and geological environments.

7.21.3 Characterization of deposited organic material

While it is relatively well established that hadal trenches act as depocenters, it is not known to what extent this facilitates enhanced local carbon mineralization versus burial. Therefore it is required to gain more detailed insight on the nature and amounts of deposited organic material. More specifically it is the aim of this subtask to quantify the amount of sedimentary organic material in the surface sediment and to identify the sources and characteristics of this material. This is done by i) standard measuring routines quantifying porosity, density, the C/N ratio of deposited material, concentrations of organic material and phytopigments, ii) by analysis of stable isotopes providing insight in the potential sources of material, and iii) sophisticated detailed analysis for specific biomarkers and e-DNA for identifying material

from terrestrial, phycodetrital, chemosynthetic and aquatic plants sources. Combined with determination of aging and sediment accumulation rates quantified in other sub-packages (i.e. section 7.20) this will give unique insight on the nature and amount of material that is deposited and accumulated in the sediment.

Work at sea

7.21.3 Acoustic data acquisition and processing

Multibeam echosounder data were acquired using a Kongsberg EM122 full ocean depth multibeam echosounder with an optimum operating frequency of 12 kHz and has 432 beams. The beam width was set to 146° (73° each on port and starboard transducer) resulting in a swath width of ~24 km in an operating water depth of ~7800 m. Both high-resolution bathymetry (Fig. 7.21.1) and backscatter intensity data were acquired concurrently although due significant water depths the quality of backscatter intensity data was variable. Three sound velocity profiles (derived from CTD casts) were applied during data acquisition to calibrate the EM122 system (Fig. 7.21.2). A further seventeen SVPs were generated for use during data processing.

Some initial processing of bathymetric data was undertaken during the cruise using Caris HIPS and SIPS. The original raw data registered during the survey will be processed using Caris by AWI (bathymetry) and using FM Geocoder by the BGS (backscatter intensity) post-cruise. FM Geocoder corrects the backscatter intensities registered by the multibeam echosounder system, and then geometrically corrects and positions each acoustic sample in a backscatter mosaic (Fonseca and Calder, 2005). The backscatter intensity data will be gridded at a resolution best suited to the quality of the processed data.

An ATLAS PARASOUND P70 parametric sub-bottom profiler was used which uses the nonlinear parametric effect between two primary frequencies to produce a low frequency secondary signal (SLF), typically at 4 kHz, which is used for sub-bottom profiling. During the entire cruise the following settings were used: SLF frequency of 4 kHz, PHF frequency of 18.8 kHz, 2 periods per pulse with a pulse length of 0.5 ms, rectangular pulse shape, and a time interval of 12800 ms. The system automatically adds positions and compensates vessel movements by applying roll, pitch and heave values from the Seapath MRU-GPS system. Generally sediments were imaged up to a maximum of ~80 m sub-seabed by the SLF signal.

Two file formats were recorded: *.ps3 and *.sgy-files (SEG-Y files) recorded along with the auxiliary data. Two software packages operate the PARASOUND system. ATLAS HYDROMAP CONTROL sets the control parameters, modes of operation and ranges of the echosounder. ATLAS PARASTORE is an acquisition, visualisation, processing, conversion, quality control, print and data storage software. A software upgrade pre-cruise introduced a bug in the software whereby a catastrophic crash of the system occurred at times. This would require a full system reboot including killing power to the transducer and restarting. The received errors included “TxRxEnabled Process Overload”, “Failed to transfer product generation request for SLF data” and “Timeout while waiting on water depth / heading / position / speed telegram”. A fix was obtained on the 19th March which solved the problem, thereafter the system became stable and reliable. The fix was to change the ‘system depth source’ from ‘other sounding system’ to ‘controlled ATLAS PARASOUND PHF’. Post-cruise the ATLAS PARASOUND data will be uploaded to MOVE software suite for processing and interpretation by the BGS.

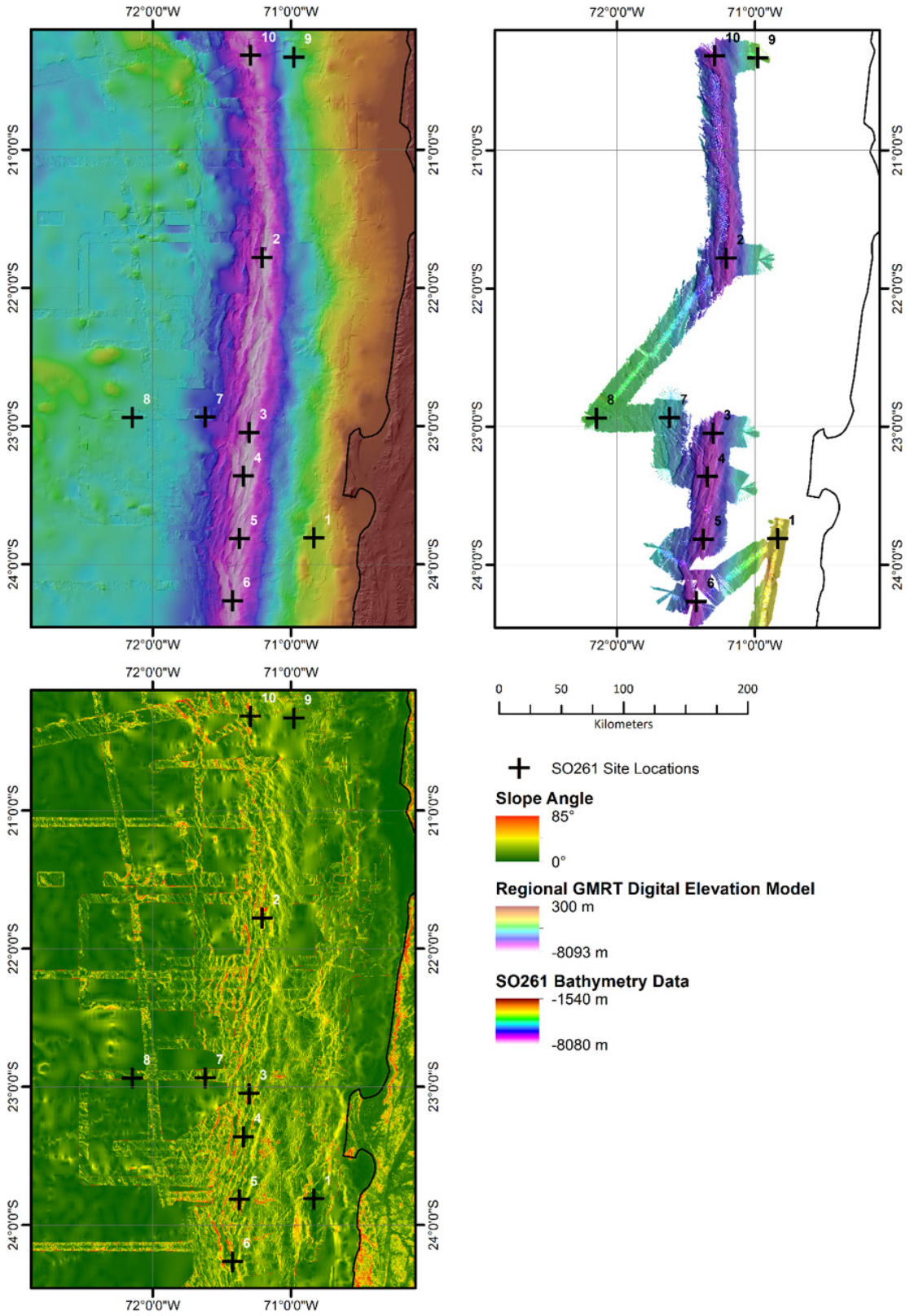

Figure 7.21.1 *(A) Overview of the regional bathymetry data (Ryan et al., 2009) from the Atacama Trench study area; (B) Overview of the unprocessed multibeam bathymetry data acquired during the course of Expedition SO261; (C) Slope angles derived from the regional bathymetry data (Ryan et al., 2009). Sites 1-10 are marked for reference.*

Data acquisition and storage of the multibeam echosounder and PARASOUND signal was switched on after leaving the 12nm limit of Chilean EEZ and switched off after departing the final site coincident with crossing 20° S reflecting the limit of area of operations covered by the Expedition permit. Generally PARASOUND data were acquired on an ad hoc basis during transit between stations with an acquisition vessel speed of ~12 knots. However a number of lines were acquired at 4-5 knots and during MOCNESS and OFOBS deployments at ~2 knots vessel speed (e.g. Fig. 7.21.3).

Multibeam echosounder data acquired during periods with a lower vessel speed will be prioritized for backscatter intensity processing. The PARASOUND system was turned off when the vessel was holding station during operations. The mulitbeam echosounder was turned off during operations involving communication with the acoustic releases located on the deployed landers.

Note that both multibeam echosounder and sub-bottom profiler data are susceptible to degradation by errors introduced during equipment setup prior to acquisition, poor weather, and increasing water depths, even for systems with an operational window within the expected water depths to be encountered.

7.21.4 Sediment samples

Recovered sediment cores for use in characterization of deposited organic material were sectioned in intervals (0-10 cm in 1 cm slices; 10-20 cm in 2.5 cm slices and >20 cm in 5 cm slices) and subdivided into different fractions for later analysis. Samples are frozen at -20°C or -80°C until analysis in the respective laboratories.

Sediment cores for use in geological characterization were sectioned in 1 cm intervals for later particle size analysis (0.5 phi intervals to 63 µm, laser diffraction on the <63 µm). Initial observations on grain size, colour and visible sedimentary structures (e.g. layers) were made during offshore operations.

