Cruise Report

CARACALHIS

December 15-26 2015
Panama (Colon) - Guadeloupe (Pointe-à-Pitre)

Chief Scientist Luc BEAUFORT(1)
Shipboard Scientific Party :
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Associated cruise
HAITI BGF
Nadine Ellouz-Zimmermann (Chief scientist) IFPEN

Scientific Vessel
ATALANTE
Captain : Philippe MOINEAU

1- Introduction

1.1 Scientific objectives

Coccolithophores and planktonic foraminifera produce more than 90% of pelagic carbonates. They are an essential link in the carbon cycle. Their calcification is dependent on the carbonate ion concentration in the ocean (Barker and Elderfield, 2002; Beaufort et al., 2011; de Moel et al., 2009; Riebesell et al., 2000). Carbon dioxide produced by human activities since the beginning of the industrial revolution has already caused a decrease of 0.1 pH units (Gattuso and Lavigne, 2009; Raven et al., 2005). The impact of this decrease on carbonate production has not yet been assessed and this is what we propose to do here. The Caribbean Sea is supersaturated in carbonate ions and at the same time is a very important anthropogenic CO2 sink (Gledhill et al., 2008). It is therefore acidifying rapidly (Figure 1). Thus it is an excellent laboratory for conducting research on acidification. It is therefore important to sample coccoliths and foraminifera to describe, quantify and understand how their calcification evolves. Calcareous plankton are particularly well calcified in this area as shown by the eponymous species Gephyrocapsa caribbeanica which is the most calcified of its kind and was first described in this area (Okada and McIntyre, 1979). This study area is part of a sample of six very different areas from a chemical and ecological point of view that will allow us to monitor and understand the evolution of calcifying plankton during current acidification on a global scale.

The originality of this work lies in the fact that the degree and evolution of pelagic calcification is currently unknown. This is an essential parameter of carbonate chemistry and therefore one of the keys to understanding ocean acidification and whether it will have a strong biogeochemical impact. This is the first study of its kind on a global scale. The Caribbean is a key area for the success of this study.

1.2 Sampling strategy

In the Caribbean, we chose Puerto Rico because we were aware of a core that is perfectly suited to the objectives of this work (Nyberg et al., 2001). This core was collected 20 years ago from the southern flank of the Puerto Rican island margin (17°53.270N, 66°36.020W) at a depth of 349m. The sediments at this site are a slightly silty green clay-limestone mud. This core is rich in microfossils such as planktonic foraminifera which are well preserved. The sedimentation rates measured between 0.5 and 1.5 mm/year are sufficiently high for our study. For the core samples, we used the Kullenberg corer of Atalante and a surface mini-corer UWITEC of CEREGE which we used 4 times in a row. The station where these samples were taken is CARAC 7. It is positioned 4 miles south of the original point because an area of dredge deposits has affected the Nyberg core site since 2008.

With a rosette fitted with a CTD and 12 x 12L Niskin bottles, we sampled at 8 stations, with an average of 15 depths sampled in two operations. The water was used for coccoliths, pH, and other carbonate chemistry parameters, and for genetic studies. Seawater chemistry will be measured and evaluated in the laboratory (pH, DIC, alkalinity, temperature and salinity measurements). We used our MultiNet to collect planktonic foraminifera at 5 different depths. For technical reasons, the net could only be used once we arrived in Puerto Rican waters. We made four MultiNet hauls, i.e. 20 nets.

We sampled in the widest possible range of pH and chemical conditions surrounding the values of the Puerto Rico station: in particular we benefit from the positions of the HAITI-BGF campaign in

Haitian waters and CARACALHIS in Puerto Rican waters. In these waters, we have carried out a large-mesh sampling, with as many CTD stations as possible.

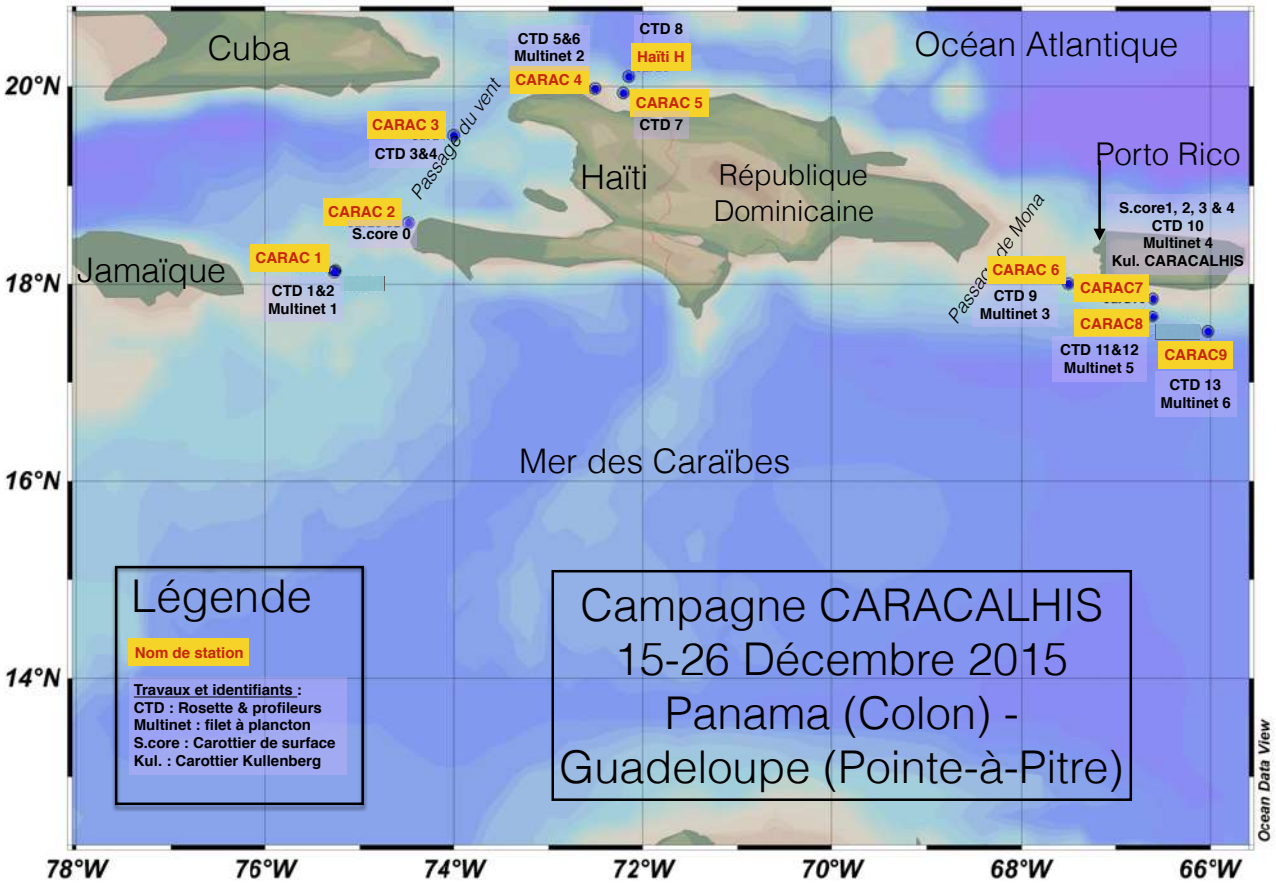
-Haitian Caribbean waters (CARAC 1)
-Windward Passage (CARAC 3)
-North Haitian Atlantic waters (CARAC 4 and 5)
-Mona Passage to Puerto Rico (CARAC 6)
-Puerto Rican Caribbean Waters (CARAC 7-8 & 9)

Continuously in Haitian and Puerto Rican waters, we measured pH, and phytoplankton composition by fluoprobe. We collected surface water quite frequently (13 samples) between stations in order to be able to relate morphology, genetics and chemistry at a finer scale.

