ATLANTIS 21-02; NSF #OCE-1031050

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Cruise Objectives

Cruise objectives were:

1. recover moorings deployed ~1 year previously
2. sample multiple seep populations for population genetics and demography using the Jason ROV
3. study larval distributions in the water column using MOCNESS tows
4. rear larvae of selected seep invertebrates
5. collect physical measurements of the water column using xbts and CTD
6. obtain multibeam bathymetry and subsurface bottom profiles in selected area

Cruise Narrative

31 May 2012

A Clearance Modification Request for additional work areas in Barbados was requested (6 work areas at 1500, 2500, and 5000 m; see Figure 1). Scientists He, Eggleston, Lillis, Zambon did not join Leg 1 due to illness (He) and travel delays.

On surfacing, we transitioned to a CTD cast above Mount Manon commencing ~1800h and finishing ~2200 h (local).

1 June 2012

Departed Bridgetown Barbados at 0945 h (local) for Atalante mud volcano 150 km, east of the accretionary wedge deformation front, steaming 11 kts. Collected 10 xbt profiles (460 m) enroute (~ every hour beginning ~1800 UTC plus a test at 1300 UTC), with multibeam and CHIRP beginning at 2100h and a mapping swath for 45 min beginning around 2200h of the Atalante-Manon seafloor features and completed one swath that extended across the deformation front and over both mud volcanoes. The resulting map shows Atalante with a contour depth of 4950 m and the structure is geographically and morphologically consistent with the structure reported In Olu et al. 1997.

2 June 2012

Deployed MOCNESS from 2500 m to surface over Atalante-Manon region (start: ~1300 h local, end ~0530 h local). Net index did not fire, resulting in samples only from 250 m to 50 m, 50 m to surface, and the composite sample. A cut in cable covering and exposed wires was noted upon recovery.

Jason 632 lowering commenced at ~0815 h (local) and targeted clam beds on the SW quadrant of the **Atalante** mud volcano. Jason was equipped with 5 bioboxes, 11 pushcores, 4 slurp bins, baited crab trap (flying fish), t-probe, and weights (maintained for the duration of the research cruise). The crab trap and markers were not deployed. Nominally about 35 clams (vesicomyids, *Abyssogena southwardae*) with anemones (*Monactis vestita*) were collected using a basket net and slurp sampler, along with slurp samples of pogonophorans (*Sclerolinum* sp.), 4 squat

lobsters, amphipods, and a piece of a carbonate outcrop. Two pushcores were collected adjacent to clams to collect juveniles. Depth range of samples was from ~4930 to 4040 m.

On processing, we discovered 4 species of clams, of which the large vesicomyid was dominant; including juveniles, we collected ~65 individuals of this species. A single large nautiliniellid was recovered from the mantle cavity of a large clam. A thyasirid bivalve was less abundant (5 individuals), with a third species represented by two specimens and a fourth species represented by one specimen. The only other mollusk represented was the large predatory gastropod *Phymorhynchus* (two specimens plus two egg capsules). We identified at least 4 species of amphipods in abundances of less than ~15 individuals per species; the largest species was collected from one of the large pogonophoran beds on Atalante. Non-siboglinid polychaetes were rare in the samples, represented by a nereid and two polynoid individuals.

A deep MOCNESS tow over Atalante/Manon was initiated at ~ 2100 h (local), with nets sampling the water column between 3350 m and 1250 m. The tow was completed by 0600 h (local) on 3 June.

3 June 2012
A second multibeam swath was collected over the Atalante/Manon study area between 0600 h and 0800 h (local).

Jason 633 lowering commenced at ~0815 h (local) and targeted clams at the center of the **Manon** mud volcano. We landed on the seep field and commenced sampling sponges (5 small bushes of *Cladorhiza methanophila*), *Sclerolinum* (slurp), and clams (about 65 individuals.), miscellaneous samples of opportunity (scale worm, *Phymorhynchus*, squat lobster) and 5 pushcores over bacterial mats. We collect HD video of sites and the artists – Karen Jacobsen, Mary Edna Fraser, and Jolene Mok – worked in the van with great images. We terminated the dive at 1500 h (local) having achieved all of our sampling goals. Samples included a variety of polychaete worms not seen in Atalante material (a second ampharetid, maldanids, an orbiniid, etc) but less bivalve diversity. We began preserving samples for stable isotope analysis with this material, but did not get a complete set (e.g., although we collected *Phymorhynchus*, provannid gastropods, and large polynoids, we did not preserve any of their tissues for stable isotopes).