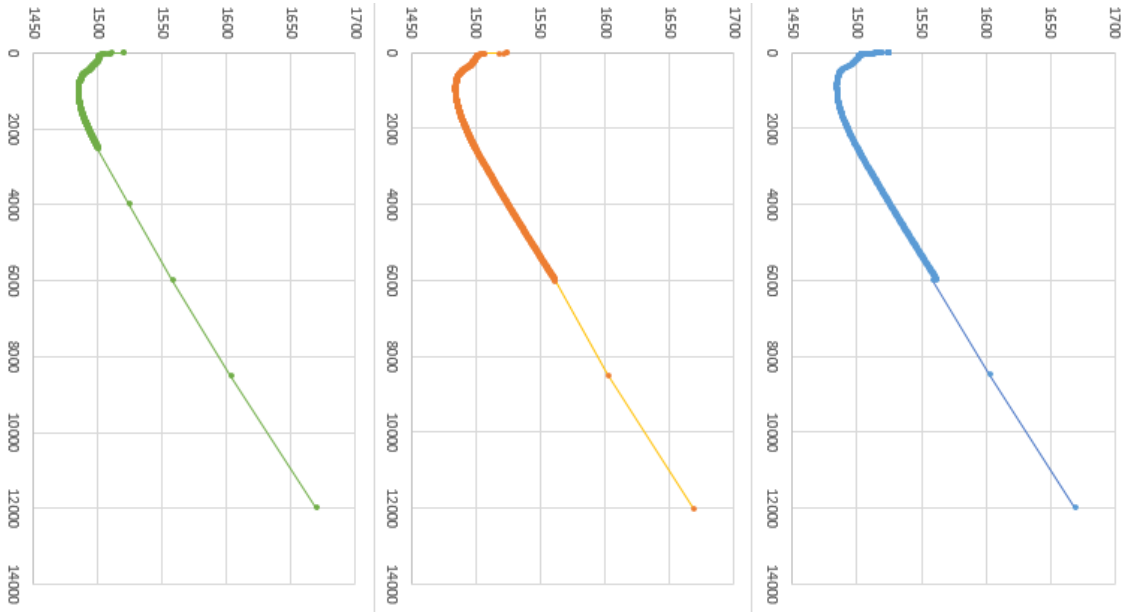

Figure 7.21.2 *The Sound Velocity Profiles applied in the Kongsberg SIS programme during acquisition. X axis = velocity of sound; y axis = water depth.*

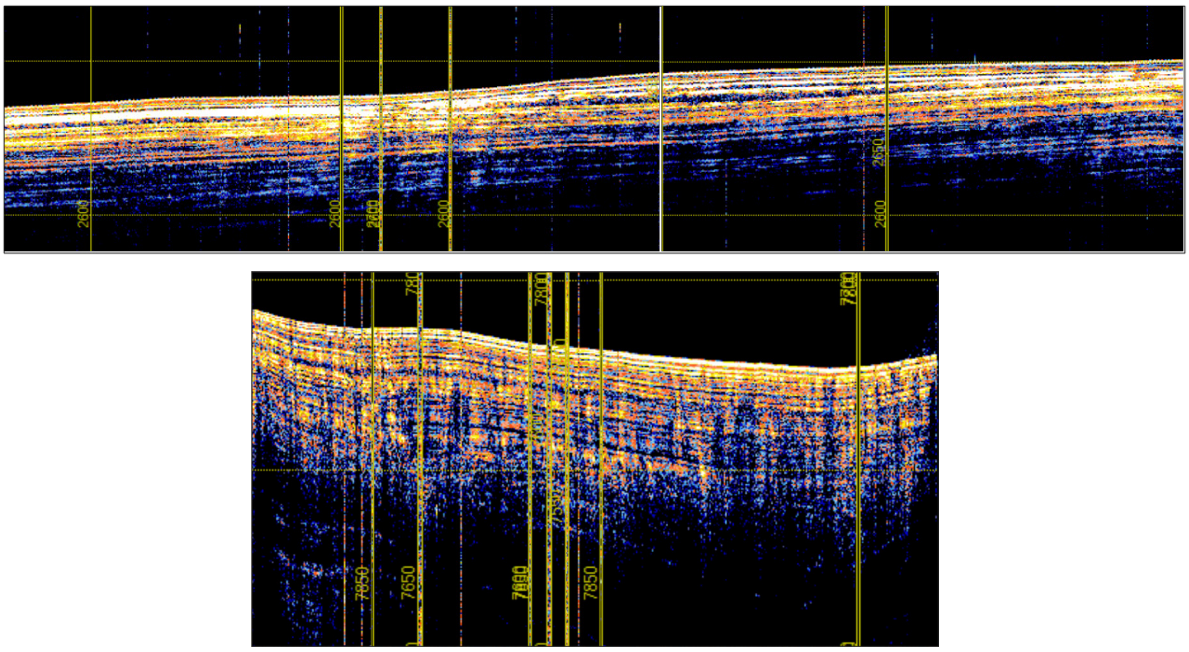

Figure 7.21.3 *Examples of the ATLAS PARASOUND data derived via screen grabs during data acquisition. Top image is over Site 1 an area of smooth seabed around 2560 m water depth on the upper section of the overriding plate; middle image is around Site 5 at around 7770 m water depth within the Atacama Trench axis.*

Initial Results

7.21.5 Geological Characterization and Setting

Acquired bathymetry data reveal the deepest soundings within the study area to be 8080 m in the vicinity of Site 4, Richards Deep. The shallowest depth recordings were in the vicinity of Site 1 where water depths of 1540 m (ridge located to the southwest of Site 1 and oriented slightly oblique to the vessel track) were observed. A single gully was crossed on the transit to Site 1 from the south which is incised up to 550 m into the surrounding seafloor.

The bathymetry data show that the most conspicuous features of the Atacama Trench are an extensive network of elongate ridges and troughs interpreted as the seafloor expression of normal fault scarps on the underriding tectonic plate (Pacific Plate) (Fig. 7.21.1A and B). The seafloor expression of these faults can be detected up to 50-55 km seaward from the trench axis approximately coincident with the onset of the 4300 m bathymetric contour. The faults may still exist cropping out at seabed at locations even further from the trench axis but they are not resolved in the resolution of the regional bathymetry data available (e.g. Ryan *et al.* 2009).

The strikes of the faults are roughly parallel to the trench axis with seafloor offsets ~600 m to ~1400 m 0-30 km seaward of the trench axis, reducing to a maximum of around 200 m offset with increasing distance (>30 km) from the trench axis. Slope angles associated with the fault scarps are typically between 10° and 40° with slopes frequently in excess of 25° (Fig. 7.21.1C). The escarpments are laterally continuous with the throw, or vertical offset, decreasing towards the escarpment ends. Escarpments appear as areas of high backscatter intensity reflecting bedrock (basalt) cropping out at seabed and areas of cobbles and boulders. This was confirmed visually via the first OFOBS transects.

Initial observations of the MUC cores indicates mass waste deposits and layered sediments were sampled from the study area. Post-cruise integration of particle size analysis data, seafloor photographs and multibeam echsounder data will give unprecedented insight into the geomorphology, sedimentary environments and seafloor heterogeneity of the Atacama Trench.

7.21.6 Characterization of deposited organic material

As all chemical analysis will be done in different laboratories after the cruise there are no preliminary data to present in this context.

Data management

Acoustic data will be imported into PANGAEA Data Publisher for Earth & Environmental Science. Processed .xyz files and ArcGIS rasters of the bathymetry data will be submitted alongside screen prints of the PARASOUND sub-bottom data. At least 2 publications are planned utilizing these data. After a moratorium time of 2 years after the cruise these data will be made publicly available.

7.22 Distribution of pollutions in sediments

RN Glud, F Wenzhöfer

Objectives

As trenches act as depocenters it is plausible that various antrophogenic pollutants also would accumulate in trench sediments. This idea has won support by recent findings of elevated concentrations of Persistent Organic Pollutants (POP's) in sediments and amphipods sampled in the Mariana Trench (Dasgupta et al., 2018) The objective of this subproject is to a) investigate if sediments at the trench axis contain higher levels of POP, heavy metals, microplastics and PAH as compared to reference sites at shallower depth off the trench and b) to find if amphipods and crustacean in the trench are enriched in POPs as compared to animals caught above or off the trench.

Work at sea & preliminary results

Sediments was collected by the multiple corer at seven different sites and cores were sectioned and preserved at conditions that to the best possible extent avoid any contamination. Similarly were animals collected by MOCNESS net (see 7.7) and camera landers (see 7.5.3) and preserved for later analysis. Given that all analyses will be carried out in specialised laboratories back on land we have no preliminary results at this stage.