2- CHRONOLOGY

STATION	Latitude N	Longitude W	Date	Heure début	Heure fin	Sonde (m)	Opérations	Résultat
CARAC 1	18°06.838	75°15.808	18-12-15	13:00	14:10	3058 m	CTD 1 - 1000 m	CTD1: 8 bouteilles / 12
				15:15	15:50		CTD 2 - 200 m	CTD2:11 bouteilles /12
				16:00	16:45		Filet Multinet 489 m	T1: Echec
CARAC 2	18°34	74°34	19-12-15	2:40	3:30	396 m	Carotte surface	Score 0: Echec
CARAC 3	19°30	74°00	19-12-15	9:30	10:35	1801 m	CTD 1 - 700 m	CTD 3: 12 Bouteilles
				11:00	11:25		CTD 2 - 200 m	CTD 4: 12 Bouteilles
CARAC 4	19°59,20	72°30.30	21-12-15	3:00	4:10	696 m	CTD 1 - 638 m	CTD 5: 11 bouteilles /12
				4:50	5:30		CTD 2 - 200 m	CTD 6: 12 Bouteilles
				6:20	6:46		Filet Multinet 303 m	T2: Echec
CARAC 5	19°56.147	72°12,728	21-12-15	10:00	11:15	981 m	CTD - 900 m	CTD 7: 12 Bouteilles
Haiti H	20°05.81	72°09.47	21-12-15	19:00	21:00	2159 m	CTD - 2111 m	CTD 8: 11/12 Bouteilles
CARAC 6	18°00	67°30	23-12-15	18:45	19:50	1080 m	CTD - 1012 m	CTD 9: 11 bouteilles /12
				20:15	21:00		Filet Multinet 352 m	T3 : 5 échantillons
CARAC 7	17°51.070	66°36.02	24-12-15	3:00	3:45	394 m	Pinger: Test longueur filée	415 m
				3:55	4:10		Carotte surface	Score 1: 21 cm
				4:15	5:00		Filet Multinet 351m	T4 : 5 échantillons
				5:10	5:25		Carotte surface	Score 2: 19 cm
				5:30	6:25		CTD 1 - 368 m	CTD10: 12 bouteilles
				6:30	6:45		Carotte surface	Score 3: 18 cm
				7:05	7:20		Carotte surface	Score 4: 20 cm
				7:35	8:25		Carotte piston 5 m	CARCALHIS - 4,40m
CARAC 8	17°40.057	66°36.207	24-12-15	10:10	10:35	2400 m	CTD 1 - 201 m	CTD 11: 12 Bouteilles
				11:00	13:00		CTD 2 - 2156 m	CTD 12: 12 Bouteilles
				13:00	13:35		Filet Multinet 300 m	T5 : 5 échantillons
CARAC 9	17°30.782	66°01.624	24-12-15	18:45	19:05	2400 m	Filet Multinet 150 m	T6 : 5 échantillons
				19:15	19:45		CTD 1 - 130 m	CTD 13: 12 Bouteilles
temps total							23h30 sans Haïti H	25h30 avec Haïti H

L'Atalante left the port of Colon in Panama on the evening of Tuesday 15 December 2015 and entered the port of Pointe-à-Pitre in Guadeloupe in the middle of the day on 26 December 2015. The stations are positioned on the ship's route around Haiti and around the original position of southern Puerto Rico, for the coring station. The transit time related to CARACALHIS was therefore minimal. The cumulative working time was of the order of 24 hours, depending on



whether or not the Haiti H station was taken into account, where the deep CTD (2159 m) was carried out for the Haiti BGF campaign but which we also sampled.

3- Work description

3.1- Cast / CTD sampling

Matthieu Labaste,

Tableau prélèvements CTD

CTD n°	Date	Heure	lat N	long W	B1 m	B2 m	B3 m	B4 m	B5 m	B6 m	B7 m	B8 m	B9m	B10m	B11m	B12m
1	18/12/15	18:21:48	18 06.83 N	075 15.82 W	998	800	601	594	400	181	150	119	89	59	29	2
2	18/12/15	20:16:41	18 07.79 N	075 15.25 W	123	123	123	123	51	51	51	51	5	5	5	5
3	19/12/15	14:41:10	19 30.00 N	074 00.02 W	702	599	499	350	200	149	100	70	50	30	10	2
4	19/12/15	16:07:10	19 30.00 N	074 00.02 W	122	122	122	122	40	40	40	40	4	4	4	4
5	21/12/15	08:13:39	19 58.69 N	072 30.59 W	632	595	550	501	295	200	150	100	80	60	40	30
6	21/12/15	09:53:41	19 58.75 N	072 30.32 W	110	110	110	110	50	50	50	50	5	5	5	5
7	21/12/15	15:29:38	19 56.01 N	072 12.83 W	904	700	500	250	1505	90	90	90	70	40	18	10
8	22/12/15	00:03:32	20 05.81 N	072 09.47 W	2111	2110	2111	2111	2111	1000	148	100	100	50	10	NON
9	23/12/15	23:53:27	18 00.06 N	067 30.06 W	1012	800	600	300	150	100	100	100	50	50	50	12
10	24/12/15	10:35:23	17 50.99 N	066 35.99 W	368	250	150	95	80	60	30	30	30	10	10	10
11	24/12/15	15:10:56	17 40.01 N	066 36.19 W	201	149	149	99	100	78	78	60	40	20	10	10
12	24/12/15	16:02:48	17 40.02 N	066 35.97 W	2156	2156	2156	1801	1600	1399	1199	1000	798	601	400	140
13	25/12/15	00:18:05	17 30.80 N	066 01.67 W	130	118	100	100	91	82	71	60	49	40	30	20

We deployed the rosette at 9 stations, 5 of which had two casts: one surface and one deep.

The rosette was equipped with 12 Niskin bottles of 12 litres and 3 CTDs: i) 2 SBE CTDs Parc d'instrumentation national (France) INSU - Seabird SBE 911 and 19+. ii) one SBE19B+I CTD owned by INVEMAR - Colombia.
The CTDs were instrumented with the following sensors: 2 temperature sensors, 2 salinity sensors, an oxygen sensor, a total fluorescence sensor, and a transmissiometer usable down to 6000m depth. A SeaBird pH sensor (18SBE) usable to a depth of 1200m, calibrated with a buffer solution at ±0.2 and with an accuracy of ±0.1 pH units.

3.1.2 : Measurements and sampling for physical and chemical parameters

Diana Ruiz Pino, Claude Mignon, Magnolia Murcia-Riano, Paula Rojas-Higuera
1) Hydrological measurements: Temperature, Conductivity and Salinity:
a) Semi-continuous surface, HASCH micro-sensor: Measurements carried out from 16 (15:05 local time) to 26 December (6am local time), frequency of measurements 1 hour.
b) Water column discrete salinity sampling: analysis on land (LOCEAN) with Salinometer; but calibration of surface sensors used in continuous (19 samples) and for CTD (41 samples)
2) Chemical and other physical measurements tracers of biological parameters (carbonate system, DIC/Alk, pH), pigments, fluorescence 5 wavelengths)
a) pH: Hasch micro sensor, on-board measurements.
- 162 semi-continuous surface measurements,
- 14 measurements at Coccos stations, sampling from sea water pumped onto the boat at the surface (4.5m)
- 29 measurements for incubations and acidification experiments of Coccolithophorids
b) DIC/Alkalinity: analysis by potentiometry on land (LOCEAN- SNAPO)
- 40 surface samples concomitant with biology
- 104, concomitant pH and semi-continuous, frequency every hour.
c) Fluorescence 5 wavelengths fluoprobe sensor. Purpose separation and quantification of the abundance of 5 groups of plankton: Diatoms, Haptophytes, Cryptophytes, blue algae, green algae.
d) Samples for pigments: calibration of the fluoprobe, measurement by HPLC on land (IFREMER-Brest).

3.1.2 Isolation of coccolithophore strains / culture

Ian Probert
At each station 2 means of sampling planktonic communities were carried out:

- surface water sampling (0-10m) with a plankton net with a mesh size of 5 microns
- seawater sampling from Niskin bottles at 3 depths ("surface", "Deep Chlorophyll Maximum", "deep").

All samples were pre-filtered (40 micron mesh screen) to remove larger organisms (notably copepods). For seawater collected in Niskin bottles at least 1 sample per station was concentrated by Tangential Filtration (1.5 litres concentrated into 50ml). 10ml of culture medium (seawater sterilised by filtration through a 0.2 micron polycarbonate filter, with nutrients added according to the K/10 recipe) was added to each sample. The samples were stored at 25°C with natural light.
Coccolithophore cells were isolated from several samples. Cells were identified and isolated by micropipette following observation under an inverted microscope (Zeiss TS100). Individual cells were transferred to culture tubes containing 10ml of K/10 medium. Approximately 150 isolations were made, including isolations of previously uncultured species (e.g. *Umbellosphaera* sp., *Discosphaera tubifera*, *Rhabdosphaera clavigera, Florisphaera profunda*). Isolations and samples will be transferred to incubators in the laboratory at the Station Biologique de Roscoff where the success rate of live culture isolations will be assessed.

3.1.3 - Sampling of the water column for biology (genetics...)

Sarah Romac

Three depths were sampled per station: subsurface (10m), deep chlorophyll maximum (DCM) (~50m) and deeper (~100m). Seawater collected from the Niskin bottles was first pre-filtered through a 20μm mesh screen.
Filters were made for scanning electron microscopy, molecular biology in situ hybridisation and high throughput sequencing genetic diversity analysis.

Scanning electron microscopy: (24 samples)
~1.5 L were filtered through a 47mm diameter polycarbonate membrane at 1.2μm. The filter was oven dried for at least 6 hours at 50°C and then stored at room temperature in a dry place, protected from light.

Genetics : (59 samples)
Between 5 and 11 L of seawater was filtered through a 47mm diameter polycarbonate membrane at 1.2μm. The filters were then stored directly at -80°C.

