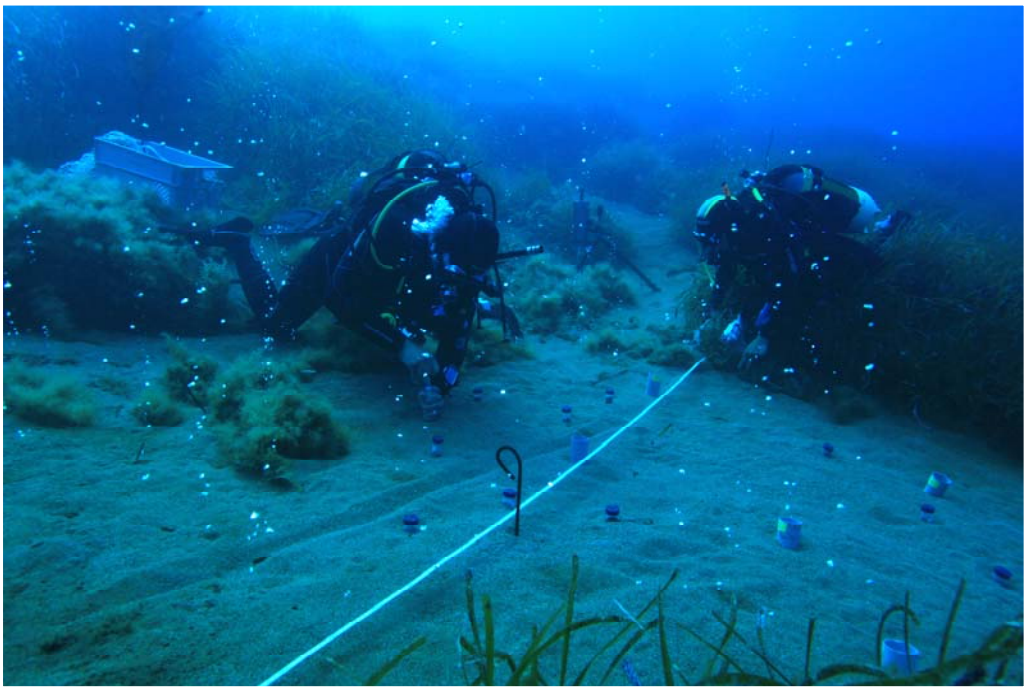
HYDRA Institute for Marine Sciences, Elba Field Station, Elba, Italy
Max Planck Institute for Marine Microbiology, Bremen, Germany

CRUISE REPORT
ECO2-2

(Panarea Island, Italy)



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September 2011

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1 OBJECTIVES

As part of the Aeolian Archipelago, Panarea Island (Italy) is influenced by the active volcano Stromboli. Fumarolic activities and submarine gas seeps are common features around Panarea and have been known to occur in this area since ancient times [1,2]. Based on the high CO_2 content of the released gases, the long-term seepage activity and the shallow water depth, Panarea constitutes an excellent natural laboratory for investigating the effects of CO_2 leakage and ocean acidification on marine benthic organisms and their habitats [2]. Hence, Panarea was taken up into the list of suitable natural analogues within the EU 7th Framework Programme project "ECO_2 – Sub-seabed CO_2 Storage: Impact on Marine Ecosystems" (www.eco2-project.eu) that this field trip was related to.

In conjunction with an increasing interest in studying the effect of high CO_2–low pH on the structure and function of marine benthic organisms, the main objectives of our research at the shallow submarine vents off Panarea Island are:

1) To investigate if CO_2-leakage may change benthic (bacterial, meiofaunal) community composition as compared to non-gas-impacted areas.

2) To improve our monitoring strategies for investigating the impact of CO_2 leakage on gas-impacted ecosystems (biology, geochemistry).

3) To set up areal estimates for the impact of CO_2 leakage on benthic organisms.

In particular for the field trip ECO2-2 (2011), we focused on identifying sites off Panarea Island for studying the impacts of CO_2 emissions on sedimentary marine ecosystems and on finding a suitable non-impacted background site for comparison. A small set of samples and measurements was obtained (i) to test if CO_2 leakage in this area has an influence on bacterial and meiofaunal benthic communities, and (ii) to biogeochemically characterize the sampled habitats. Based on the obtained data we will be able to design future short- and long-term exposure experiments at this site.

2 NARRATIVE of this FIELD TRIP

Our work on Panarea began on 29.05.2011 with the arrival of Miriam Weber, Boris Unger and Christian Lott (HYDRA Institute for Marine Sciences, Elba Field Station, Elba, Italy) on the island, who were in charge of the overall logistics and dive planning throughout this field trip. During the first five days eleven gas emission sites were explored that had been pre-selected based on literature research [3,4] and personal communication. At each site water was sampled for pH and sulfide measurements. Further, temperature measurements were conducted and documentary pictures and videos were taken. The four parameters, (i) decreased pH, (ii) no or only low sulfide concentration, (iii) no elevated temperature and (iv) visible impact on calcareous epibionts were the basis for the ultimate site selection.

At the end of these five exploration days, two CO_2-impacted and one non-gas-impacted background site had been identified to serve as suitable sampling sites for functional long-term investigations of the microbial and meiofaunal community affected by CO_2 emissions: “Red with Gas”, “Grey with Gas” and “Grey no Gas” (Fig. 1).