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10. APPENDICES / ANHÄNGE

A.1 Liste der teilnehmenden Institutionen / Participating Institutions

	Addresse / Address
AWI	Alfred-Wegener Institute Helmholtz Center for Polar and Marine Research Handelshafen 12 27570 Bremerhaven, Germany www.awi.de
BGS	British Geological Survey The Lyell Centre Research Avenue South Edinburgh, EH14 4AP, UK www.bgs.ac.uk
Ifremer	French Research Institute for Exploitation of the Sea Centre Bretagne - ZI de la Pointe du Diable - CS 10070 29280 Plouzané, France wwz.ifremer.fr
IMAPRE	Instituto del Mar del Perú Esquina Gamarra y General Valle S/N Chucuito Callao, Perú www.imarpe.gob.pe
IMO	Millenium Institute of Oceanography University of Concepion 4070386 Concepción, Chile www.imo-chile.cl
JAMSTEC	Japan Agency for Marine-Earth Science and Technology Kanagawa 237-0061 Yokosuka, Japan www.jamstec.go.jp
MPI	Max Planck Institute for Marine Microbiology Celsiusstr. 1 28359 Bremen, Germany www.mpi-bremen.de

	Addresse / Address
NCU	Newcastle University School of natural and Environmental Science Ridley Building NE17RU Newcastle, UK www.ncl.ac.uk
SAMS	Scottish Association for Marine Science Argyll, PA37 1QA Oben, Scotland www.sams.ac.uk
Scripps	Scripps Institution of Oceanography 9500 Gilman Drive La Jolla, CA 92093 San Diego, USA scripps.ucsd.edu
SDU	University of Southern Denmark Campusvej 55 5230 Odense M, Denmark www.sdu.dk
SUSTech	Southern University of Science and Technol- ogy 1088 Xueyuan Blvd, Nanshan District Shen Zhen, Guangdong, China www.sustc.edu.cn/en
UDEC	University of Concepion Campus Concepción Víctor Lamas 1290 4070386 Concepion, Chile www.udec.cl
UB/Marum	University Bremen/Marum Leobener Str. 8 28359 Bremen, Germany www.marum.de
UW	University of Washington 620 University Rd, Friday Harbor WA 98250, USA www.washington.edu

A.2 Station List / Stationsliste

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_1-1	04.03.18 21:13	23° 48.744‘ S	070° 50.051‘ W	2549.7	LANDER	deployment	Reiver	1
SO261_1-1	05.03.18 00:37	23° 48.156‘ S	070° 50.025‘ W	2559.6	LANDER	recovery	Reiver	1
SO261_2-1	04.03.18 22:45	23° 49.000‘ S	070° 50.121‘ W	2544.6	CTD	max depth/ on ground	CTD/ Rosette	1
SO261_3-1	05.03.18 02:34	23° 48.368‘ S	070° 49.965‘ W	2559.8	OFOS	profil start	OFOBS	1
SO261_3-1	05.03.18 04:48	23° 48.496‘ S	070° 50.727‘ W	2551.2	OFOS	profil end	OFOBS	1
SO261_4-1	06.03.18 00:31	23° 48.719‘ S	070° 50.036‘ W	2559.7	LANDER	deployment	FLUX-Lander	1
SO261_4-1	06.03.18 14:36	23° 47.956‘ S	070° 49.884‘ W	2559.8	LANDER	recovery	FLUX-Lander	1
SO261_5-1	06.03.18 00:57	23° 48.980‘ S	070° 50.100‘ W	2554.1	LANDER	deployment	Camera-Lander-1	1
SO261_5-1	06.03.18 11:06	23° 49.245‘ S	070° 50.287‘ W	2545.8	LANDER	recovery	Camera-Lander-1	1
SO261_6-1	06.03.18 01:27	23° 49.245‘ S	070° 50.167‘ W	2545.0	LANDER	deployment	Camera-Lander-2	1
SO261_6-1	06.03.18 12:14	23° 48.612‘ S	070° 50.074‘ W	2548.3	LANDER	recovery	Camera-Lander-2	1
SO261_7-1	06.03.18 03:01	23° 49.248‘ S	070° 50.164‘ W	2549.1	CTD	max depth/ on ground	CTD/ Rosette	1
SO261_8-1	06.03.18 05:19	23° 49.242‘ S	070° 50.282‘ W	2547.8	MUC	max depth/ on ground	MUC-1	1
SO261_9-1	06.03.18 07:41	23° 49.250‘ S	070° 50.283‘ W	2544.6	MUC	max depth/ on ground	MUC-2	1
SO261_10-1	06.03.18 09:35	23° 49.246‘ S	070° 50.284‘ W	2547.6	GC	max depth/ on ground	GC 6m	1
SO261_11-1	06.03.18 17:02	23° 48.328‘ S	070° 50.047‘ W	2567.4	CTD	max depth/ on ground	CTD/ Rosette	1
SO261_12-1	06.03.18 22:24	24° 15.963‘ S	071° 25.380‘ W	7804.0	LANDER	deployment	Reiver	6
SO261_12-1	07.03.18 02:16	24° 16.082‘ S	071° 25.418‘ W	7835.7	LANDER	recovery	Reiver	6
SO261_13-1	07.03.18 01:15	24° 16.082‘ S	071° 25.414‘ W	7837.8	CTD	max depth/ on ground	CTD/ Rosette	6

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_14-1	07.03.18 10:25	24° 11.834‘ S	071° 36.961‘ W	5638.6	OFOS	profil start	OFOBS	6
SO261_14-1	07.03.18 14:05	24° 11.769‘ S	071° 34.785‘ W	5751.2	OFOS	profil end	OFOBS	6
SO261_15-1	07.03.18 17:10	24° 15.963‘ S	071° 25.385‘ W	7818.2	LANDER	deployment	Nano-Lander	6
SO261_15-1	08.03.18 08:06	24° 15.897‘ S	071° 25.533‘ W	7836.7	LANDER	recovery	Nano-Lander	6
SO261_16-1	07.03.18 17:39	24° 16.233‘ S	071° 25.386‘ W	7835.8	LANDER	deployment	Profiler-Lander	6
SO261_16-1	08.03.18 21:24	24° 17.100‘ S	071° 25.438‘ W	7832.8	LANDER	recovery	Profiler-Lander	6
SO261_17-1	07.03.18 18:12	24° 16.504‘ S	071° 25.388‘ W	7835.9	LANDER	deployment	Camera-Lander-1	6
SO261_17-1	08.03.18 20:34	24° 17.095‘ S	071° 25.444‘ W	7835.9	LANDER	recovery	Camera-Lander-1	6
SO261_18-1	07.03.18 18:37	24° 16.777‘ S	071° 25.389‘ W	7834.5	LANDER	deployment	Camera-Lander-2	6
SO261_18-1	08.03.18 22:57	24° 16.081‘ S	071° 25.204‘ W	7834.5	LANDER	recovery	Camera-Lander-2	6
SO261_19-1	07.03.18 23:38	24° 17.042‘ S	071° 25.401‘ W	7830.4	CTD	max depth/ on ground	Hadal-Rosette	6
SO261_20-1	08.03.18 04:35	24° 17.044‘ S	071° 25.403‘ W	7832.0	GC	max depth/ on ground	GC 6m	6
SO261_21-1	08.03.18 11:22	24° 17.099‘ S	071° 25.440‘ W	7831.3	MUC	max depth/ on ground	MUC-1	6
SO261_22-1	08.03.18 18:36	24° 17.100‘ S	071° 25.440‘ W	7831.5	MUC	max depth/ on ground	MUC-2	6
SO261_23-1	09.03.18 05:10	24° 16.771‘ S	071° 25.394‘ W	7832.7	CTD	max depth/ on ground	CTD/ Rosette	6
SO261_24-1	09.03.18 12:17	24° 16.773‘ S	071° 25.390‘ W	7834.1	CTD	max depth/ on ground	Hadal-Rosette	6
SO261_25-1	09.03.18 15:15	24° 16.769‘ S	071° 25.389‘ W	7832.6	NET	station start	MOCNESS	6
SO261_25-1	10.03.18 02:30	24° 02.264‘ S	071° 27.989‘ W	6976.6	NET	station end	MOCNESS	6
SO261_26-1	10.03.18 05:39	23° 52.146‘ S	071° 42.297‘ W	5345.0	OFOS	profil start	OFOBS	5
SO261_26-1	10.03.18 11:14	23° 52.884‘ S	071° 40.811‘ W	5654.6	OFOS	profil end	OFOBS	5
SO261_27-1	10.03.18 15:58	23° 49.017‘ S	071° 22.322‘ W	7873.0	LANDER	deployment	Reiver	5
SO261_27-1	10.03.18 20:00	23° 49.124‘ S	071° 22.344‘ W	7874.2	LANDER	recovery	Reiver	5