COD FISH (9 samples)
450 mL of seawater collected in DCM was fixed with 50 mL of 10% PFA- 6mM Na2CO3. The mixture was then incubated for ~2.5 hours at 4°C in the dark.
After fixation, the samples were filtered on Anodisc membranes (Whatman), then rinsed successively with 50%, 80%, and 100% ethanol. After drying at room temperature, the filters were stored at -80°C.

CARACALHIS

Tableau prélèvements biologiques

Station	Date	Category	CAST	LAT	LONG	Depth	Numerical depth	Fraction	Replicate	Volume_L	Conditionment	Final storage
CARAC_1	18/12/15	SEM	CTD2			Subsurface	3	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_1	18/12/15	SEM	CTD2			DCM	55	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_1	18/12/15	SEM	CTD2			Deep	120	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_1	18/12/15	Culture exp	CTD2			Deep	120	[<20]	1	1		
CARAC_1	18/12/15	Culture exp	CTD2			Deep	120	[<20]	1	1		
CARAC_1	18/12/15	Culture exp	CTD2			Subsurface	3	[<20]	1	1		
CARAC_1	18/12/15	Culture exp	CTD2			Subsurface	3	[<20]	1	1		
CARAC_1	18/12/15	Culture exp	CTD2			Subsurface	3	[<20]	1	1		
CARAC_1	18/12/15	COD-FISH	CTD2			DCM	55	[0,22-20]	1	450	50mLPFA,incub2,5h4°C, Fil 0.22 Anodisc	-20°C
CARAC_1	18/12/15	DNA	CTD2			Subsurface	3	[1.2-20]	1	9.5		-20°C
CARAC_1	18/12/15	DNA	CTD2			DCM	55	[1.2-20]	1	6		-20°C
CARAC_1	18/12/15	DNA	CAST			Deep	120	[1.2-20]	1	9.5		-20°C
CARAC_1	18/12/15	DNA	CTD2			Subsurface	3	[1.2-20]	2	9.5		-20°C
CARAC_1	18/12/15	DNA	CTD2			DCM	55	[1.2-20]	NA	NA		
CARAC_1	18/12/15	DNA	CTD2			Deep	120	[1.2-20]	2	10		-20°C
CARAC_1	18/12/15	TFF	CTD2			Subsurface	3					
CARAC_1	18/12/15	TFF	CTD2			DCM	55					
CARAC_1	18/12/15	TFF	CTD2			Deep	120					
CARAC_3	19/12/15	SEM	CTD2			Subsurface	5	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_3	19/12/15	SEM	CTD2			DCM	40	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_3	19/12/15	SEM	CTD2			Deep	120	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_3	19/12/15	COD-FISH	CTD2			DCM	40	[0,22-20]	1	450	50mLPFA,incub2,5h4°C, Fil 0.22 Anodisc	-20°C
CARAC_3	19/12/15	DNA	CTD2			Subsurface	5	[1.2-20]	1	8.5		-20°C
CARAC_3	19/12/15	DNA	CTD2			DCM	40	[1.2-20]	1	7		-20°C
CARAC_3	19/12/15	DNA	CTD2			Deep	120	[1.2-20]	1	11		-20°C
CARAC_3	19/12/15	DNA	CTD2			Subsurface	5	[1.2-20]	2	8	DIRTY	-20°C
CARAC_3	19/12/15	DNA	CTD2			DCM	40	[1.2-20]	2	7		-20°C
CARAC_3	19/12/15	DNA	CTD2			Deep	120	[1.2-20]	2	11		-80°C
CARAC_3	19/12/15	TFF	CTD2			Subsurface	5					
CARAC_3	19/12/15	TFF	CTD2			DCM	40					
CARAC_3	19/12/15	TFF	CTD2			Deep	120					
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	Sediment	[[0-1] cm	[total]	1		CARAC-core1-0-1cm	-80°C
CARAC_4	20/12/15	TFF	CTD2	N19°58,749	W 72°30,35	Subsurface	5					
CARAC_4	20/12/15	TFF	CTD2	N19°58,749	W 72°30,35	DCM	50					
CARAC_4	20/12/15	TFF	CTD2	N19°58,749	W 72°30,35	Deep	110					
CARAC_4	20/12/15	COD-FISH	CTD2	N19°58,749	W 72°30,35	DCM	50	[0,22-20]	1	450	50mLPFA,incub2,5h4°C, Fil 0.22 Anodisc	-80°C
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	Subsurface	5		1	8		-80°C
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	DCM	50		1	11		-80°C
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	Deep	110		1	10		-80°C
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	Subsurface	5		2	6		-80°C
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	DCM	50		2	6.75		-80°C
CARAC_4	20/12/15	DNA	CTD2	N19°58,749	W 72°30,35	Deep	110		2	9		-80°C
CARAC_4	20/12/15	SEM	CTD2	N19°58,749	W 72°30,35	Subsurface	5	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_4	20/12/15	SEM	CTD2	N19°58,749	W 72°30,35	DCM	50	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_4	20/12/15	SEM	CTD2	N19°58,749	W 72°30,35	Deep	110	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_5	21/12/15	SEM	CTD2	N 19°56,006	W 72° 12,782	Subsurface	5	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_5	21/12/15	SEM	CTD2	N 19°56,006	W 72° 12,782	Deep	90	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_5	21/12/15	DNA	CTD2	N 19°56,006	W 72° 12,782	Subsurface	5		1	8		-80°C
CARAC_5	21/12/15	DNA	CTD2	N 19°56,006	W 72° 12,782	Deep	90		1	10		-80°C
CARAC_5	21/12/15	DNA	CTD2	N 19°56,006	W 72° 12,782	Subsurface	5		1	4		-80°C
CARAC_5	21/12/15	DNA	CTD2	N 19°56,006	W 72° 12,782	Deep	90		1	5.5		-80°C
HT15-H	21/12/15	SEM	CTD1	N 20°14,359	W 72°13,988	Subsurface	10	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
HT15-H	21/12/15	SEM	CTD1	N 20°14,359	W 72°13,988	Deep	100	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
HT15-H	21/12/15	Culture exp-CODFISH	CTD2			Deep	100	[<20]	1	0.9	DeepIIA10mPFA, incuba 2,5h4°C, Fil 0.22 Anodisc	-80°C
HT15-H	21/12/15	Culture exp-CODFISH	CTD2			Deep	100	[<20]	1	1	DeepIIB10mPFA, incuba 2,5h4°C, Fil 0.22 Anodisc	-80°C
HT15-H	21/12/15	Culture exp-CODFISH	CTD2			Subsurface	10	[<20]	1	1	SurfCONTII, 10mPFA, incuba 2,5h4°C, Fil 0.22 Anodisc	-80°C
HT15-H	21/12/15	Culture exp-CODFISH	CTD2			Subsurface	10	[<20]	1	1	SurfIIA, 10mPFA, incuba 2,5h4°C, Fil 0.22 Anodisc	-80°C
HT15-H	21/12/15	Culture exp-CODFISH	CTD2			Subsurface	10	[<20]	1	1	SurfIIB, 10mPFA, incuba 2,5h4°C, Fil 0.22 Anodisc	-80°C
CARAC_6	23/12/15	SEM	CTD2			Surface	0	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_6	23/12/15	SEM	CTD2			DCM	50	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_6	23/12/15	SEM	CTD2			Deep	100	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_6	23/12/15	DNA	CTD2			Surface	0	[1.2-20]	1	5		-80°C
CARAC_6	23/12/15	DNA	CTD2			DCM	50	[1.2-20]	1	6.5		-80°C
CARAC_6	23/12/15	DNA	CTD2			Deep	100	[1.2-20]	1	7.5		-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	0-1cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	1-2 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	2-3 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	3-4 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	4-5 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	5-6 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	6-7 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	7-8 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	8-9 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	9-10 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	10-11 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	11-12 cm	[total]	1			-80°C