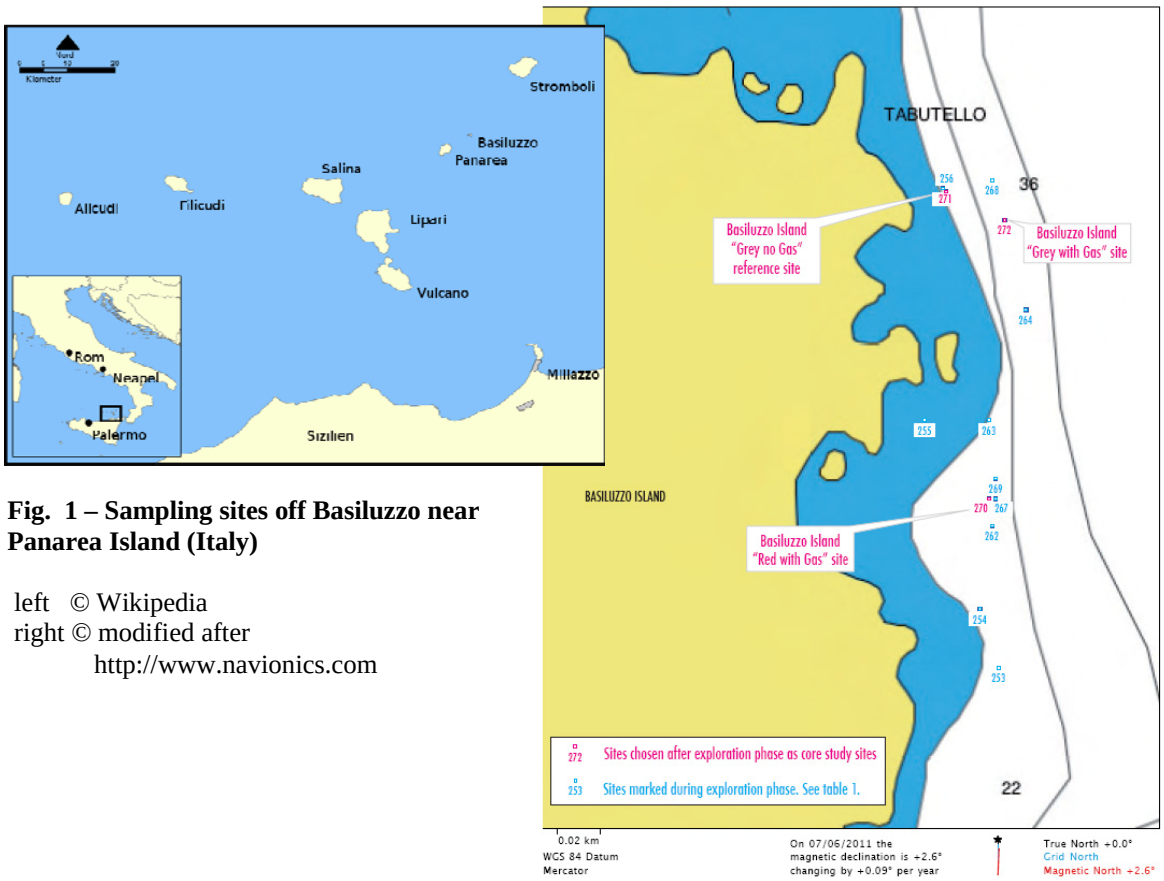

Fig. 1 – Sampling sites off Basiluzzo near Panarea Island (Italy)

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right © modified after
http://www.navionics.com

On 04.06.2012, Frank Wenzhöfer and Stefanie Grünke (Max Planck Institute for Marine Microbiology, Bremen, Germany) joined the team for sampling and *in situ* measurements. Sampling of the three sites was conducted until 10.06.2012 and included (i) surface sediment samples as well as sediment sections from cores to about 15 cm sediment depth for molecular and meiofauna analysis, (ii) pore water for geochemical analysis, (iii) bulk water at the sediment surface for geochemical and molecular analyses, (iv) measurements of current, temperature, pH, pCO_2 and oxygen with sensors for 14-24 h as well as (iv) several continuous video recordings for 2-4 h. In addition, one of the identified CO_2 leakage sites and the non-gas-impacted background site were chosen for sampling seagrass for molecular and meiofauna analysis. The sampling included seagrass leaves, seagrass rhizomes and seagrass meadow, pore water of the seagrass meadow, water from amongst the seagrass leaves and water from above the seagrass for geochemical analysis.

Finally, Frank Wenzhöfer and Stefanie Grünke left the island on 10.06.2011 after a successful field trip. The HYDRA team stayed for three more days to set up the logistics for next year's campaign and finalize packing.

3 PARTICIPANTS

	Name	**First name**	**Activity**	**Institute**
1	Weber	Miriam	logistics, diving, meiofauna	HYDRA
2	Unger	Boris	diving	HYDRA
3	Lott	Christian	diving	HYDRA
4	Wenzhöfer	Frank	geochemistry, profiling	MPI
5	Grünke	Stefanie	microbiology	MPI

4 FIELD SURVEY and IDENTIFICATION of SAMPLING SITES

During the first five days of ECO2-2, eleven gas emission sites were explored. In order to cover a large area in search of emission sites the Manta-towing technique was applied, where a snorkelling person is pulled on a 20 m rope behind the boat, giving hand signals when an emission spot is sighted. At each site the divers then sampled water for pH and sulfide measurements, did temperature measurements and took documentary pictures and video. The four parameters, (i) decreased pH, (ii) no or only low sulfide concentrations, (iii) no elevated temperature and (iv) visible impact on calcareous epibionts were the basis for the ultimate site selection.