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_28-1	10.03.18 18:42	23° 49.121‘ S	071° 22.351‘ W	7873.6	CTD	max depth/ on ground	CTD/ Rosette	5
SO261_29-1	10.03.18 23:31	23° 49.023‘ S	071° 22.314‘ W	7893.3	LANDER	deployment	Profiler-Lander	5
SO261_29-1	12.03.18 01:00	23° 49.838‘ S	071° 22.525‘ W	7893.3	LANDER	recovery	Profiler-Lander	5
SO261_30-1	11.03.18 00:19	23° 49.281‘ S	071° 22.385‘ W	7894.9	LANDER	deployment	Sediment-Lander	5
SO261_30-1	12.03.18 09:30	23° 48.703‘ S	071° 22.253‘ W	7894.9	LANDER	recovery	Sediment-Lander	5
SO261_31-1	11.03.18 01:01	23° 49.739‘ S	071° 20.780‘ W	7615.6	LANDER	deployment	Camera-Lander-1	5
SO261_31-1	12.03.18 13:16	23° 48.955‘ S	071° 20.717‘ W	7615.6	LANDER	recovery	Camera-Lander-1	5
SO261_32-1	11.03.18 01:26	23° 49.981‘ S	071° 20.635‘ W	7480.1	LANDER	deployment	Camera-Lander-2	5
SO261_32-1	12.03.18 18:00	23° 48.421‘ S	071° 21.211‘ W	7730.5	LANDER	recovery	Camera-Lander-2	5
SO261_33-1	11.03.18 02:08	23° 49.569‘ S	071° 22.452‘ W	7893.8	LANDER	deployment	Nano-Lander	5
SO261_33-1	11.03.18 05:18	23° 49.837‘ S	071° 22.519‘ W	7890.1	LANDER	recovery	Nano-Lander	5
SO261_34-1	11.03.18 05:33	23° 49.836‘ S	071° 22.534‘ W	7894.0	WS	max depth/ on ground	Hadal-Rosette	5
SO261_35-1	11.03.18 11:13	23° 49.834‘ S	071° 22.521‘ W	7890.2	MUC	max depth/ on ground	MUC-1	5
SO261_36-1	11.03.18 17:54	23° 49.839‘ S	071° 22.527‘ W	7894.0	MUC	max depth/ on ground	MUC-2	5
SO261_37-1	11.03.18 23:12	23° 49.834‘ S	071° 22.524‘ W	7894.6	GC	max depth/ on ground	GC 6m	5
SO261_38-1	12.03.18 21:53	23° 21.763‘ S	071° 20.600‘ W	8065.5	LANDER	deployment	Reiver	4
SO261_38-1	13.03.18 01:27	23° 21.967‘ S	071° 20.644‘ W	8065.5	LANDER	recovery	Reiver	4
SO261_39-1	13.03.18 00:44	23° 21.965‘ S	071° 20.654‘ W	8061.3	CTD	max depth/ on ground	CTD/ Rosette	4
SO261_40-1	13.03.18 07:42	23° 21.716‘ S	071° 20.614‘ W	8063.7	CTD	max depth/ on ground	CTD/ Rosette	4
SO261_41-1	13.03.18 13:16	23° 21.713‘ S	071° 20.633‘ W	8062.7	CTD	max depth/ on ground	CTD/ Rosette	4

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_42-1	13.03.18 16:32	23° 21.980‘ S	071° 20.652‘ W	8062.7	LANDER	deployment	Nano-Lander	4
SO261_42-1	14.03.18 02:54	23° 21.861‘ S	071° 20.930‘ W	8062.7	LANDER	recovery	Nano-Lander	4
SO261_43-1	13.03.18 16:56	23° 22.248‘ S	071° 20.662‘ W	8063.3	LANDER	deployment	Profiler-Lander	4
SO261_43-1	14.03.18 20:44	23° 23.013‘ S	071° 20.696‘ W	8063.3	LANDER	recovery	Profiler-Lander	4
SO261_44-1	13.03.18 17:55	23° 22.506‘ S	071° 20.679‘ W	8061.5	LANDER	deployment	Sediment-Lander	4
SO261_44-1	14.03.18 22:06	23° 23.124‘ S	071° 20.723‘ W	8061.5	LANDER	recovery	Sediment-Lander	4
SO261_45-1	13.03.18 18:19	23° 22.774‘ S	071° 20.683‘ W	8063.9	LANDER	deployment	Camera-Lander-1	4
SO261_45-1	14.03.18 23:15	23° 23.115‘ S	071° 20.732‘ W	8063.9	LANDER	recovery	Camera-Lander-1	4
SO261_46-1	13.03.18 19:00	23° 22.384‘ S	071° 23.577‘ W	7205.8	LANDER	deployment	Camera-Lander-2	4
SO261_46-1	15.03.18 04:11	23° 21.617‘ S	071° 23.375‘ W	7205.8	LANDER	recovery	Camera-Lander-2	4
SO261_47-1	13.03.18 23:22	23° 23.017‘ S	071° 20.699‘ W	8066.5	WS	max depth/ on ground	Hadal-Rosette	4
SO261_48-1	14.03.18 06:52	23° 23.012‘ S	071° 20.703‘ W	8063.3	MUC	max depth/ on ground	MUC-1	4
SO261_49-1	14.03.18 12:55	23° 23.020‘ S	071° 20.700‘ W	8063.3	MUC	max depth/ on ground	MUC-2	4
SO261_50-1	14.03.18 18:16	23° 23.011‘ S	071° 20.703‘ W	8066.6	GC	max depth/ on ground	GC 6m	4
SO261_51-1	14.03.18 21:20	23° 23.118‘ S	071° 20.722‘ W	8063.3	LANDER	deployment	Nano-Lander	4
SO261_51-1	15.03.18 18:31	23° 21.788‘ S	071° 20.595‘ W	8063.3	LANDER	recovery	Nano-Lander	4
SO261_52-1	14.03.18 21:41	23° 23.122‘ S	071° 20.722‘ W	8066.6	NET	station start	Multinet	4
SO261_52-1	14.03.18 23:17	23° 23.115‘ S	071° 20.733‘ W	8066.6	NET	station end	Multinet	4
SO261_53-1	15.03.18 11:07	23° 26.814‘ S	071° 06.020‘ W	5040.7	OFOS	profil start	OFOBS	4
SO261_53-1	15.03.18 11:29	23° 26.829‘ S	071° 06.082‘ W	5048.8	OFOS	profil end	OFOBS	4
SO261_54-1	15.03.18 17:16	23° 21.782‘ S	071° 20.592‘ W	8063.4	CTD	max depth/ on ground	CTD/ Rosette	4

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_55-1	15.03.18 23:18	23° 22.709‘ S	071° 20.722‘ W	8059.1	NET	station start	MOCNESS	4
SO261_55-1	16.03.18 14:35	23° 01.788‘ S	071° 17.779‘ W	7984.5	NET	station end	MOCNESS	4
SO261_56-1	16.03.18 15:21	23° 02.962‘ S	071° 18.124‘ W	7994.9	LANDER	deployment	Reiver	3
SO261_56-1	16.03.18 19:06	23° 03.064‘ S	071° 18.151‘ W	7992.9	LANDER	recovery	Reiver	3
SO261_57-1	16.03.18 18:12	23° 03.065‘ S	071° 18.159‘ W	7992.1	CTD	max depth/ on ground	CTD/ Rosette	3
SO261_58-1	16.03.18 22:12	23° 02.605‘ S	071° 18.034‘ W	7991.7	LANDER	deployment	Profiler-Lander	3
SO261_58-1	18.03.18 11:57	23° 02.607‘ S	071° 18.031‘ W	7964.5	LANDER	recovery	Profiler-Lander	3
SO261_59-1	16.03.18 23:04	23° 02.874‘ S	071° 18.097‘ W	7991.7	LANDER	deployment	Sediment-Lander	3
SO261_59-1	18.03.18 13:14	23° 02.606‘ S	071° 18.026‘ W	7961.9	LANDER	recovery	Sediment-Lander	3
SO261_60-1	16.03.18 23:48	23° 02.998‘ S	071° 15.044‘ W	7179.0	LANDER	deployment	Camera-Lander-1	3
SO261_60-1	18.03.18 17:33	23° 02.114‘ S	071° 15.042‘ W	7179.0	LANDER	recovery	Camera-Lander-1	3
SO261_61-1	17.03.18 00:20	23° 03.015‘ S	071° 13.993‘ W	6980.0	LANDER	deployment	Camera-Lander-2	3
SO261_61-1	18.03.18 18:37	23° 02.112‘ S	071° 15.037‘ W	6980.0	LANDER	recovery	Camera-Lander-2	3
SO261_62-1	17.03.18 03:36	23° 03.142‘ S	071° 18.176‘ W	7995.4	WS	max depth/ on ground	Hadal-Rosette	3
SO261_63-1	17.03.18 09:09	23° 03.131‘ S	071° 18.180‘ W	7994.6	MUC	max depth/ on ground	MUC-1	3
SO261_64-1	17.03.18 15:03	23° 03.139‘ S	071° 18.171‘ W	7994.0	MUC	max depth/ on ground	MUC-2	3
SO261_65-1	17.03.18 20:42	23° 03.140‘ S	071° 18.165‘ W	7995.6	GC	max depth/ on ground	GC 6m	3
SO261_66-1	18.03.18 04:00	23° 02.229‘ S	071° 05.233‘ W	5167.5	OFOS	profil start	OFOBS	3
SO261_66-1	18.03.18 04:13	23° 02.266‘ S	071° 05.301‘ W	5173.4	OFOS	profil end	OFOBS	3
SO261_67-1	18.03.18 22:30	23° 02.912‘ S	071° 18.131‘ W	7992.3	PS	profile start	Parasound	
SO261_67-1	19.03.18 02:11	23° 21.586‘ S	071° 20.575‘ W	8064.5	PS	profile end	Parasound	
SO261_67-2	19.03.18 02:12	23° 21.618‘ S	071° 20.578‘ W		PS	profile start	Parasound	