Station	Date	Category	CAST	LAT	LONG	Depth	Numerical depth	Fraction	Replicate	Volume_L	Conditionment	Final storage
CARAC_7	24/12/15	DNA	CORER			Sediment	12-13 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	13-14 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	14-15 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	15-16 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	16-17 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	17-18 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER			Sediment	18-19 cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	50cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	100cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	150cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	200cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	250cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	300cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	350cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	400cm	[total]	1			-80°C
CARAC_7	24/12/15	DNA	CORER_B			Sediment	440cm	[total]	1			-80°C
CARAC_7	24/12/15	SEM	CTD1			Surface	0	[1.2-20]	1	1.2	dry ~6h @ 50°C	RT
CARAC_7	24/12/15	SEM	CTD1			DCM	50	[1.2-20]	1	1.2	dry ~6h @ 50°C	RT
CARAC_7	24/12/15	DNA	CTD1			Surface	0	[1.2-20]	1	5		-80°C
CARAC_7	24/12/15	DNA	CTD1			DCM	50	[1.2-20]	1	7		-80°C
CARAC_8	24/12/15	SEM	CTD1	N17°40.057	W56°36.207	Surface	10	[1.2-20]	1	1	dry ~6h @ 50°C	RT
CARAC_8	24/12/15	SEM	CTD1	N17°40.057	W56°36.207	DCM	100	[1.2-20]	1	1	dry ~6h @ 50°C	RT
CARAC_8	24/12/15	SEM	CTD1	N17°40.057	W56°36.207	Deep	150	[1.2-20]	1	1	dry ~6h @ 50°C	RT
CARAC_8	24/12/15	DNA	CTD1	N17°40.057	W56°36.207	Surface	10	[1.2-20]	1	6		-80°C
CARAC_8	24/12/15	DNA	CTD1	N17°40.057	W56°36.207	DCM	100	[1.2-20]	1	8.5		-80°C
CARAC_8	24/12/15	DNA	CTD1	N17°40.057	W56°36.207	Deep	150	[1.2-20]	1	7.5		-80°C
CARAC_8	24/12/15	COD-FISH	CTD1	N17°40.057	W56°36.207	DCM	100	[0.22-20]	1	450	50mLPFA,incub2,5h4°C, Fil 0.22 Anodisc	-80°C
CARAC_9	24/12/15	SEM	CTD1			Surface	20	[1.2-20]	1	1.5	dry ~6h @ 50°C	RT
CARAC_9	24/12/15	SEM	CTD1			DCM	80	[1.2-20]	1	2	dry ~6h @ 50°C	RT
CARAC_9	24/12/15	SEM	CTD1			Deep	100	[1.2-20]	1	2	dry ~6h @ 50°C	RT

3.1.4 - Coccolithophores sampling

Luc Beaufort / Jean-Charles Mazur / Amos Winter

At all possible depths, 3.6 to 6 litres of water are filtered through cellulose acetate membranes of 0.8 μm porosity and 4.5 mm diameter. The membranes are dried and preserved in an oven at 60°C. At 2 or 3 depths per station 3.63 litres are filtered onto polycarbonate membranes (for scanning electron microscopy).
At 13 intermediate positions at the stations, we filtered 3.6 to 6 litres of surface water (taken from the bucket). These filters are labelled F1 to F13. Temperature, salinity and pH measurements are made on these samples.

Prélèvements par rosette

Stations	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume	Niveau/ volume
CARACA 1 ctd 1 cast 1, 2	30M 3,75l	60M 3,75l	120M 3,75l	120m 6L	55m 6L	3m6L		3m 4l Nucleo	55m 4L nucleo	120m 4L nucleo	
CARACA 2 ctd 2 cast 1	0m 3,75L	10m 3,75L	30m 3,75L	50m 3,75L	70m 3,75l	100m 3,75l	150m 3,75l	200m 3,75l			
CARACA 2 ctd 2 cast 2	5m 6L	40m 6L	120m 6L	40m 4L nucleo	120m 3,5L ??	5m 4l nucleo					
CARAC 4 ctd 3 cast 1	20M 3L	40M 3L	60M 3L	80m 3,75l	100m3,75L	150m 3,75l					
Carac 4 ctd 3 cast 2	110M 4L	50M 4L	5M 4L	110 M 2L nucleo	50M 2L nucleo	5M nucleo					
Caraca 5	surface 4L	surface 2L nucleo	10m 4L	20M 4L	40M 4L	70M 4L	90M 4L	90m 3,6L nucleo	150m 3,75L		
Haiti H	surface 2L	1,5L nucleo	10m 3,1L	50m 2L	100m 4L	100m 2L nucleo	150m 2L				
Carac 6	0m 4L	100m 4L	10M 4L	50M 4L	0m 2L nucleo	50m 2L nucleo	100m 2L nucleo				
Carac 7	Surface 3L	10m 3,75L	30m 1,8L	60M 3,75L	80m 3?75L	95M 3,75L	150m 3,75l	95M 1,5L nucleo	Surface 2,5L nucleo		
Carac 8	20m 4L	150M 3,75l	40m3,75l	10m 4L	200m 3,75L	60m 3,75l	100m 4L	80m 3,75l	surface 4l	surface 2L nucleo	100m 2,5L nucleo
Carac 9	3,75l	100m3,75	90m 3,75l	40m 3,75l	70m 3,75l	50m 3,75l	20m 3,75l	120M 3,75l	60m 3,75l	130m 3,75l	30M 3,75L

Prélèvement surface au seau

Prélèvements au seau	Coordonnées	Volumes	Temp Diana	T° eau bateau	P: total 3 mesures	Salinité: 3mes	Date, heure
F1	Panama port	2L					14-12-15 17:00
F2	09°.30.185N 079°. 49.700W	3,75l					15-12-15 20:30
F3	11°15.021N 078°38.641w	3,75l					16-12-15 8:20
F4	12°05.943N 078°03.642w	3,75l		28,9°c	8,28, 8,30 8,33	37,2 37,3 37,2	16-12-15 14:00
F5	13°01.443N 077°37.894w	6L	28,1 28,1 28,1	28°c	8,27 8,29 8,30	37,4 ; 37,4 ; 37,4	16-12-15 20:00
F6	14°55.096N 076°53.323w	5,9l	28,0 28,0 28,0	27,9°c	8,28 8,29 8,30	37,2 37,2 37,2	17-12-15 8:20
F7	15°46.525N 076°25883W	6L	28,3 28,3 28,4	27°8	8,26 8,27 8,29	37,2 37,1 37,1	17-12-15 14:10
F8	16°34.458N 076°00.002W	6L	28,4 28,4 28?4	28,2°c	8,25 8,25 8,29	37,1 37,2 37,1	17-12-15 20:10
F9	18°44 050N 074°27 451W	6L	27,63 27,6		8,29 8,25 8,26	37,0 37,1 37,1	19-12-15 4:15
F10	19°59.896N 073°45.038w	6L		28,1°c			19-12-15 16:30
F11	20°19.167N 073°14.938 W	3,1l	28,3 28,3 28,3	28,5°c	8,17, 8,17 8,18	37,7 37,7 37,7	20-12-15 8:20
F12	20°23.281 N 072°54 460 W	2,4L	27,8 27,8 27,8		8,18 8,19 8,20	37,9 37,9 37,8	20-12-15 15:25
F13	20°01N 70°57W	2L	Pas de mesures				23-12-15 15:20
F14	68°28.636N 18°55.322w	2,5L	27,7 27,7 27,7		8,15 8,17 8,18	37,8 37,6 37,6	24-12-15 10:30

3.1.5 - Incubation experience

Ian Probert / Luc Beaufort

Tableau Incubation

Filtre #	Station	Prof.	date -heure début	date -heure fin 1	durée J	Additif 1	date-heure fin 2eme	durée J	Additif 2	Aire d'incubation	t°C début	Sal. début	pH début	t°C fin	Sal. fin	pH fin
1	CARAC1	3	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20				Pont - Refroidi eau mer	28.7	36.3	8,24 8,27 8,28	28.0	37.5	8.17 8.19 8.19
10	CARAC1	3	18-12-15 16:00	25-12-15 10:00	6.7502	1mL K20				Pont - Refroidi eau mer	28.7	36.3	8,24 8,27 8,28	27.5	37.5	8.20 8.21 8.22
2	CARAC1	3	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL (0.1 N)				Pont - Refroidi eau mer	28.93	37.9	7.76 7,74 7,78	28.1	37.5	7.64 7.66 7.66
3	CARAC1	3	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL (0.1 N)				Pont - Refroidi eau mer	28.93	37.9	7.76 7,74 7,78	28.1	37.5	7.67 7.69 7.69
6	CARAC1	3	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL (0.1 N)	25-12-15 10:00	3.7085	2.25 mL NaOH (0.2 N)	Pont - Refroidi eau mer	28.93	37.9	7.76 7,74 7,78	27.6	37.3	8.34 8.35 8.36
7	CARAC1	3	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20	25-12-15 10:00	3.7085	2.25 mL NaOH (0.2 N)	Pont - Refroidi eau mer	28.93	37.9	7.76 7,74 7,78	27.5	37.3	8.42 8.43 8.36
11	CARAC1	120	18-12-15 16:00	25-12-15 10:00	6.7502	1mL K20				Cabine	28.5	37.7	8,24 8,25 8,24	23.5	38	8.12 8.13 8.14
4	CARAC1	120	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL				Cabine	28.5	37.8	7.71 7.74 7.75	24.8	37.9	7.66 7.66 7.67
5	CARAC1	120	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL (0.1 N)				Cabine	28.5	37.8	7.71 7.74 7.75	25.2	37.9	7.66 7.63 7.62
8	CARAC1	120	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL (0.1 N)	25-12-15 10:00	3.7085	2.25 mL NaOH (0.2 N)	Cabine	28.5	37.8	7.71 7.74 7.75	24.0	37.9	8.30 8.30 8.31
9	CARAC1	120	18-12-15 16:00	21-12-15 17:00	3.0417	1mL K20 2mL HCL (0.1 N)	25-12-15 10:00	3.7085	2.25 mL NaOH (0.2 N)	Cabine	28.5	37.8	7.71 7.74 7.75	24.5	37.7	8.28 8.29 8.29
12	Haiti H	10	21-12-15 23:00	25-12-15 10:00	3.459	1mL K20				Pont - Refroidi eau mer	28.2	38.1	8.11 8.12 8.14	27.7	37.4	8.16 8.17 8.17
13	Haiti H	10	21-12-15 23:00	25-12-15 10:00	3.459	1mL K20 2mL HCL (0.1 N)				Pont - Refroidi eau mer	28.1	38.0	7.60 7.61 7.62	27.5	38.1	7.60 7.62 7.62
14	Haiti H	10	21-12-15 23:00	25-12-15 10:00	3.459	1mL K20 2mL HCL (0.1 N)				Pont - Refroidi eau mer	28.1	38.1	7.61 7.62 7.63	27.7	38.1	7.56 7.62 7.64
15	Haiti H	100	21-12-15 23:00	25-12-15 10:00	3.459	1mL K20				Cabine	23.7	37.8	8.14 8.14 8.17	23.9	38.2	8.08 8.08 8.09
16	Haiti H	100	21-12-15 23:00	25-12-15 10:00	3.459	1mL K20 2mL HCL (0.1 N)				Cabine	23.9	38.0	7.62 7.62 7.63	24.0	38.2	7.57 7.57 7.58