At the site “Secca di Lisca Nera” the water around emissions spots had a decreased pH and the temperature was not elevated, but sulfide was detected. At the emission sites “Corpi Morti” discovered along the NE of Panarea Island the temperature of the sediment was so high that the divers could not leave their hand in the sand. The two emission sites discovered at Basiluzzo Island “Roman fish cage” and “Red with Gas” did both fulfil the criteria for a suitable sampling site. The pH was decreased, no sulfide was detected and the temperature was not elevated. At the site “Red with Gas” the gas emissions were more numerous and the sediment area was larger, so that this site was selected for ultimate sampling. The search for a suitable background site (no gas emissions and the same or similar sediment characteristics) along Basiluzzo Island revealed several sites, which were either too deep or had sediment with a visibly larger grain size than at “Red with Gas”. Only after repeated searching, a site with similar sediment parameters was found and could be chosen as suitable background site, then termed “Grey no Gas”.

During a survey along a 250 meter long transect from the site “Red with Gas” to the “Grey no Gas” site another sedimentary gas emission field was found and called “Grey with Gas”. Sulfide and elevated temperatures were not detected along the transect.

Finally, the three sites “Red with Gas” (Fig. 2), “Grey with Gas” (Fig. 3) and “Grey no Gas” (Fig. 4) were chosen for ultimate sediment sampling, which are located between 15-20 m water depth at a temperature of 19°C.

Fig. 2 – Site "Red with Gas" (Panarea Island, Italy) © HYDRA

Fig. 3 – Site "Grey with Gas" (Panarea Island, Italy) © HYDRA

Fig. 4 – Site "Grey no Gas" (Panarea Island, Italy) © HYDRA

Table 4.1 – Main characteristics of the three sedimentary sampling sites that were identified as being suitable for investigating the impact of high CO_2-low pH on benthic communities at Panarea Island (Italy). Observations were made during field trip ECO2-2 (2011).

	"Red with Gas"	**"Grey with Gas"**	**"Grey no Gas"**
Coordinates	N 38°39.749' E 15°07.132'	N 38°39.820' E 15°07.137'	N 38°39.827' E 15°07.118'
Water depth	14-15 m	21 m	14-16 m
Temperature	19°C	19°C	19°C
Gas emission	yes	yes	no
Area	10 × 20 m	3.5 × 5 m	10 × 10 m
Substrate	fine-medium sediment	fine-medium sediment	fine-medium sediment
Substrate color	red-brown (rusty)	grey	grey
Seagrass present?	yes (*Posidonia oceanica*)	yes (*Posidonia oceanica*)	yes (*Posidonia oceanica*)
Seagrass epibionts	few calcareous, many hydrozoa & bryozoa	some calcareous	mostly calcareous

In addition to the identification of the sedimentary sampling sites mentioned above, this field trip also included a survey of sites where other ECO_2 project partners and colleagues had put long-term-measuring instruments. At the site "Black Smoker / INGV Buoy" the INGV Palermo (Italy) has a long-term-measuring sensor stand in the middle of an emission area with sand, gravel, rock and seagrass formations. There we measured decreased pH, detected sulfide and elevated temperatures. At the site "Point 21" colleagues of the TU Freiberg (Germany) had deployed instruments to measure gas flow. At this site we measured decreased pH, detected sulfide, elevated temperature and did not find any sedimentary substrate. At Bottaro West "Crater" our ECO_2 partners of UniRoma1 (Italy) have three instruments positioned that were developed during the EU project RISCS. We measured decreased pH, little elevated temperature and sulfide at the main emission area. The substrate was gravel, rock and seagrass.

Summarized, the three selected sedimentary sampling sites (Table 4.1, Fig. 2-4) are suitable for functional long-term investigations of the benthic communities affected by CO_2 emissions. Due to elevated temperature, high sulfide concentrations or diving safety reasons (depth) the other explored sites mentioned above are not suitable for further studies in this respect.

All sites and sampling events were thoroughly documented by HD videography (SONY EX1) and photography (CANON EOS 5D), including their surroundings and specific features like precipitates or shells.

5 BENTHIC BIOLOGY and GEOCHEMISTRY

5.1 Biological Sampling of Sediment

Sediment samples for investigating bacterial benthic communities were obtained by using segmented push cores (0-2 cm intervals, maximum length up to 15 cm) as well as sterile Sarstedt tubes (for scooping 0-2 cm surface sediment) (Fig. 5). For sampling meiofaunal communities only segmented push cores were used. Samples were either preserved at -20°C for DNA analyses (bacteria), or were fixed in 4% formaldehyde/seawater for cell counts (bacteria) as well as counting and taxonomic identification of meiofauna. Bacterial community composition will be analyzed in the laboratories of the MPI, while meiofauna samples were sent to our ECO_2 partners Ann Vanreusel and Katja Guilini from the University of Ghent (Ghent, Belgium). Overall, these samples will help to elucidate the potential impact of CO_2 leakage and/or decreased pH on the benthic communities as compared to a non-CO_2-impacted background scenario.