4 June 2012
Second multibeam/CHIRP swath across study area including Volcano A (2245 h to 0600 h).

Jason 634 lowering commenced at ~0815 h (local) over the **Volcano A** study area and targeted clam beds at the top of the mound. There was discussion of coordinates – the coordinates in Olu et al. 1997 (13 51.63N, 57 45.55W) did not perfectly match the seafloor feature mapped with multibeam by *Atlantis.* Our center fix was ~13 51.411 N, 57 45.621 W. We approached the mound from the SSW and encountered cladorhizid sponges and the field of clams at the top of the feature. Carbonate outcrops ringed the central clam field and at one location we noted methane hydrate beneath a low-relieve carbonate overhang. We sampled about 40 clams, and

a few sponges, snails and squat lobsters. Siboglinids were reported at the start of the dive but were not relocated. The central region of the Brothers clam field (named after Laura Brothers who mapped us to the site) included splotches of bacterial mat. **Marker 1** was deployed in the vicinity of *Cladorhiza methanophila* bushes in the southern periphery of the clam bed. The dive ended ~1715h. Relatively low apparent invertebrate diversity at Volcano A compared to Manon – one maldanid fragment and no ampharetids in our samples, for example. Two of the galatheid squat lobsters collected were host to copepod parasites that place egg capsules as mimics of the host eggs on the ventral abdomen. The capsules have a stalk that may connect the egg to the host tissues for nutrition. The egg masses apparently increase in size as the embryos develop; each capsule contains on the order of two thousand embryos (nauplii; Craig Young observation).

Deep MOCNESS at Volcano A at night (2025 h to 0630 h local), working deep layers from 4700 m to 3300 m and from 1250 m to 550 m (6 sample nets), towing NE from the Atalante-Manon study area.

5 June 2012
Jason 635 engineering dive near Manon and transit west. Collected a pushcore over *Sargassum* at ~5000 m. Sampled *Sargassum* for isotopes, plus one maldanid (background organism) for isotopes, DNA (ethanol, RNA Later), and voucher (posterior end, formalin).

Deep MOCNESS toward Atalante (general tow direction for this cruise has been NE) from the SW (~2100 h to 0730 h local).

6 June 2012
Jason 636 dive at Atalante, eastern region cancelled due to weather. We remained on station until 1100 h (local) to allow MOCNESS samples to be sorted, then transited to Clearance Modification Area C (2500 m contour) with 6 xbts en route, followed by multibeam/CHIRP mapping and transit to Bridgetown.

7 June 2012
Arrived Barbados 1200 h (local); science transfer. Departure from Bridgetown 1600 h (local), en route to Atalante.

8 June 2012
Weather delayed Jason 636 launch at **Atalante East**; commenced at 1100 h (local). Collected a few clams, five sponges, many hundreds of worms (*Amathys/Amphisamytha*, maldandids, ampharetids, dorvilleids, a couple of polynoids), amphipods, isopods.

Deep MOCNESS in region of Cyclops (from 10 nm SE to site).

9 June 2012
Change of plan from diving on Cyclops to diving on a mud volcano east of Manon (i.e., furthest east mud volcano in our clearance box). This is a new area of exploration and we have named

the site **Gingersnap**. The lowering began on the slope to the NE; clams were encountered as we moved upslope and on the plateau. We were able to sample clams (half a dozen), squat lobsters (3), *Phymorhynchus* (10), *Sclerolinum* (2 push cores and a slurp), and *Sargassum* before the manipulators grounded, leaving us with video sampling and exploration capabilities. Remaining hours of dive time were used to navigate to the WSW across the plateau and then S on the upper most contours of the feature.

CTD at night, 5000 m, followed by mapping to complete the box.

10 June 2012

Lowering at **Tim Tam**, a likely mud volcano between Manon and Gingersnap and closer to the deformation front. No chemosynthetic seep assemblages observed. Sampled *Enypniastes exima* (2 individuals)*, Benthodytes, Psychropotes* for background stable isotope analyses and genetics. Winch failure during dive, resulting in test delays and slow recovery rate (no more than 20 m/min max); recovery at ~2215 h local.