We carried out incubations of pre-filtered seawater on 20μm mesh at the Carac1 and Haiti H stations, at two depths (3 or 10m and 100 or 120m). The duration varied between 3 and 7 days. One millilitre of K20 culture medium was added to the 1.2 litre bottles. Except for the controls, we modified the pH to values close to that at the surface in the Peruvian upwelling (~7.6), i.e. with 2 ml of 1N HCl. For two incubations after three days we raised the pH to initial conditions by adding 2.2 mL of 2N NaOH. The incubations were filtered on cellulose acetate membranes with a pore size of 0.8μm and a diameter of 4.5 cm. Two incubations of Haiti-H were also treated for COD-FISH.

3.2 - Stratified Plankton Net : Planktonic Foraminifera

Thibault de Garidel-Thoron / Jean-Charles Mazur

The CEREGE MultiNet HydroBios Midi net was set 6 times during the cruise to (1) determine planktonic foraminiferal assemblages in the water column and (2) serve as a reference for calcification index reconstructions over time. Only 4 of the 6 plankton tows were able to sample, as several breakdowns occurred on the net during the cruise. The 4 plankton tows took place on December 24, 2015, in the area south of Puerto Rico.

Problems that occurred on the net and solutions adopted:
(1) Loss of the net arming bar during the transport of the equipment. This bar was replaced by a light metal tube that was pinched.
(2) Short circuit on the flow meter outside the net: this short circuit prevented the flow meter from working properly. The fault was caused by a cut in the cable connecting the flow meter to the unit mounted on the thread. The flow meter was removed and the cable replaced with a plug.
(3) Breakage of the nylon pin locking the polymer gear. Fault found after the second plankton thread. A 3x16 nylon screw has been recut and now replaces this nylon pin.
(4) Thread problem of the mechanical gear driving the thread release: for this problem, the Atlantean mechanics have replaced the defective thread by a spacer, which allows the metal gear to turn infinitely.
(5) Thread failure: (short circuit) due to the poor condition of the batteries after the alignment of the rotational axis was reset.

The plankton samples were transferred directly into bottles and blotted with a minimum 50% solution of 96% Ethanol. A total of 20 samples document a transect around the Puerto Rican coring site.

3-3 Coring

Luc Beaufort, Thibault de Garidel-Thoron, Jean-Charles Mazur

The surface corer was tested at the western point of Haiti at the CARAC 2 station. This was a failure probably due to the hard substrate.
At CARAC 7, we cored 5 times, 4 of which were with the UWITEC interface corer and 1 with the Kullenberg from Atalante. For the surface cores, we first needed to know the relationship between spun length and probe depth and we didn't know when the UWITEC corer would penetrate the sediment. We tested the spun length with a pinger. We estimated the cable length at 405 m compared to 395 m at the loch. We cored at a speed of 1m/s awith 415 m of cable. The 4 surface cores were fast and about 20 cm long with excellent surface preservation (visible presence of epibionts at the water/sediment interface - see Photo of Core 4).

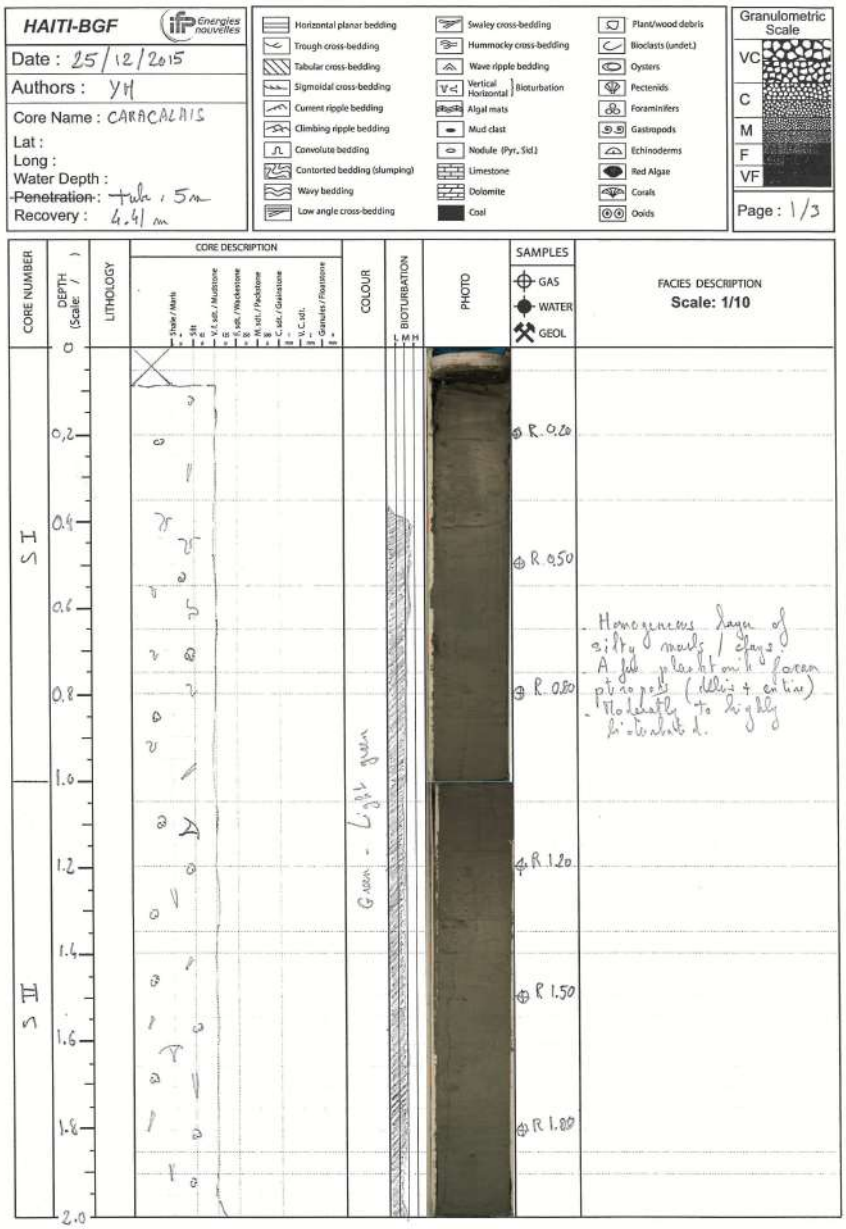
Tableau des prélèvements par filet Multinet