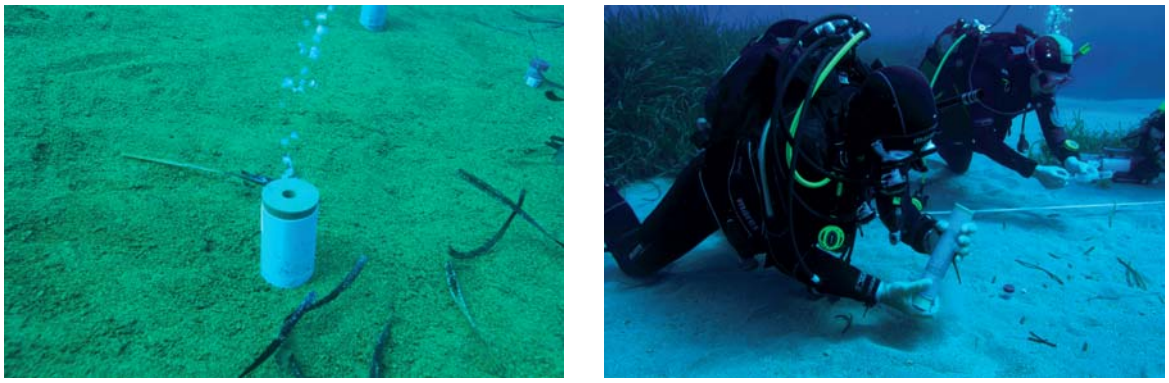

Fig. 5 – Taking sediment samples with push cores and Sarstedt tubes © HYDRA

5.2 Sediment Mineralogy

Four surface samples were obtained for mineralogical analyses, i.e. two from “Red with Gas” and two from “Grey no Gas”, by scooping the upper 0-2 cm of sediment under water into sterile Sarstedt tubes. Back in the field laboratory, the samples were washed with tap water to remove residual seawater. One of the two replicates per site was then stored as is, while the other was dried at ambient temperature. All samples were sent to Prof. Merkel, a cooperating scientist at the TU Freiberg (Freiberg, Germany) for further analysis of their elemental composition.

5.3 Pore-water Geochemistry

To obtain a first overview on how pH, DIC (dissolved inorganic carbon), TA (total alkalinity) and sulfide/sulfate/chloride concentrations change with depth at the investigated sites, 10 mL-syringes were equipped with conventional cannulaes to extract (pore) water from the sediment surface (0 cm), 5 cm below the surface and 10 cm below the surface.

For pH, measurements were done directly in the field laboratory with a pH 96 by WTW (WTW Wissenschaftlich-Technische Werkstätten GmbH, Weilheim, Germany) and an InLab Semi-Micro electrode by Mettler Toledo (Gießen, Germany). Samples were cooled to *in situ* temperature (19°C) before measuring pH. Calibration was done with conventional buffer solutions by Mettler Toledo (pH 4.00 and 7.00).

For DIC and TA, 2 replicate (pore) water samples of 2 mL each were filled headspace-free into glass vials, fixed with $HgCl_2$, and stored at 4-11°C until analyses will be conducted in the MPI home laboratories.

Samples for measuring sulfide/sulfate/chloride concentrations were fixed in ZnAC. Additionally to sampling at 0 cm, 5 cm and 10 cm below the surface, the profiles were complemented with samples from 10 cm above the seafloor. To prevent any loss, the 10mL-syringes used for under-water sampling were pre-filled with 2 mL 2% ZnAc. In that way, potentially present sulfide was directly fixed/precipitated upon filling the syringes with (pore) water up to 10 mL. In the field laboratory, the samples were then transferred to 15 mL-Sarstedt tubes and stored at 4-11°C until their analyses will be done in the MPI home laboratories.

6 SEAWATER MICROBIOLOGY and GEOCHEMISTRY

In order to obtain background information with regard to benthic bacterial community composition and geochemistry, a 5 L-Niskin bottle was used to sample seawater at a height of approx. 10 cm above each of the sedimentary sampling areas. All subsequently described analyses are pending and will be conducted in the home laboratories of the MPI.

In the field laboratory, sub-samples were fixed for DIC and TA (see 5.3), were used for pH measurements (see 5.3), or were preserved without any fixation at -20°C in 15 mL-Sarstedt tubes for analyzing nutrients and salinity. Sub-samples for measuring CH_4 concentration were filled into evacuated and pre-weighed glass containers that contained 2-3 NaOH pellets. Oxygen concentrations were determined on-site by Winkler titration.

To investigate the bacterial community composition, seawater samples were filtered and filters were stored at -20°C for subsequent DNA analyses in the MPI home laboratories. With the help of a portable vacuum pump, 500 mL of seawater were either passed through a 0.2 µm GTTP-filter (Merck Millipore, Billerica, MA), or were fractionated by using first a 3 µm PCMB-filter (Whatman, Germany) and thereafter a 0.2 µm GTTP-filter. In all cases, cellulose nitrate filters (0.45 µm or 3µm; Sartorius, Göttingen, Germany) were used as support filters. If possible, filtrations were repeated to finally obtain 2 replicates per filtration method.

In addition, part of the seawater was fixed with formaldehyde (final concentration of 1%) over night at 11°C in sterile 50 mL-Sarstedt tubes. The following filtrations were conducted: 30 mL through a 0.2 µm GTTP-filter, 60 mL through a 0.2 µm GTTP-filter, 50 mL fractionated through 3 µm- and 0.2 µm-filters. In all cases, cellulose nitrate filters were used as support filters. If possible, filtrations were repeated to finally obtain 2 replicates per filtration method. These samples will be used for evaluating if a pre-filtration of the seawater is necessary and what seawater volume is most sufficient when determining bacterial cell numbers by DAPI-staining and fluorescence *in situ* hybridization.