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_67-2	19.03.18 06:42	23° 18.990‘ S	071° 36.649‘ W	5589.1	PS	profile end	Parasound	
SO261_67-3	19.03.18 06:43	23° 18.983‘ S	071° 36.700‘ W	5594.9	PS	profile start	Parasound	
SO261_67-3	19.03.18 13:24	22° 48.498‘ S	071° 36.841‘ W	5488.9	PS	profile end	Parasound	
SO261_68-1	19.03.18 14:32	22° 56.267‘ S	071° 37.080‘ W	5532.3	LANDER	deployment	Reiver	7
SO261_68-1	19.03.18 16:07	22° 56.559‘ S	071° 37.084‘ W	5539.0	LANDER	recovery	Reiver	7
SO261_69-1	19.03.18 18:57	22° 56.131‘ S	071° 37.187‘ W	6032.8	LANDER	deployment	Profiler-Lander	7
SO261_69-1	20.03.18 20:53	22° 56.233‘ S	071° 37.222‘ W	6032.8	LANDER	recovery	Profiler-Lander	7
SO261_70-1	19.03.18 20:38	22° 56.403‘ S	071° 37.196‘ W	5551.3	LANDER	deployment	FLUX-Lander	7
SO261_70-1	20.03.18 21:40	22° 56.231‘ S	071° 37.225‘ W	5551.3	LANDER	recovery	FLUX-Lander	7
SO261_71-1	19.03.18 20:57	22° 56.677‘ S	071° 37.202‘ W	5569.4	LANDER	deployment	Sediment-Lander	7
SO261_71-1	20.03.18 23:37	22° 55.439‘ S	071° 37.897‘ W	5569.4	LANDER	recovery	Sediment-Lander	7
SO261_72-1	19.03.18 21:23	22° 56.948‘ S	071° 37.197‘ W	5563.3	LANDER	deployment	Camera-Lander-1	7
SO261_72-1	20.03.18 19:41	22° 56.198‘ S	071° 37.189‘ W	5563.3	LANDER	recovery	Camera-Lander-1	7
SO261_73-1	19.03.18 22:12	22° 56.282‘ S	071° 40.686‘ W	4971.7	LANDER	deployment	Camera-Lander-2	7
SO261_73-1	20.03.18 16:37	22° 55.666‘ S	071° 40.638‘ W	4965.9	LANDER	recovery	Camera-Lander-2	7
SO261_74-1	20.03.18 01:17	22° 57.269‘ S	071° 37.243‘ W	5534.0	CTD	max depth/ on ground	CTD/ Rosette	7
SO261_75-1	20.03.18 05:51	22° 57.266‘ S	071° 37.246‘ W	6064.1	MUC	max depth/ on ground	MUC-1	7
SO261_76-1	20.03.18 10:06	22° 57.266‘ S	071° 37.242‘ W	5535.8	MUC	max depth/ on ground	MUC-2	7
SO261_77-1	20.03.18 13:50	22° 57.259‘ S	071° 37.245‘ W	5532.4	GC	max depth/ on ground	GC 9m	7
SO261_78-1	21.03.18 05:16	22° 56.232‘ S	071° 36.468‘ W	5568.3	OFOS	profil start	OFOBS	7
SO261_78-1	21.03.18 05:23	22° 56.247‘ S	071° 36.447‘ W	5575.7	OFOS	profil end	OFOBS	7
SO261_79-1	21.03.18 12:31	22° 56.475‘ S	072° 08.755‘ W	4008.0	LANDER	deployment	Reiver	8

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_79-1	21.03.18 15:38	22° 56.797‘ S	072° 08.747‘ W	4008.0	LANDER	recovery	Reiver	8
SO261_80-1	21.03.18 15:01	22° 56.803‘ S	072° 08.759‘ W	4118.1	CTD	max depth/ on ground	CTD/ Rosette	8
SO261_81-1	22.03.18 01:40	21° 46.858‘ S	071° 12.476‘ W	7904.6	LANDER	deployment	Reiver	2
SO261_81-1	22.03.18 05:35	21° 47.125‘ S	071° 12.478‘ W	7858.1	LANDER	recovery	Reiver	2
SO261_82-1	22.03.18 04:29	21° 47.129‘ S	071° 12.482‘ W	7853.2	CTD	max depth/ on ground	CTD/ Rosette	2
SO261_83-1	22.03.18 11:54	21° 46.500‘ S	071° 12.272‘ W	7937.3	WS	max depth/ on ground	Hadal-Rosette	2
SO261_84-1	22.03.18 14:43	21° 46.505‘ S	071° 12.269‘ W	7940.0	LANDER	deployment	Profiler-Lander	2
SO261_84-1	24.03.18 06:50	21° 47.313‘ S	071° 12.277‘ W	7907.9	LANDER	recovery	Profiler-Lander	2
SO261_85-1	22.03.18 15:04	21° 46.780‘ S	071° 12.262‘ W	7885.2	LANDER	deployment	Sediment-Lander	2
SO261_85-1	24.03.18 14:10	21° 47.887‘ S	071° 12.276‘ W	7885.2	LANDER	recovery	Sediment-Lander	2
SO261_86-1	22.03.18 15:46	21° 47.051‘ S	071° 12.256‘ W	7928.3	LANDER	deployment	Nano-Lander	2
SO261_86-1	23.03.18 18:35	21° 47.323‘ S	071° 12.264‘ W	7928.3	LANDER	recovery	Nano-Lander	2
SO261_87-1	22.03.18 16:45	21° 44.497‘ S	071° 15.465‘ W	6738.3	LANDER	deployment	Camera-Lander-1	2
SO261_87-1	25.03.18 02:52	21° 43.677‘ S	071° 15.448‘ W	6738.3	LANDER	recovery	Camera-Lander-1	2
SO261_88-1	22.03.18 17:28	21° 43.220‘ S	071° 15.813‘ W	6520.0	LANDER	deployment	Camera-Lander-2	2
SO261_88-1	25.03.18 03:40	21° 43.673‘ S	071° 15.452‘ W	6520.0	LANDER	recovery	Camera-Lander-2	2
SO261_89-1	22.03.18 21:03	21° 47.269‘ S	071° 12.279‘ W	7908.4	CTD	max depth/ on ground	CTD/ Rosette	2
SO261_90-1	23.03.18 02:23	21° 47.581‘ S	070° 58.233‘ W	4852.3	OFOS	profil start	OFOBS	2
SO261_90-1	23.03.18 03:56	21° 47.581‘ S	070° 58.895‘ W	4837.1	OFOS	profil end	OFOBS	2
SO261_91-1	23.03.18 09:37	21° 47.329‘ S	071° 12.337‘ W	7888.1	WS	max depth/ on ground	Hadal-Rosette	2
SO261_92-1	23.03.18 16:33	21° 47.317‘ S	071° 12.259‘ W	7927.5	MUC	max depth/ on ground	MUC-1	2

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_93-1	24.03.18 03:10	21° 47.319‘ S	071° 12.261‘ W	7911.9	MUC	max depth/ on ground	MUC-2	2
SO261_94-1	24.03.18 09:57	21° 47.311‘ S	071° 12.275‘ W	7898.3	GC	max depth/ on ground	GC 9m	2
SO261_95-1	24.03.18 16:12	21° 47.880‘ S	071° 12.276‘ W	7879.9	CTD	max depth/ on ground	CTD/ Rosette	2
SO261_96-1	24.03.18 23:05	21° 46.779‘ S	071° 12.299‘ W	7939.0	WS	max depth/ on ground	Hadal-Rosette	2
SO261_97-1	25.03.18 04:24	21° 44.308‘ S	071° 15.484‘ W	7939.0	NET	station start	Multinet	2
SO261_97-1	25.03.18 05:44	21° 44.302‘ S	071° 15.482‘ W	7939.0	NET	station end	Multinet	2
SO261_98-1	25.03.18 07:19	21° 42.606‘ S	071° 15.961‘ W	7939.0	NET	station start	MOCNESS	2
SO261_98-1	25.03.18 16:48	21° 52.079‘ S	071° 12.015‘ W	7912.5	NET	station end	MOCNESS	2
SO261_99-1	25.03.18 23:57	20° 19.143‘ S	071° 17.462‘ W	7737.5	LANDER	deployment	Reiver	10
SO261_99-1	26.03.18 04:34	20° 19.276‘ S	071° 17.451‘ W	7741.7	LANDER	recovery	Reiver	10
SO261_100-1	26.03.18 03:27	20° 19.279‘ S	071° 17.463‘ W	7742.0	CTD	max depth/ on ground	CTD/ Rosette	10
SO261_101-1	26.03.18 07:39	20° 19.008‘ S	071° 17.543‘ W	7735.3	LANDER	deployment	Profiler-Lander	10
SO261_101-1	27.03.18 13:15	20° 18.297‘ S	071° 17.541‘ W	7735.3	LANDER	recovery	Profiler-Lander	10
SO261_102-1	26.03.18 08:08	20° 19.276‘ S	071° 17.543‘ W	7741.5	LANDER	deployment	Sediment-Lander	10
SO261_102-1	27.03.18 17:24	20° 18.516‘ S	071° 17.629‘ W	7734.6	LANDER	recovery	Sediment-Lander	10
SO261_103-1	26.03.18 09:27	20° 20.608‘ S	071° 07.281‘ W	5913.2	LANDER	deployment	Camera-Lander-1	10
SO261_103-1	27.03.18 05:45	20° 19.933‘ S	071° 07.351‘ W	5913.2	LANDER	recovery	Camera-Lander-1	10
SO261_104-1	26.03.18 09:55	20° 20.610‘ S	071° 07.824‘ W	6034.5	LANDER	deployment	Camera-Lander-2	10
SO261_104-1	27.03.18 06:45	20° 19.934‘ S	071° 07.297‘ W	6034.5	LANDER	recovery	Camera-Lander-2	10
SO261_105-1	26.03.18 13:23	20° 19.572‘ S	071° 17.549‘ W	7734.4	MUC	max depth/ on ground	MUC-1	10
SO261_106-1	26.03.18 19:54	20° 19.572‘ S	071° 17.551‘ W	7746.0	MUC	max depth/ on ground	MUC-2	10