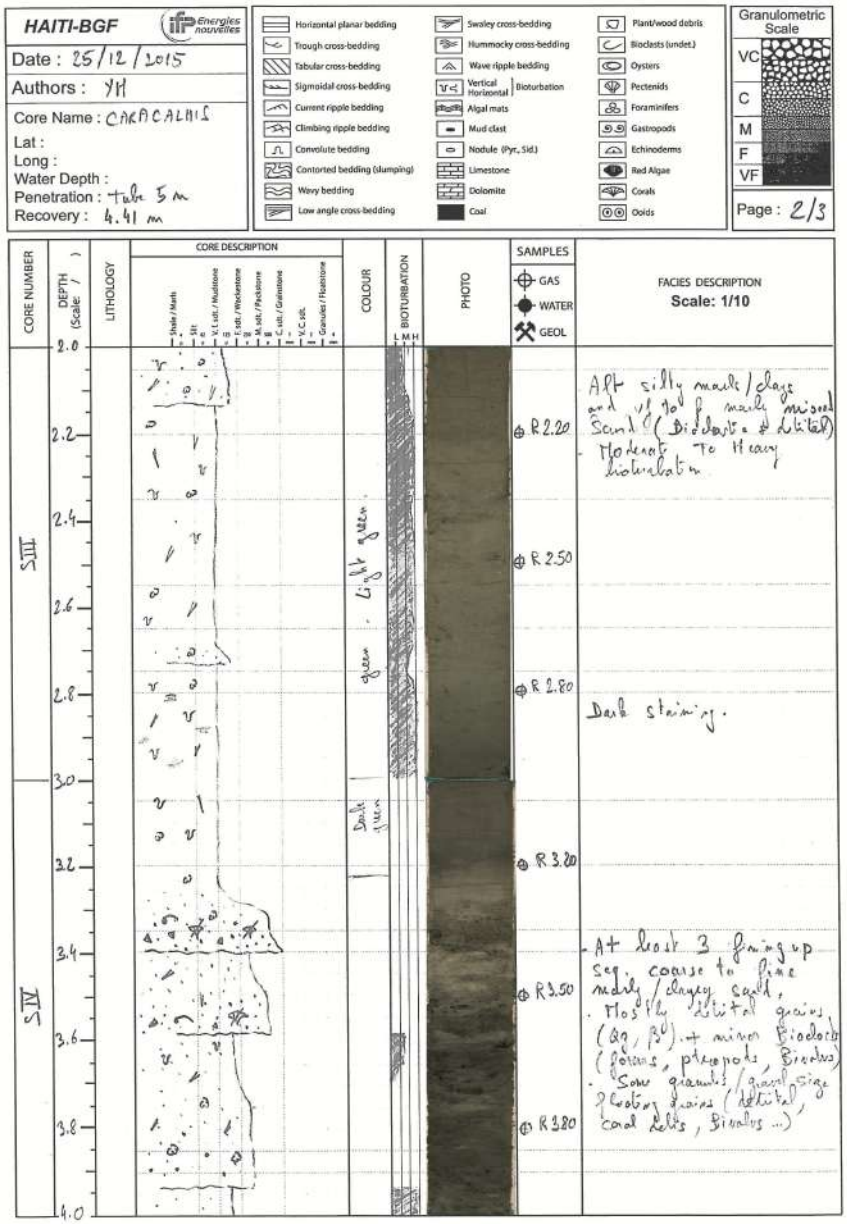
Station ID	Tow #	Longitude	LatitudE	Max. depth	samples	MPS File ID	Hydro. data	Comments
CARAC-1	T1	75°15.062	18°7.978	489	0	MPS2606_2015_12_18_22_14_08.hbl	X	No sample recovered : error of motor. - offset in fluo data on the way up : likely due to low voltage associated with the overturning of the motor
CARAC-4	T2	72°30.33	19°58.788	303	0	MPS2606_2015_12_21_12_34_18.hbl	X	No sample recovered : pb of gear wheel axis
CARAC-6	T3	67°29.41	18°0.33	352	5	MPS2606_2015_12_24_02_23_47.hbl	X	
CARAC-7	T4	66°36.018	17°51.021	351	5	MPS2606_2015_12_24_10_34_42.hbl	X	
CARAC-8	T5	66°35.959	17°40.112	352	5	MPS2606_2015_12_24_19_14_05.hbl	X	
CARAC-9	T6	66°1.624	17°30.782	150	5	MPS2606_2015_12_25_01_03_32.hbl	X	

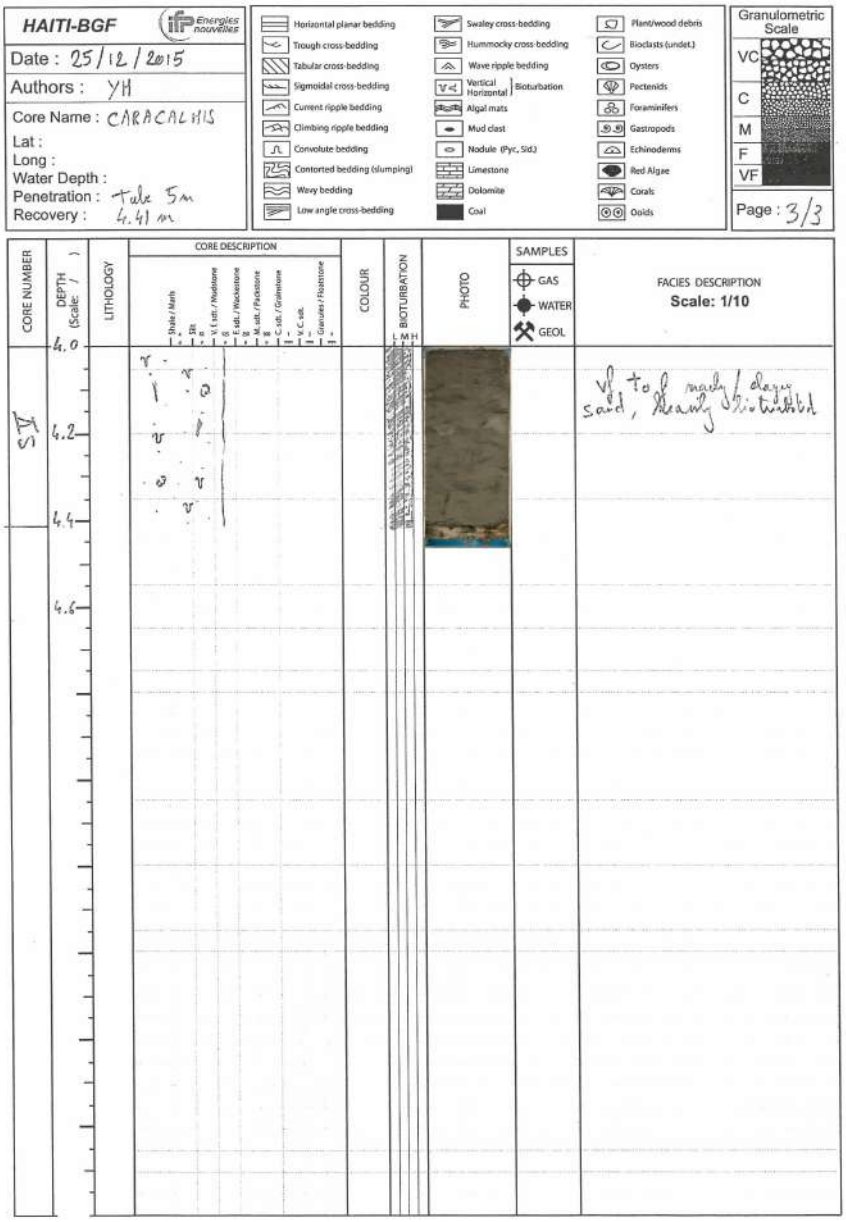
Three cores were sampled in 1cm increments and one preserved in its jacket. All were placed in the freezer at -80°C.

Photo of core 4

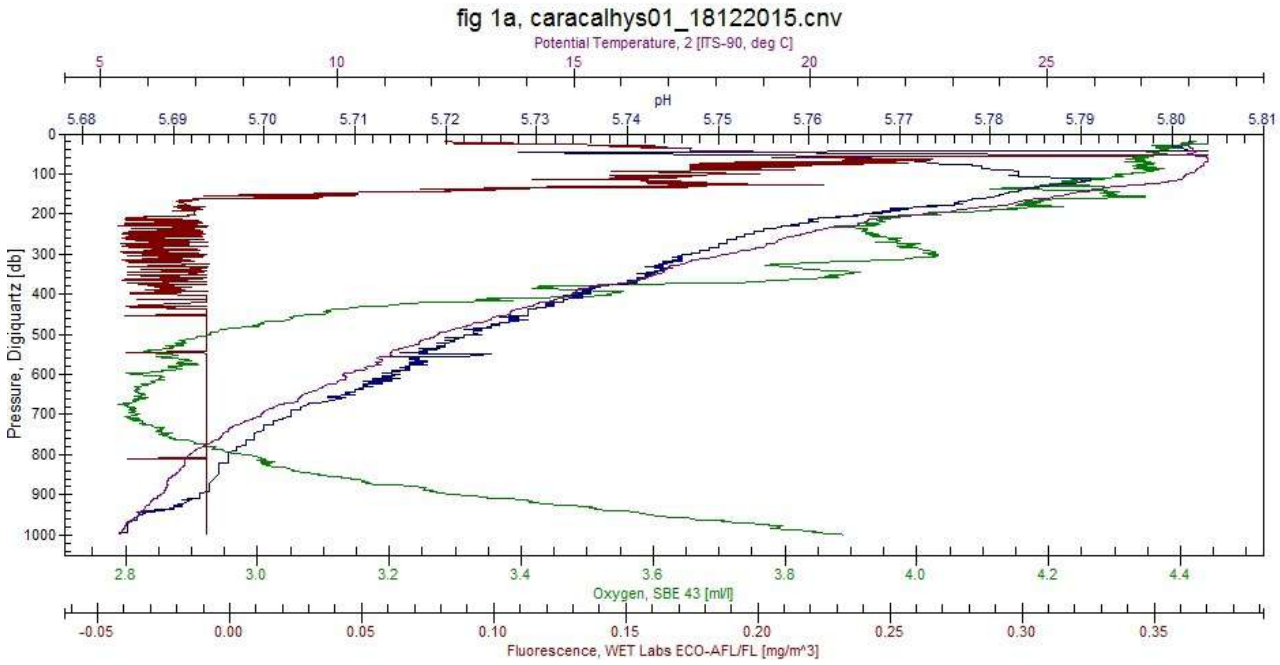
A 4.40 m core (CARACALHIS) was obtained with a 5 m Kullenberg corer. The core was cut into 1m sections and opened, photographed and described by the Haiti BGF team.