7 SEAGRASS SAMPLING

A survey along a 250 m long transect from the site “Red with Gas” to the “Grey no Gas” site was conducted to document the growth of epibionts on the leaves of the seagrass *Posidonia oceanica* as a proxy in order to detect a possible CO_2 gradient. At emission sites where the pH was decreased the overgrowth of the seagrass leaves lacked most of the common calcareous epibionts (Fig. 6). Instead, we noted that certain species were very abundant, possibly favoured by the lack of encrusting, fast-growing coralline algae: a feather-like unidentified plumulariid hydrozoon, a branched upright ctenostomatid bryozoon, and the calcifying

bryozoon *Lichenopora* species. At the background site, the seagrass leaves had "normal" epibiont overgrowth (Fig.7).

Fig. 6 – The seagrass leaves at the sampling site "Red with Gas" had few calcareous epibionts (left). A feather-like unidentified plumulariid hydrozoon (right), a branched upright ctenostomatid bryozoon, and the calcifying bryozoon *Lichenopora* sp. were abundant. © HYDRA

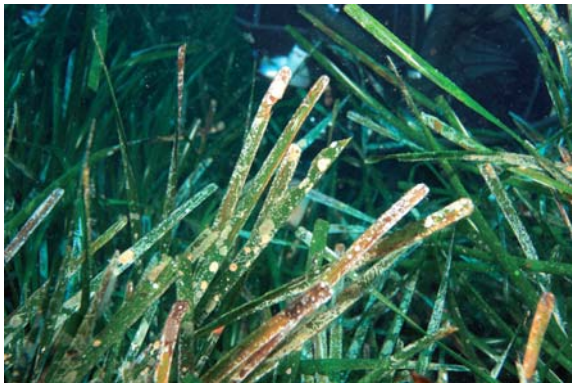

Fig. 7 – The seagrass leaveas at the sampling site "Grey no Gas" had "normal" epibiont overgrowth. © HYDRA

Furthermore, the divers observed that the gradients of pH and of the epibiont changes occur in the range of tenths of meters. We assume that the epibionts have a threshold for pH in the ambient water when they colonize the seagrass leaves. However, we found seagrass leaves with "normal" overgrowth at areas close to gas emissions and noticed a patchiness in the distribution of epibionts. Our first observations have to be taken with caution and further analyses that take into account the changes in the water movement regime (tides, waves, currents) need to be made.

Seagrass meadows (*Posidonia oceanica*) were sampled at "Grey no Gas" (background site) and "Red with Gas" (CO_2-impacted site). A few samples were retrieved to test if scraping the surface of the leaves will yield sufficient amounts of bacterial DNA for subsequent

community analyses. Scrapings were preserved at -20°C in 1 mL 1×TE-buffer (molecular grade; Promega, Madison, WI). In addition, undisturbed leaf sections were fixed in a 4% formaldehyde/seawater solution for bacterial cell counts. These data could eventually supplement the benthic bacterial community analyses. The samples are currently being processed in the home laboratories of the MPI.

A few seagrass leafs were fixed in formaldehyde (final concentration 4%) and sent to our partners Ann Vanreusel and Katja Guilini at the University of Ghent (Ghent, Belgium) to analyze the associated meiofauna.

In addition to sampling leafs, also seawater was collected with a 5 L-Niskin bottle at the site "Grey no Gas", and was prepared for DNA analyses, bacterial cell counts, DIC, TA, CH_4 concentration, pH and nutrient measurements (see 5.3 and 6). Syringes were used at both sites "Grey no Gas" and "Red with Gas" for obtaining seawater from different positions within the respective seagrass meadows to measure sulfide/sulfate/chloride concentrations, DIC, TA, pH (see 5.3), and oxygen concentrations (see 6).

8 GAS SAMPLING

Gas samples were taken by the divers directly under water into 10 mL-glass vials. Upon retrieval, the samples were fixed with a few drops $HgCl_2$ to prevent potentially present and/or metabolically active microbes from changing the gas composition. First analyses with a HP 5890 gas chromatograph (Hewlett Packard; equipped with a thermal conductivity detector) showed that the emitted gas was composed of up to 94% CO_2 at the "Red with Gas" site, and up to 91% CO_2 at the "Grey with Gas" site. Sulfide (qualitatively) and methane (detection limit 500 ppm) were not detected.

9 IN SITU MEASUREMENTS

Several *in-situ*-measuring devices were deployed at the investigated sedimentary sites to geochemically characterize the respective habitats and to test their potential for improved monitoring strategies of CO_2 leakage. Gas seepage intensity was monitored for several hours at both gas-impacted sites with a camera. These recordings are currently being evaluated by HYDRA. Observations made by the divers under water indicate the potential for considerable differences in seepage intensity during the day that may be caused by wave action, tides or changing currents.

9.1 Handheld Profiler

The “Handheld” profiler is a small microsensor profiler that can be operated by divers and records sensor data at high temporal resolution within the water column (Fig. 8). During this field trip, it was equipped with sensors for pCO_2 (Microelectrodes Inc., USA), temperature (Pt100; UST Umweltsensortechnik GmbH, Geschwenda, Germany), pH and oxygen [5,6]. Due to an unexpected sensor drift only one data set may be available (“Red with Gas”), which is currently being evaluated.