Station - No	Date time	Latitude	Longitude	Depth [m]	Gear	Action	Comment (Device)	Site
SO261_107-1	27.03.18 01:36	20° 19.574‘ S	071° 17.551‘ W	7743.3	GC	max depth/ on ground	GC 9m	10
SO261_108-1	27.03.18 13:28	20° 18.298‘ S	071° 17.537‘ W	7729.9	WS	max depth/ on ground	Hadal-Rosette	10
SO261_109-1	27.03.18 22:23	20° 19.964‘ S	070° 58.744‘ W	3931.4	OFOS	profil start	OFOBS	9
SO261_109-1	28.03.18 02:30	20° 20.015‘ S	071° 00.893‘ W	4203.5	OFOS	profil end	OFOBS	9
SO261_110-1	28.03.18 06:23	20° 20.008‘ S	070° 59.395‘ W	4021.2	CTD	max depth/ on ground	CTD/ Rosette	9
SO261_111-1	28.03.18 08:29	20° 20.005‘ S	070° 59.408‘ W	4021.7	LANDER	deployment	Profiler-Lander	9
SO261_111-1	28.03.18 19:54	20° 20.227‘ S	070° 59.370‘ W	4021.7	LANDER	recovery	Profiler-Lander	9
SO261_112-1	28.03.18 08:46	20° 20.272‘ S	070° 59.405‘ W	4040.3	LANDER	deployment	Sediment-Lander	9
SO261_112-1	28.03.18 21:20	20° 19.381‘ S	070° 59.311‘ W	4040.3	LANDER	recovery	Sediment-Lander	9
SO261_113-1	28.03.18 09:05	20° 20.546‘ S	070° 59.406‘ W	4052.6	LANDER	deployment	Camera-Lander-1	9
SO261_113-1	28.03.18 17:27	20° 21.086‘ S	070° 59.407‘ W	4133.9	LANDER	recovery	Camera-Lander-1	9
SO261_114-1	28.03.18 09:28	20° 20.816‘ S	070° 59.406‘ W	4087.4	LANDER	deployment	Camera-Lander-2	9
SO261_114-1	28.03.18 18:19	20° 21.087‘ S	070° 59.404‘ W	4087.4	LANDER	recovery	Camera-Lander-2	9
SO261_115-1	28.03.18 10:50	20° 21.090‘ S	070° 59.399‘ W	4128.1	GC	max depth/ on ground	GC 12m	9
SO261_116-1	28.03.18 14:02	20° 21.089‘ S	070° 59.401‘ W	4134.0	MUC	max depth/ on ground	MUC-1	9
SO261_117-1	28.03.18 17:17	20° 21.087‘ S	070° 59.411‘ W	4139.8	MUC	max depth/ on ground	MUC-2	9

A.3 Multicorer sample distribution

Station	Analysis	Research group	No of cores
So261-8 (site 1)	Geochem	MZ- Marum	1-1
So261-8 (site 1)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-8 (site 1)	Biogeochem & microb	RNG -SDU	1-3
So261-8 (site 1)	Biogeochem	BT - SDU	1-4
So261-8 (site 1)	Biogeochem	BT - SDU	1-5
So261-8 (site 1)	Storage & microsensor	RNG - SDU	1-6
So261-8 (site 1)	Geology	HS - BGS	1-7
So261-8 (site 1)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-8 (site 1)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-8 (site 1)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-8 (site 1)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-8 (site 1)	Microplastics	FW - MPI	1-12
So261-9 (site 1)	Biogeochem & microb	RNG -SDU	2-1
So261-9 (site 1)	dropped	dropped	2-2
So261-9 (site 1)	Biomarkers Geochem	RNG – SDU (hast/ sustech)	2-3
So261-9 (site 1)	Biogeochem	BT - SDU	2-4
So261-9 (site 1)	Biogeochem	BT - SDU	2-5
So261-9 (site 1)	Storage	RNG - SDU	2-6
So261-9 (site 1)	POP	RNG – SDU (SU)	2-7
So261-9 (site 1)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-8
So261-9 (site 1)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-9 (site 1)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-9 (site 1)	Virus& cells	CS- SDU (KU)	2-11
So261-9 (site 1)	POP PAH Metals	RNG- SDU (DMU)	2-12
So261-21 (site 6)	Biogeochem & microb	RNG -SDU	1-1
So261-21 (site 6)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-21 (site 6)	Microplastics	FW - MPI	1-3
So261-21 (site 6)	Biogeochem	BT - SDU	1-4
So261-21 (site 6)	Biogeochem	BT - SDU	1-5
So261-21 (site 6)	Storage & microsensor	RNG/AG - SDU	1-6
So261-21 (site 6)	Geochem	MZ- Marum	1-7
So261-21 (site 6)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-21 (site 6)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-21 (site 6)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-21 (site 6)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-21 (site 6)	Geology	HS - BGS	1-12
So261-22 (site 6)	Biogeochem & microb	RNG -SDU	2-1
So261-22 (site 6)	Virus & diverse	CS- SDU (Chile req & Jeff)	2-2
So261-22 (site 6)	Biomarkers Geochem	RNG – SDU (hast/ sustech)	2-3

Station	Analysis	Research group	No of cores
So261-22 (site 6)	Biogeochem	BT - SDU	2-4
So261-22 (site 6)	Biogeochem	BT - SDU	2-5
So261-22 (site 6)	Storage	RNG - SDU	2-6
So261-22 (site 6)	POP	RNG – SDU (SU)	2-7
So261-22 (site 6)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-8
So261-22 (site 6)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-22 (site 6)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-22 (site 6)	POP PAH Metals	RNG- SDU (DMU)	2-11
So261-22 (site 6)	dropped	dropped	2-12
So261-35 (site 5)	Biogeochem & microb	RNG -SDU	1-1
So261-35 (site 5)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-35 (site 5)	Storage & microsensor	RNG - SDU	1-3
So261-35 (site 5)	Biogeochem	BT - SDU	1-4
So261-35 (site 5)	Biogeochem	BT - SDU	1-5
So261-35 (site 5)	lost	lost	1-6
So261-35 (site 5)	Geochem	MZ- Marum	1-7
So261-35 (site 5)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-35 (site 5)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-35 (site 5)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-35 (site 5)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-35 (site 5)	Geology	HS - BGS	1-12
So261-36 (site 5)	Virus & RNA	CS - SDU	2-1
So261-36 (site 5)	POP PAH Metals	RNG- SDU (DMU)	2-2
So261-36 (site 5)	Biogeochem	BT - SDU	2-3
So261-36 (site 5)	Biogeochem	BT - SDU	2-4
So261-36 (site 5)	dropped	dropped	2-5
So261-36 (site 5)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-6
So261-36 (site 5)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-7
So261-36 (site 5)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-8
So261-36 (site 5)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-36 (site 5)	Biomarkers Geochem	RNG – SDU (hast/ sustech)	2-10
So261-36 (site 5)	Microplastics	FW - MPI	2-11
So261-36 (site 5)	Biogeochem & microb	RNG -SDU	2-12
So261-48 (site 4)	Biogeochem & microb	RNG &CS -SDU	1-1
So261-48 (site 4)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-48 (site 4)	Microplastics	FW - MPI	1-3
So261-48 (site 4)	Biogeochem	BT - SDU	1-4
So261-48 (site 4)	Biogeochem	BT - SDU	1-5
So261-48 (site 4)	Storage & microsensor	RNG - SDU	1-6
So261-48 (site 4)	Geochem	MZ- Marum	1-7
So261-48 (site 4)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8

Station	Analysis	Research group	No of cores
So261-48 (site 4)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-48 (site 4)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-48 (site 4)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-48 (site 4)	Geology	HS - BGS	1-12
So261-49 (site 4)	Biogeochem & microb	RNG &CS -SDU	2-1
So261-49 (site 4)	Biomarkers Geochem	RNG – SDU (hast/ sustech)	2-2
So261-49 (site 4)	Biogeochem	BT - SDU	2-3
So261-49 (site 4)	Biogeochem	BT - SDU	2-4
So261-49 (site 4)	Storage & microsensor	RNG/AG - SDU	2-5
So261-49 (site 4)	POP	RNG – SDU (SU)	2-6
So261-49 (site 4)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-7
So261-49 (site 4)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-8
So261-49 (site 4)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-49 (site 4)	POP PAH Metals	RNG- SDU (DMU)	2-10
So261-49 (site 4)	Viral metagenomics	CS SDU (KU)	2-11
So261-49 (site 4)	LOST	LOST	2-12
So261-63 (site 3)	Biogeochem & microb	RNG -SDU	1-1
So261-63 (site 3)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-63 (site 3)	Microplastics	FW - MPI	1-3
So261-63 (site 3)	Biogeochem	BT - SDU	1-4
So261-63 (site 3)	Biogeochem	BT - SDU	1-5
So261-63 (site 3)	Storage & microsensor	RNG/AG - SDU	1-6
So261-63 (site 3)	Geochem	MZ- Marum	1-7
So261-63 (site 3)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-63 (site 3)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-63 (site 3)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-63 (site 3)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-63 (site 3)	Geology	HS - BGS	1-12
So261-64 (site 3)	Biogeochem & microb	RNG -SDU	2-1
So261-64 (site 3)	Biomarkers Geochem	RNG – SDU (hast/ sustech)	2-2
So261-64 (site 3)	Biogeochem	BT - SDU	2-3
So261-64 (site 3)	Biogeochem	BT - SDU	2-4
So261-64 (site 3)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-5
So261-64 (site 3)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-6
So261-64 (site 3)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-7
So261-64 (site 3)	dropped	dropped	2-8
So261-64 (site 3)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-64 (site 3)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-64 (site 3)	Viral metagenomics	CS SDU	2-11
So261-64 (site 3)	dropped	dropped	2-12