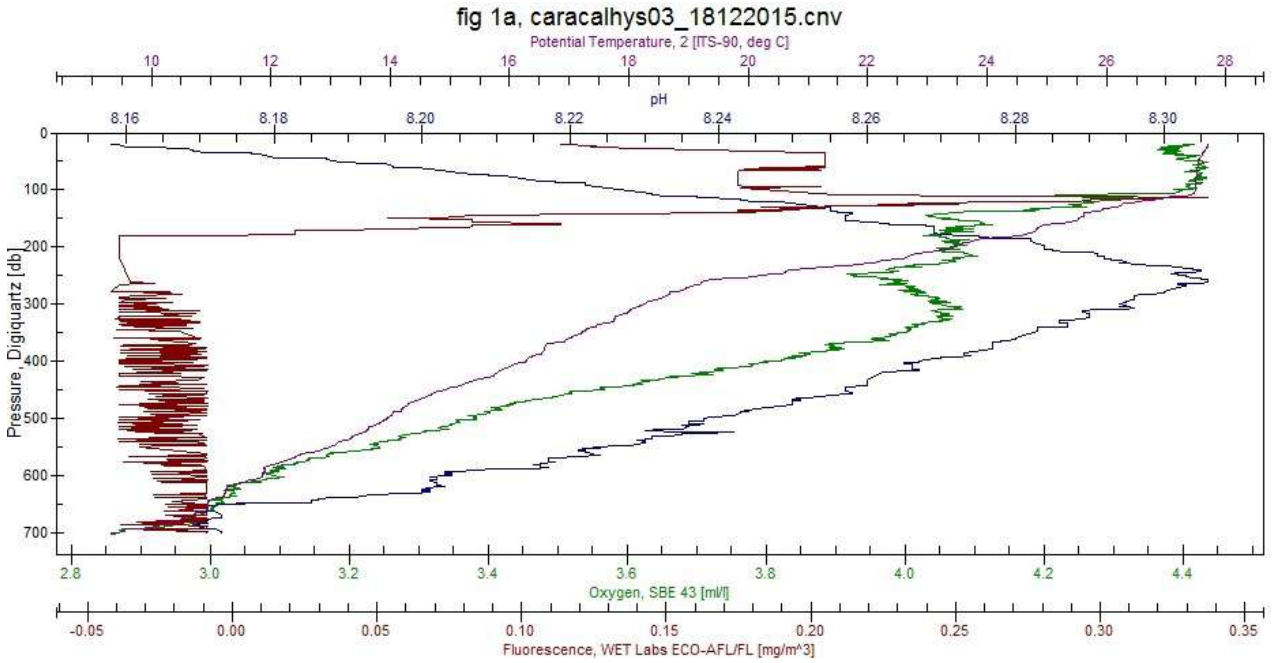

HAITI-BGF
Energies nouvelles
Date : 25/12/2015
Authors : YH
Core Name : CARACALHIS
Lat :
Long :
Water Depth :
Penetration : tube : 5m
Recovery : 4.41 m
Horizontal planar bedding
Trough cross-bedding
Tabular cross-bedding
Sigmoidal cross-bedding
Current ripple bedding
Climbing ripple bedding
Convolute bedding
Contorted bedding (slumping)
Wavy bedding
Low angle cross-bedding
Swaley cross-bedding
Hummocky cross-bedding
Wave ripple bedding
Vertical
Horizontal
Bioturbation
Algal mats
Mud clast
Nodule (Pyr, Sid.)
Limestone
Dolomite
Coal
Plant/wood debris
Bioclasts (undet.)
Oysters
Pectenids
Foraminifers
Gastropods
Echinoderms
Red Algae
Corals
Ooids
Granulometric Scale
VC
C
M
F
VF
Page : 1/3
CORE NUMBER
DEPTH (Scale: 1/10)
LITHOLOGY
CORE DESCRIPTION
Shale / Marls
Silt
V.f. sds. / Mudstone
f. sds. / Wackestone
m. sds. / Packstone
C. sds. / Grainstone
V.C. sd.
Granules / Floatstone
COLOUR
BIOTURBATION
L M H
PHOTO
SAMPLES
GAS
WATER
GEOL
FACIES DESCRIPTION
Scale: 1/10
S I
S II
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
R. 0.20
R 0.50
R. 0.80
R 1.20
R 1.50
R 1.80
Light green
- Homogeneous layer of silty marls / clays
- A few plant or fish fossil pieces (debris + entire)
- Moderately to highly bioturbated.


HAITI-BGF
Energies nouvelles
Date : 25/12/2015
Authors : YH
Core Name : CARACALHIS
Lat :
Long :
Water Depth :
Penetration : Tube 5 m
Recovery : 4.41 m
Horizontal planar bedding
Trough cross-bedding
Tabular cross-bedding
Sigmoidal cross-bedding
Current ripple bedding
Climbing ripple bedding
Convolute bedding
Contorted bedding (slumping)
Wavy bedding
Low angle cross-bedding
Swaley cross-bedding
Hummocky cross-bedding
Wave ripple bedding
Vertical / Horizontal Bioturbation
Algal mats
Mud clast
Nodule (Pyr., Sid.)
Limestone
Dolomite
Coal
Plant/wood debris
Bioclasts (undet.)
Oysters
Pectenids
Foraminifers
Gastropods
Echinoderms
Red Algae
Corals
Ooids
Granulometric Scale
VC
C
M
F
VF
Page : 2/3
CORE NUMBER
DEPTH (Scale: 1/)
LITHOLOGY
CORE DESCRIPTION
Shale / Marls
Silt
V.f. sst. / Mudstone
f. sst. / Wackestone
m. sst. / Packstone
c. sst. / Grainstone
v.c. sst.
Granules / Rudstone
COLOUR
BIOTURBATION
L M H
PHOTO
SAMPLES
GAS
WATER
GEOL
FACIES DESCRIPTION
Scale: 1/10
SIII
SIV
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
R 2.20
R 2.50
R 2.80
R 3.20
R 3.50
R 3.80
Light green
Dark green
Aft silty marls / clays and vf to f marly mixed Sand (Bioclast + detrital)
- Moderate to Heavy bioturbation
Dark staining.
- At least 3 fining up Seq. coarse to fine
marly / clayey sand,
. Mostly detrital grains (Qz, Fsp) + minor Bioclasts (forams, ptreopods, Bivalves)
. Some granules / gravel Size Pebbles grains (detrital, coral Rubs, Bivalves ...)


HAITI-BGF
Energies nouvelles
Date : 25/12/2015
Authors : YH
Core Name : CARACALHIS
Lat :
Long :
Water Depth :
Penetration : Tube 5m
Recovery : 4.41 m
Horizontal planar bedding
Trough cross-bedding
Tabular cross-bedding
Sigmoidal cross-bedding
Current ripple bedding
Climbing ripple bedding
Convolute bedding
Contorted bedding (slumping)
Wavy bedding
Low angle cross-bedding
Swaley cross-bedding
Hummocky cross-bedding
Wave ripple bedding
Vertical / Horizontal Bioturbation
Algal mats
Mud clast
Nodule (Pyr., Sid.)
Limestone
Dolomite
Coal
Plant/wood debris
Bioclasts (undet.)
Oysters
Pectenids
Foraminifers
Gastropods
Echinoderms
Red Algae
Corals
Ooids
Granulometric Scale
VC
C
M
F
VF
Page : 3/3
CORE NUMBER
DEPTH (Scale: 1/)
LITHOLOGY
CORE DESCRIPTION
Shale / Marls
Silt
Vf. Sdt. / Mudstone
F. Sdt. / Wackestone
M. Sdt. / Packstone
C. Sdt. / Grainstone
V. C. Sdt.
Granules / Floatstone
COLOUR
BIOTURBATION
PHOTO
SAMPLES
GAS
WATER
GEOL
FACIES DESCRIPTION
Scale: 1/10
4.0
4.2
4.4
4.6
ST
Vf to f sandy / clayey sand, heavily bioturbated