9.2 SEAGUARD Recording Current Meter

During this field trip a SEAGUARD recording current meter (AADI, Norway) was deployed at all three sedimentary sites (“Red with Gas”, “Grey with Gas” and “Grey no Gas”). The device (Fig. 8) recorded current speed and direction, temperature, salinity/conductivity, pressure, turbidity and oxygen concentrations within the water column. The data analysis is still in progress.

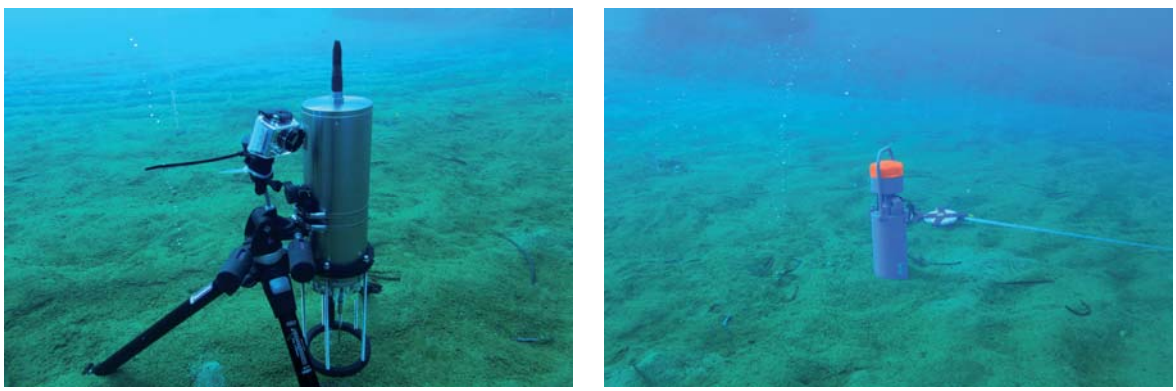

Fig. 8 – Left: Handheld profiler (right) and camera, Right: SEAGUARD recording current meter © HYDRA

10 BOTTARO

In addition to the identification of the sedimentary sampling sites, this field trip also included a survey of sites where other ECO_2 project partners had put long-term-measuring instruments. At Bottaro West "Crater" (Fig. 9), our colleagues from UniRoma1 (Italy) have put three long-term-measuring systems. The first system is within the main crater with strong continuous gas emissions, gravel with white precipitations and/or bacteria, and no seagrass. We measured pH 6.0-7.4, detected sulfide, and temperature was elevated by 2-3°C compared to the surrounding seawater (19°C). The second measuring system from UniRoma1 (Italy) is located SE of the main crater with continuous gas emissions, but the amount of the emitted gas was less than at the main crater, at very little gravel and mainly rock boulders with algal overgrowth, and seagrass in small patches. We measured pH to 7.2-7.4, sulfide was not detected, and the temperature equal to the surrounding seawater (19°C). The third measuring system from UniRoma1 (Italy) is located SW of the main crater where no gas emissions were detected as well as very little gravel and only some rock boulders with algal overgrowth. Seagrass occurred in large patches. We measured pH of 8.0, did not detect sulfide, and the temperature was equal to the surrounding seawater (19°C). On the seagrass we observed calcareous epibiota.

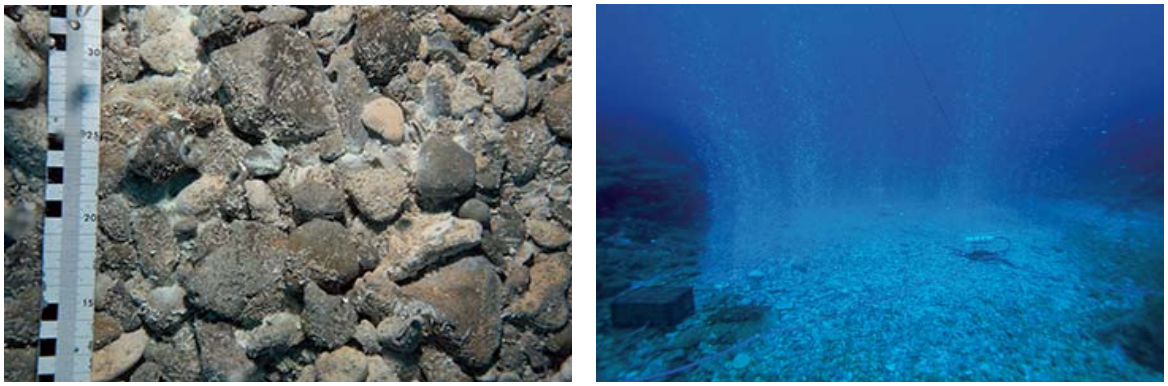

Fig. 9 – Bottaro West "Crater" is a large crater-like area with strong gas emissions that is located between 8-12.5 m water depth. The seafloor is carpeted mostly with gravel (stones 2-4 cm diameter), which are partially covered with white sulfur-related precipitations or algae (left picture). The amount of gas emitted at each emission spot was less than at the main crater area (right picture), however, the emissions were continuous. © HYDRA

Furthermore, we conducted a survey along a 200 meter transect to document the changes of the epibionts on various substrates along the gradient around the emissions in more detail. Where the pH was decreased the divers found less to no calcareous encrusting epibionts and the calcifying algae *Acetabularia acetabulum* with visibly lower calcification (green colour)

on the gravel and the seagrass. This site was chosen for sampling gravel for molecular and meiofauna analysis at the three instruments of UniRoma1 (Italy) and one background site. The sampling included also pore water and water above the gravel surface for geochemical analysis (sulfide/sulfate/chloride, DIC, TA, pH, oxygen; see 5.3 and 6). Analyses are still pending. The sampling was documented on video.