Station	Analysis	Research group	No of cores
So261-75 (site 7)	Biogeochem & microb	RNG -SDU	1-1
So261-75 (site 7)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-75 (site 7)	Microplastics	FW - MPI	1-3
So261-75 (site 7)	Biogeochem	BT - SDU	1-4
So261-75 (site 7)	Biogeochem	BT - SDU	1-5
So261-75 (site 7)	Storage & microsensor	RNG/AG - SDU	1-6
So261-75 (site 7)	Geochem	MZ- Marum	1-7
So261-75 (site 7)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-75 (site 7)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-75 (site 7)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-75 (site 7)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-75 (site 7)	Geology	HS - BGS	1-12
So261-76 (site 7)	Biogeochem & microb	RNG -SDU	2-1
So261-76 (site 7)	Virus biotech	CS/RNG SDU	2-2
So261-76 (site 7)	Biomarker/microbial	AG/RG (sustech-hast)	2-3
So261-76 (site 7)	Biogeochem	BT - SDU	2-4
So261-76 (site 7)	Biogeochem	BT - SDU	2-5
So261-76 (site 7)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-6
So261-76 (site 7)	Storage & microsensor	RNG/AG – (Jeff)	2-7
So261-76 (site 7)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-8
So261-76 (site 7)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-76 (site 7)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-76 (site 7)	POP PAH Metals	RNG- SDU (DMU)	2-11
So261-76 (site 7)	dropped	dropped	2-12
So261-92 (site 2)	Biogeochem & microb	RNG -SDU	1-1
So261-92 (site 2)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-92 (site 2)	Microplastics	FW - MPI	1-3
So261-92 (site 2)	Biogeochem	BT - SDU	1-4
So261-92 (site 2)	Biogeochem	BT - SDU	1-5
So261-92 (site 2)	Storage & microsensor	RNG/AG - SDU	1-6
So261-92 (site 2)	Geochem	MZ- Marum	1-7
So261-92 (site 2)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-92 (site 2)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-92 (site 2)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-92 (site 2)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-92 (site 2)	Geology	HS - BGS	1-12
So261-93 (site 2)	Biogeochem & microb	RNG -SDU	2-1
So261-93 (site 2)	Biomarker/microbial	AG/R (sustech-hast kaust)	2-2
So261-93 (site 2)	POP PAH Metals	RNG- SDU (DMU)	2-3
So261-93 (site 2)	Biogeochem	BT - SDU	2-4
So261-93 (site 2)	Biogeochem	BT - SDU	2-5
So261-93 (site 2)	Storage & microsensor	RNG/AG	2-6

Station	Analysis	Research group	No of cores
So261-93 (site 2)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-7
So261-93 (site 2)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-8
So261-93 (site 2)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-93 (site 2)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-93 (site 2)	Virus	CS SDU	2-11
So261-93 (site 2)	POP	AG/RNG (SU)	2-12
So261-105 (site 10)	Biogeochem & microb	RNG -SDU	1-1
So261-105 (site 10)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-105 (site 10)	Microplastics	FW - MPI	1-3
So261-105 (site 10)	Biogeochem	BT - SDU	1-4
So261-105 (site 10)	Biogeochem	BT - SDU	1-5
So261-105 (site 10)	Storage & microsensor	RNG/AG - SDU	1-6
So261-105 (site 10)	Geochem	MZ- Marum	1-7
So261-105 (site 10)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-105 (site 10)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-105 (site 10)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-105 (site 10)	Biomarker e-DNA	RNG – SDU (hast/ kaust)	1-11
So261-105 (site 10)	Geology	HS - BGS	1-12
So261-106 (site 10)	Biogeochem & microb	RNG -SDU	2-1
So261-106 (site 10)	Virus	CS SDU	2-2
So261-106 (site 10)	Biomarker/microbial	AG/RG (HAST)	2-3
So261-106 (site 10)	Biogeochem	BT - SDU	2-4
So261-106 (site 10)	Biogeochem	BT - SDU	2-5
So261-106 (site 10)	Storage & microsensor	RNG/AG	2-6
So261-106 (site 10)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-7
So261-106 (site 10)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-8
So261-106 (site 10)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-106 (site 10)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-106 (site 10)	POP PAH Metals	RNG- SDU (DMU)	2-11
So261-106 (site 10)	Microb & geochemistry	sustech	2-12
So261-116 (site 9)	Biogeochem & microb	RNG -SDU	1-1
So261-116 (site 9)	Radionuclides	RT-Sams & KO- Jamstec	1-2
So261-116 (site 9)	Geology	HS - BGS	1-3
So261-116 (site 9)	Biogeochem	BT - SDU	1-4
So261-116 (site 9)	Biogeochem	BT - SDU	1-5
So261-116 (site 9)	Storage & microsensor	RNG/AG - SDU	1-6
So261-116 (site 9)	Geochem	MZ- Marum	1-7
So261-116 (site 9)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-8
So261-116 (site 9)	Microbial biodiversity	SA- Ifremer & CS- SDU	1-9
So261-116 (site 9)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	1-10
So261-116 (site 9)	Biomarker geochem 14C	AG/RNG (HAST SUStech)	1-11

Station	Analysis	Research group	No of cores
So261-116 (site 9)	POP	AG/RG	1.12
So261-117 (site 9)	Biogeochem & microb	RNG -SDU	2-1
So261-117 (site 9)	Virus	CS SDU	2-2
So261-117 (site 9)	Biomarker/microbial	AG/RG (HAST)	2-3
So261-117 (site 9)	Biogeochem	BT - SDU	2-4
So261-117 (site 9)	Biogeochem	BT - SDU	2-5
So261-117 (site 9)	Storage & microsensor	RNG/AG	2-6
So261-117 (site 9)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-7
So261-117 (site 9)	Microbial biodiversity	SA- Ifremer & CS- SDU	2-8
So261-117 (site 9)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-9
So261-117 (site 9)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-10
So261-117 (site 9)	Microbial biodiversity	DZ- Ifremer & DR- UPCH	2-11
So261-117 (site 9)	Microplastics	FW - MPI	1-12

A.4 Water sample distribution from CTD/Rosette

Site 1							
St 7-2		RT	LP	CS	XX	WS	IF
		234Th	microbiol	virus & cells	microbiol carbon	Oceanogr microbiol carbon	Zooplank-ton respiration
Bottle	Depths	L	L	L	L	L	
24	5			0,1		10	
23	50	7	0,5	0,1			
22	50				10		
21	50				10		
20	200				10		
19	200				10		
18	250	7		0,1			
17	500	7		0,1			
16	800	7		0,1			
15	1000				10		
14	1000				10		
13	1000					10	
12	1000						10
11	1000						10
10	1100	7		0,1			
9	1400	7		0,1			
8	1700	7		0,1			
7	2000	7		0,1			
6	2300	7		0,1			
5	2300					10	
4	2400	7	0,5				
3	2400				10		
2	2400			5		5	
1	2400				10		

Site 2						
st 82-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	microbiol carbon	Oceanogr microbiol carbon
Bottle	Depth	L	L	L	L	L
24	5			0.2	9.8	
23	5					10
22	50					10
21	50	7		0,2		
20	500					10
19	500	7	1	0,2		
18	1000					10
17	1000	7				
16	1000				10	
15	2000					10
14	2000	7		0,2		
13	2500		1	8		0.1
12	3000					10
11	3000	7		0,2		
10	3000				10	
9	4000					10
8	4000	7		0,2		
7	4500	7		2,2		0,2
6	5000			0,2		9.8
5	5000	7	1	2		
4	5500	7		0,2		0.1
3	6000					10
2	6000	7	1	0,2		
1	6000			0,2	10	

Site 2 st 89-1		OU
Bottle	Depths	L
24	5	10
23	5	10
22	1000	10
21	1000	10
20	2000	10
19	2000	10
18	3000	10
17	3000	10
16	3000	10
15	3000	10
14	4000	10
13	4000	10
12	4000	10
11	4000	10
10	5000	10
9	5000	10
8	5000	10
7	5000	10
6	5000	10
5	6000	10
4	6000	10
3	6000	10
2	6000	10
1	6000	10

Site 2 st 95-1		IF
Bottle 10 L	Depths	L
24	5	10
23	20	10
22	60	10
21	60	10
20	200	10
19	200	10
18	500	10
17	500	10
16	1000	10
15	1000	10
14	1000	10
13	2000	10
12	2000	10
11	2000	10
10	4000	10
9	4000	10
8	4000	10
7	4000	10
6	4000	10
5	6000	10
4	6000	10
3	6000	10
2	6000	10
1	6000	10

Site 3						
st 57-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	microbiol carbon	Oceanogr microbiol carbon
Bottle	Depths	L	L	L	L	L
24	5			0.2	9.8	
23	50					10
22	50	7		0,2		
21	500					10
20	500	7	1	0,2		
19	1000					10
18	1000	7				
17	1000				10	
16	2000					10
15	2000	7		0,2		
14	2500		1	8		0.1
13	3000					10
12	3000	7		0,2		
11	3000				10	
10	4000					10
9	4000	7		0,2		
8	4500	7		2,2		0,2
7	5000			0,2		9.8
6	5000	7	1	2		
5	5500	7		0,2		0.1
4	6000					10
3	6000	7		0,2		
2	6000				10	
1	6000			10		