Annex 1: Examples of CTD profiles





CARACALHIS

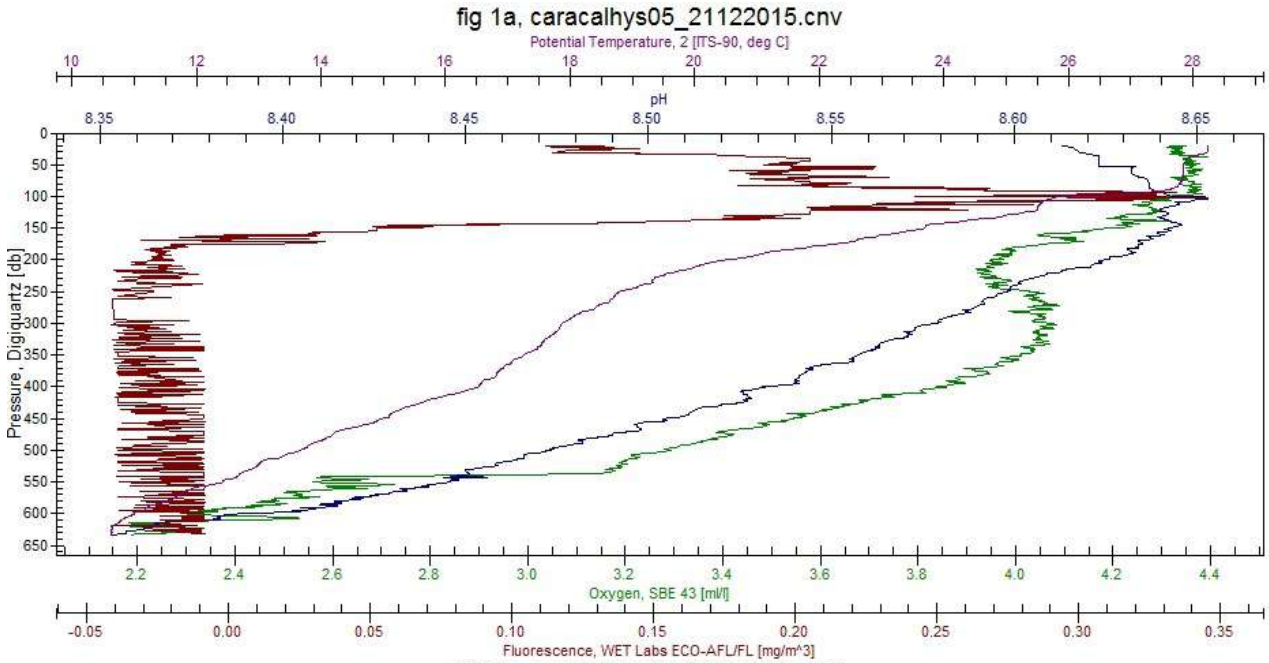


fig 1a, caracalhys05_21122015.cnv
Potential Temperature, 2 [ITS-90, deg C]
pH
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Fluorescence, WET Labs ECO-AFL/FL [mg/m^3]

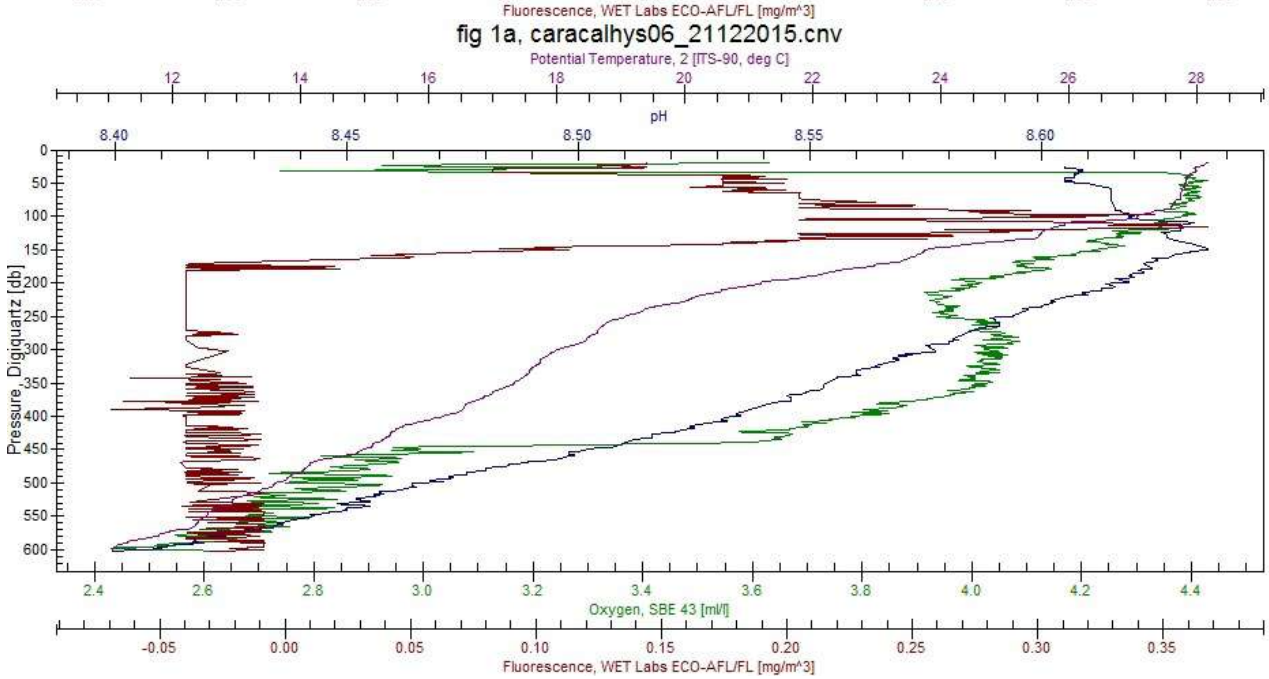


fig 1a, caracalhys06_21122015.cnv
Potential Temperature, 2 [ITS-90, deg C]
pH
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Fluorescence, WET Labs ECO-AFL/FL [mg/m^3]

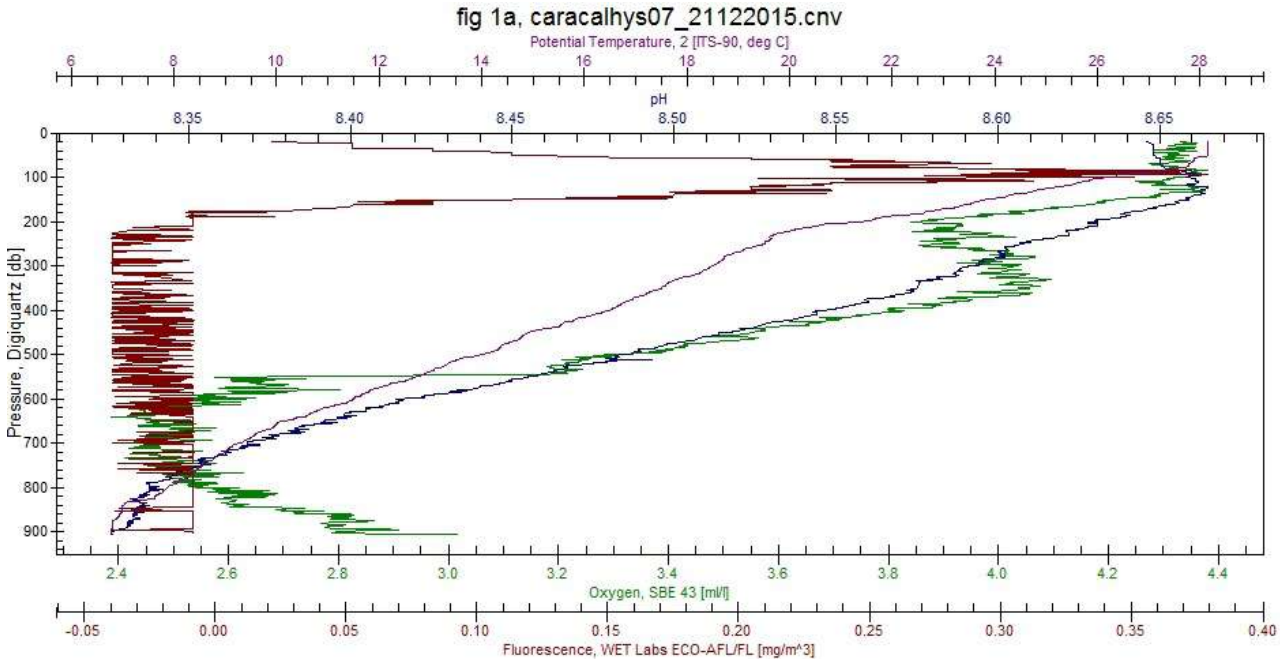


fig 1a, caracalhys07_21122015.cnv
Potential Temperature, 2 [ITS-90, deg C]
pH
Pressure, Digiquartz [db]
Oxygen, SBE 43 [ml/l]
Fluorescence, WET Labs ECO-AFL/FL [mg/m^3]