11 ACKNOWLEDGEMENTS

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13 STATION LIST (as published at www.pangaea.de)

Event label	Device	Latitude	Longitude	Elevation	Date/Time	Comment	Latitude end	Longitude end	Elevation end	Date/Time end
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ECO2-2-2	Sampling by diver	38.6431	15.0783	-15	2011-05-29T00:00:00	Corpi Morti, emission spot 1				
ECO2-2-3	Sampling by diver	38.6428	15.0788	-15	2011-05-29T00:00:00	Corpi Morti, emission spot 2				
ECO2-2-4	Sampling by diver	38.6418	15.0794	-15	2011-05-29T00:00:00	Corpi Morti, emission spot 3				
ECO2-2-5	Sampling by diver	38.6426	15.0791	-15	2011-05-29T00:00:00	Corpi Morti, emission spot 4				
ECO2-2-10	Sampling by diver	38.6628	15.1185	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 3				
ECO2-2-11	Sampling by diver	38.6638	15.1186	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 4				
ECO2-2-12	Sampling by diver	38.6651	15.1175	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 5				
ECO2-2-13	Sampling by diver	38.6608	15.1141	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 6				
ECO2-2-14	Sampling by diver	38.661	15.1143	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 7				
ECO2-2-15	Sampling by diver	38.6624	15.1189	-20	2011-05-30T00:00:00	Basiluzzo Island East, area red with gas				
ECO2-2-6	Sampling by diver	38.6606	15.1175	-20	2011-05-30T00:00:00	Basiluzzo Island South-East, emission field 1				
ECO2-2-7	Sampling by diver	38.6604	15.1177	-20	2011-05-30T00:00:00	Basiluzzo Island South-East, emission field 2				
ECO2-2-8	Sampling by diver	38.6618	15.1189	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 1				
ECO2-2-9	Sampling by diver	38.662	15.1188	-20	2011-05-30T00:00:00	Basiluzzo Island, spot 2				
ECO2-2-16	Sampling by diver	38.6628	15.1189	-20.5	2011-05-31T00:00:00	Basiluzzo Island East				
ECO2-2-17	Sampling by diver	38.6633	15.1191	-21.5	2011-05-31T00:00:00	Basiluzzo Island East, area grey no gas				
ECO2-2-18	Sampling by diver	38.6372	15.1098	-12.5	2011-05-31T00:00:00	Bottaro West "Crater"				
ECO2-2-19	Sampling by diver	38.6372	15.105	-23	2011-06-01T00:00:00	Black Smoker / Bottaro Island				
ECO2-2-20	Sampling by diver	38.6384	15.1068	-22.4	2011-06-02T00:00:00	Point 21; Wistau (2006)				
ECO2-2-21	Sampling by diver	38.6633	15.1191	-17	2011-06-02T00:00:00	Basiluzzo Island, area grey no gas				
ECO2-2-22	Sampling by diver	38.6625	15.1189	-16	2011-06-02T00:00:00	Basiluzzo Island, area red with gas				
ECO2-2-23	Sampling by diver	38.6625	15.1189	-20.5	2011-06-03T00:00:00	Basiluzzo Island, area red with gas / transect1				
ECO2-2-24	Sampling by diver	38.6625	15.1189	-17.5	2011-06-03T00:00:00	Basiluzzo Island, area red with gas / transect2				
ECO2-2-25	Sampling by diver	38.6372	15.1098	-13.5	2011-06-04T00:00:00	Bottaro West "Crater", transect1				
ECO2-2-26	Sampling by diver	38.6372	15.1098	-12.6	2011-06-04T00:00:00	Bottaro West "Crater", transect2				
ECO2-2-27	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	Basiluzzo Island, red with gas / sampling				
ECO2-2-FT-1	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				
ECO2-2-FT-10	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-FT-11	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-FT-12	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-FT-2	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				

ECO2-2-FT-3	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				
ECO2-2-FT-4	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				
ECO2-2-FT-5	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				
ECO2-2-FT-6	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				
ECO2-2-FT-7	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-FT-8	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-FT-9	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-FT-A	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; mineralogy sample				
ECO2-2-FT-B	Hand push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; mineralogy sample				
ECO2-2-GAS-1	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; gas sample				
ECO2-2-GAS-2	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; gas sample				
ECO2-2-GAS-3	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; gas sample				
ECO2-2-GAS-4	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; gas sample				
ECO2-2-HD-1	Video camera	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas	38.6625	15.1189	-14.5	2011-06-06T00:00:00
ECO2-2-MICH-1	Microsensor profiler	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas	38.6625	15.1189	-14.5	2011-06-06T00:00:00
ECO2-2-NIS-1	Bottle, Niskin 5L	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; water within seep field				
ECO2-2-PUC-1a	Push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment directly at seep				
ECO2-2-PUC-2a	Push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-PUC-3a	Push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-PUC-4a	Push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-PUC-5a	Push corer	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; sediment next to seep				
ECO2-2-PW-1	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; (pore)water				
ECO2-2-PW-2	Sampling by diver	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas; (pore)water				
ECO2-2-RCM-1	Current meter	38.6625	15.1189	-15	2011-06-05T00:00:00	red with gas	38.6625	15.1189	-14.5	2011-06-06T00:00:00
ECO2-2-28	Sampling by diver	38.6638	15.1186	-16	2011-06-06T00:00:00	Basiluzzo Island, grey no gas / sampling				
ECO2-2-FT-27	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-28	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-29	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-30	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-31	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-32	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-33	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-34	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-35	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-36	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-37	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-38	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-FT-C	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; mineralogy sample				
ECO2-2-FT-D	Hand push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; mineralogy sample				
ECO2-2-HD-2	Video camera	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas				