Site 4						
st 39-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	microbiol carbon	Oceanogr microbiol carbon
Bottle	Depths	L	L	L	L	L
24	5			0.2	9.8	
23	50					10
22	50	7		0,2		
21	500					10
20	500	7	1	0,2		
19	1000					10
18	1000	7				
17	1000				10	
16	2000					10
15	2000	7		0,2		
14	2500		1	8		0.1
13	3000					10
12	3000	7		0,2		
11	3000				10	
10	4000					10
9	4000	7		0,2		
8	4500	7		2,2		0,2
7	5000			0,2		9.8
6	5000	7	1	2		
5	5500	7		0,2		0.1
4	6000					10
3	6000	7		0,2		
2	6000				10	
1	6000			10		

Site 4 st 40-1 Bottle 10 L	Depths	OU L
24	5	10
23	5	10
22	1000	10
21	1000	10
20	2000	10
19	2000	10
18	3000	10
17	3000	10
16	3000	10
15	3000	10
14	4000	10
13	4000	10
12	4000	10
11	4000	10
10	5000	10
9	5000	10
8	5000	10
7	5000	10
6	5000	10
5	6000	10
4	6000	10
3	6000	10
2	6000	10
1	6000	10

Site 4 st 41-1 Bottle 10 L	Depths	IF L
24	5	10
23	20	10
22	60	10
21	60	10
20	200	10
19	200	10
18	500	10
17	500	10
16	1000	10
15	1000	10
14	1000	10
13	2000	10
12	2000	10
11	2000	10
10	4000	10
9	4000	10
8	4000	10
7	4000	10
6	4000	10
5	6000	10
4	6000	10
3	6000	10
2	6000	10
1	6000	10
1	6000	10

Site 5*						
st 28-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	microbiol carbon	Oceanogr microbiol carbon
Bottle	Depths	L	L	L	L	L
24	5			0.2		9.8
23	50					10
22	50				10	
21	50	7	1	0,2		
20	500					10
19	500	7	1	0,2		
18	1000					10
17	1000	7				
16	1000				10	
15	2000					10
14	2000	7		0,2		
13	2500		1	9		
12	3000					10
11	3000	7		0,2		
10	3000				10	
9	4000					10
8	4000	7		0,2		
7	4500	7		0,2		
6	5000	7	1			
5	5500	7		0,2		
4	6000					10
3	6000	7				
2	6000				10	
1	6000			10		

Sample distribution might not be fully correct !!

Site 6 st 11-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	microbiol carbon	Oceanogr microbiol carbon
Bottle	Depths	L	L	L	L	L
24	5			0.2		9.8
23	50					10
22	50				10	
21	50	7	1	0,2		
20	500					10
19	500	7	1	0,2		
18	1000					10
17	1000	7				
16	1000				10	
15	2000					10
14	2000	7		0,2		
13	2500		1	9		
12	3000					10
11	3000	7		0,2		
10	3000				10	
9	4000					10
8	4000	7		0,2		
7	4500	7		0,2		
6	5000	7	1			
5	5500	7		0,2		
4	6000					10
3	6000	7				
2	6000				10	
1	6000			10		

Site 6		
st 13 -1		
		WS et al
Bottle 10 L	Depths	L
24	5	10
23	1000	10
22	1000	10
21	2000	10
20	2000	10
19	3000	10
18	3000	10
17	3000	10
16	3000	10
15	4000	10
14	4000	10
13	4000	10
12	4000	10
11	5000	10
10	5000	10
9	5000	10
8	5000	10
7	5000	10
6	5000	10
5	6000	10
4	6000	10
3	6000	10
2	6000	10
1	6000	10

Site 7 st 74-1		RT 234Th	LP microbiol	CS virus & cells	XX micro-biol carbon	WS Oceanogr microbiol carbon
24	5			0.2	5	2
23	50					10
22	50	7		0,2		
21	500					10
20	500	7		0,2		
19	1000					10
18	1000	7				
17	1000				10	
16	2000					10
15	2000	7		0,2		
14	2500			8		0.1
13	3000					10
12	3000	7		0,2		
11	3000				10	
10	3500	7				0,2
9	4000					10
8	4000	7		0,2		
7	4500	7		2,2		0,2
6	5000			0,2	10	9,8
5	5000	7	1	2		
4	5000					
3	5200	7		0,2		
2	5400	7		0,2		
1	5400		10			

Site 8					
st 80-1		LP	CS	XX	WS
		micro-biol	virus & cells	microbiol carbon	Oceano-gr microbiol carbon
Bottle	Depths	L	L	L	L
24	5		0.2		2
23	5			10	
22	50				10
21	50		0,2		
20	100			10	
19	200			10	
18	500				10
17	500		0,2		
16	1000				10
15	1000		0,2		
14	1000			10	
13	2000				10
12	2000		0,2		
11	2500	1	1		0.1
10	3000				10
9	3000		0,2		
8	3000			10	
7	3500				0,2
6	4000				10
5	4000		0,2		
4	4000	10	2,2		0,2
3	4000			10	
2	4000				
1	4000				

Site 9						
st 100-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	micro-biol carbon	Oceanogr microbiol carbon
Bottle	Depths	L	L	L	L	L
24	5			0.2		2
23	5				10	
22	50					10
21	50	7		0,2		
20	100				10	
19	200				10	
18	500					10
17	500	7		0,2		
16	1000					10
15	1000	7		0,2		
14	1000				10	
13	1500	7				
12	2000					10
11	2000	7		0,2		
10	2500	7	1	1		0.1
9	3000					10
8	3000	7		0,2		
7	3000				10	
6	3500	7				0,2
5	4000					10
4	4000	7		0,2		
3	4000		10	2,2		0,2
2	4000				10	
1	4000					

Site 10						
st 110-1		RT	LP	CS	XX	WS
		234Th	microbiol	virus & cells	micro-biol carbon	Oceanogr microbiol carbon
Bottle	Depths	L	L	L	L	L
24	5			0.2	9.8	
23	5					10
22	50					10
21	50	7		0,2		
20	500					10
19	500	7	1	0,2		
18	1000					10
17	1000	7				
16	1000				10	
15	2000					10
14	2000	7		0,2		
13	2500		1	8		0.1
12	3000					10
11	3000	7		0,2		
10	3000				10	
9	4000					10
8	4000	7		0,2		
7	4500	7		2,2		0,2
6	5000			0,2		9.8
5	5000	7	1	2		
4	5500	7		0,2		0.1
3	6000					10
2	6000	7	1	0,2		
1	6000			0,2	10	

A.5 WATER SAMPLES FROM HADAL-ROSETTE

Site 2 Hadal #1 **Station 91-1**						
		RT	LP	CS	XX	WS
Bottle 12 L	Depths	L	L	L	L	L
1	7700				2	10
2	6500					10
3	6500	7		0,2		
4	7000	7		0,2		
5	7000					10
6	7700	7	1	0,2	3,8	
Bottle 7L						
2	6500				7	
3	6500				7	
4	7000				7	
5	7000				7	

Site 2 Hadal #2 **Station 96-1** Bottle 12 L	Depths	OU
1	7000	12
2	7000	12
3	7000	12
4	7000	12
5	7000	12
6	7000	12
Bottle 7 L		Osvaldo
2	7000	12
3	7000	12
4	7000	12
5	7000	12

Site 3 #1 **station 62-1**			RT	LP	CS	XX	WS
Bottle 12 L	Bottle 7L	Depths	L	L	L	L	L
1		7500				2	10
2	2	6500			7		10
3	3	6500	7		0,2		
4	4	7000	7		0,2		10
5	5	7500			7		
6		7500	7	1	0,2	3,8	

Site 4 #1

Station 40-1

		RT	LP	CS	XX	WS
Bottle 12 L	Depths	L	L	L	L	L
1	7700				2	10
2	6500					10
3	6500	7		0,2		
4	7000	7		0,2		
5	7000					10
6	7700	7	1	0,2	3,8	
Bottle 7L						
2	6500				7	
3	6500				7	
4	7000				7	
5	7000				7	

Site 4 Hadal #2

Station 47-1

Bottle 12 L	Depths	OU
1	7000	12
2	7000	12
3	7000	12
4	7000	12
5	7000	12
6	7000	12
Bottle 7 L		OU
2	7000	12
3	7000	12
4	7000	12
5	7000	12

Site 5 #1						
station 34-1		RT	LP	CS	XX	WS
Bottle 12 L	Depths	L	L	L	L	L
1	7500				2	10
2	6500					10
3	6500	7		0,2		
4	7000	6		0,2		6
5	7500					
6	7500	7	1	0,2	3,8	

Site 6 #1						
station 19-1		RT	LP	CS	XX	WS
Bottle 12 L	Depths	L	L	L	L	L
1	6500	7		0,2		
2	6500					10
3	7000	7		0,2		
4	7000					10
5	7500	7	1	0,2	3,8	
6	7500				2	10

Site 6 #2		
Station 24-1		
Bottle 12 L	Depths	OU
1	7000	12
2	7000	12
3	7000	12
4	7000	12
5	7000	12
6	7000	12
Bottle 7 L		OU
2	7000	12
3	7000	12
4	7000	12
5	7000	12

Site 10 Hadal #1

Station 109-1

Bottle 12 L	Depths	RT L	LP L	CS L	XX L	WS L
1	7700				2	10
2	6500					10
3	6500	7		0,2		
4	7000	7		0,2		
5	7000					10
6	7700	7	1	0,2	3,8	
Bottle 7L						
2	6500				7	
3	6500				7	
4	7000				7	
5	7000				7	

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