ECO2-2-MICH-2	Microsensor profiler	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas	38.6638	15.1186	-20	2011-06-07T00:00:00
ECO2-2-NIS-2	Bottle, Niskin 5L	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; water				
ECO2-2-PUC-1b	Push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-PUC-2b	Push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-PUC-3b	Push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-PUC-4b	Push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-PUC-5b	Push corer	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; sediment				
ECO2-2-PW-3	Sampling by diver	38.6625	15.1189	-14.5	2011-06-06T00:00:00	red with gas; water				
ECO2-2-PW-4	Sampling by diver	38.6625	15.1189	-14.5	2011-06-06T00:00:00	red with gas; water				
ECO2-2-PW-5	Sampling by diver	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; (pore)water				
ECO2-2-PW-6	Sampling by diver	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas; (pore)water				
ECO2-2-RCM-2	Current meter	38.6638	15.1186	-16	2011-06-06T00:00:00	grey no gas	38.6638	15.1186	-20	2011-06-07T00:00:00
ECO2-2-29	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	Basiluzzo Island, grey with gas / sampling				
ECO2-2-FT-53	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-FT-54	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-FT-55	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-FT-56	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-FT-57	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-FT-58	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-FT-59	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-FT-60	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-FT-61	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-FT-62	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-FT-63	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-FT-64	Hand push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-GAS-10	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; gas sample				
ECO2-2-GAS-5	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; gas sample				
ECO2-2-GAS-6	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; gas sample				
ECO2-2-GAS-7	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; gas sample				
ECO2-2-GAS-8	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; gas sample				
ECO2-2-GAS-9	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; gas sample				
ECO2-2-MICH-3	Microsensor profiler	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas				
ECO2-2-NIS-3	Bottle, Niskin 5L	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; water within seep field				
ECO2-2-PUC-1c	Push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment directly at seep				
ECO2-2-PUC-2c	Push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-PUC-3c	Push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-PUC-4c	Push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-PUC-5c	Push corer	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; sediment next to seep				
ECO2-2-PW-7	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; (pore)water				
ECO2-2-PW-8	Sampling by diver	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas; (pore)water				

ECO2-2-RCM-3	Current meter	38.6637	15.1189	-21	2011-06-07T00:00:00	grey with gas				
ECO2-2-30	Sampling by diver	38.6638	15.1186	-14	2011-06-08T00:00:00	Basiluzzo Island, grey no Gas / sampling				
ECO2-2-31	Sampling by diver	38.6625	15.1189	-14	2011-06-08T00:00:00	Basiluzzo Island, red with gas / sampling				
ECO2-2-HD-3	Video camera	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass				
ECO2-2-MICH-4	Microsensor profiler	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass	38.6638	15.1186	-14	2011-06-09T00:00:00
ECO2-2-MICH-5	Microsensor profiler	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass	38.6638	15.1186	-14	2011-06-09T00:00:00
ECO2-2-NIS-4	Bottle, Niskin 5L	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass; water				
ECO2-2-PW-10	Sampling by diver	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass; (pore)water				
ECO2-2-PW-11	Sampling by diver	38.6625	15.1189	-14	2011-06-08T00:00:00	red with gas / seagrass; (pore)water				
ECO2-2-PW-12	Sampling by diver	38.6625	15.1189	-14	2011-06-08T00:00:00	red with gas / seagrass; (pore)water				
ECO2-2-PW-9	Sampling by diver	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass; (pore)water				
ECO2-2-RCM-4	Current meter	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass	38.6638	15.1186	-14	2011-06-09T00:00:00
ECO2-2-Seagras-1	Sampling by diver	38.6638	15.1186	-14	2011-06-08T00:00:00	grey no gas / seagrass				
ECO2-2-Seagras-2	Sampling by diver	38.6625	15.1189	-14	2011-06-08T00:00:00	red with gas / seagrass				
ECO2-2-32	Sampling by diver	38.6372	15.1098	-8	2011-06-09T00:00:00	Bottaro West "Crater" / sampling at four locations in this area with depths of -8 to -12				
ECO2-2-Gravel-1	Sampling by diver	38.6372	15.1098	-8	2011-06-09T00:00:00	Bottaro West Crater / gravel				
ECO2-2-PW-13	Sampling by diver	38.6372	15.1098	-8	2011-06-09T00:00:00	Bottaro West Crater / gravel; (pore)water				
ECO2-2-PW-14	Sampling by diver	38.6372	15.1098	-8	2011-06-09T00:00:00	Bottaro West Crater / gravel; (pore)water				
ECO2-2-33	Sampling by diver	38.6625	15.1189	-15	2011-06-10T00:00:00	Basiluzzo Island, red with gas / sampling				
ECO2-2-GAS-11	Sampling by diver	38.6625	15.1189	-15	2011-06-10T00:00:00	red with gas; gas sample				
ECO2-2-GAS-12	Sampling by diver	38.6625	15.1189	-15	2011-06-10T00:00:00	red with gas; gas sample				