Shallow MOCNESS following Jason recovery and after adjustments of MOCNESS weights to improve towing angle.

11 June 2012

Finished MOCNESS tow, followed by sorting to 1230 h, then transit south to Area F, with winch test from 1700 to 2200 h, transit.

12 June 2012

CTD from 0000 to 0300 at eastern side of Area C, then transit to mapping area. Mapping initiated at ~0800 h, completed at 1030 h (at least one dive target identified), followed by CTD cast. 1300h-2100h, Jason launch at **Tagalong**, ~1500 m water depth. Began exploration in SE quadrant, 100m from summit, with undulating seabed with features parallel to slope. Numerous white snails (sampled, with pushcores as well), plus hermit crabs with anemones (sampled), bivalve shells, *Sargassum* and occasional seastars and brittle stars.

Mapping within Area F.

13 June 2012

MOCNESS from 0000 to 0500 h. Jason-640 lowering to **Nilla**. Track on bottom began in area of small boulders and crinoids – sampled one crinoid and an onuphid polychate. This region at the start of the lowering was the most rich. Nilla 2 (second dome to east of first) had a small field of old bivalve shells, but no other evidence of seepage. Most of the dive track was over featureless sediment. Several large white snails were sampled. Gastropod egg cases sampled yesterday hatched overnight. Some cases were preserved in ethanol for ID.

MOCNESS from 2200 to 0600 h.

14 June 2012

Jason lowering 641, **Milano** domes. Rich coral/sponge rock outcrop environment in high-flow zone associated with steep slopes on SE quarter of first dome (~1400 m). Bivalve shell beds on first dome, but no live beds. Collected one cobble. Near the end of the dive (~1730h local), located live tubeworms, serpulid worms, a few shrimp associated with rock ledges on the periphery of a dome.

Mapping survey ~0900 to 0300h (local).

15 June 2012

Jason lowering 642, **Madeleine** domes. Initial (4+h) survey used good navigation across the wrong map. No active sites observed and fossil sites only characterize by a few sparse shells. Encountered dense corals on the steep face of one dome.

CTD post-Jason lowering, followed by MOCNESS.

16 June 2012

Jason lowering 643, return to **Milano** seep area. Completed sampling of tubeworms and sampled 35+ live clams among a patch of dead clams. Finally discovered one live patch of mussels 30 minutes before the end of the lowering and transit back to port.

CTD (2) and xbts on transit.

Study Areas and Ship Track

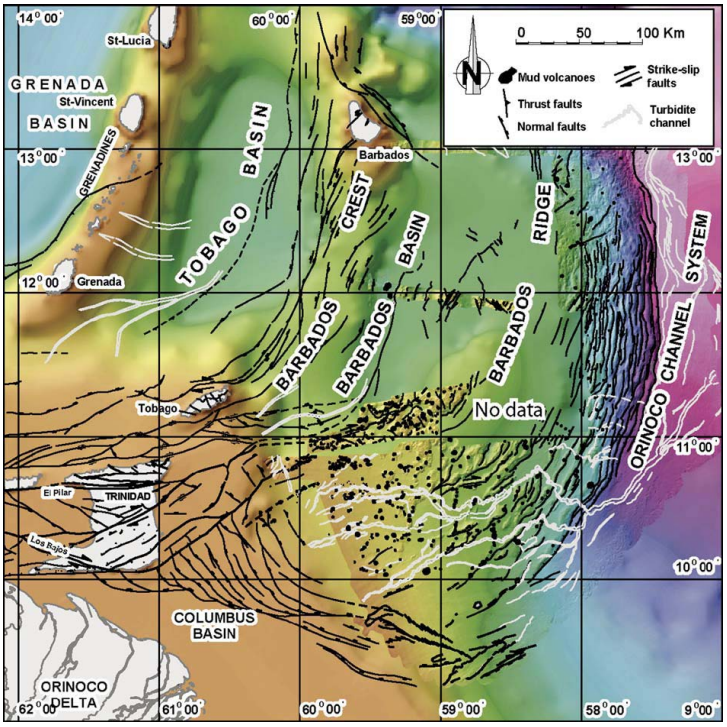

Figure 1. Structural map of the southern Barbados Accretionary prism (Deville et al. 2006). SeepC At-21-02 work is all north of 11 degrees.

R/V Atlantis SeepC Cruise (At-21-02)

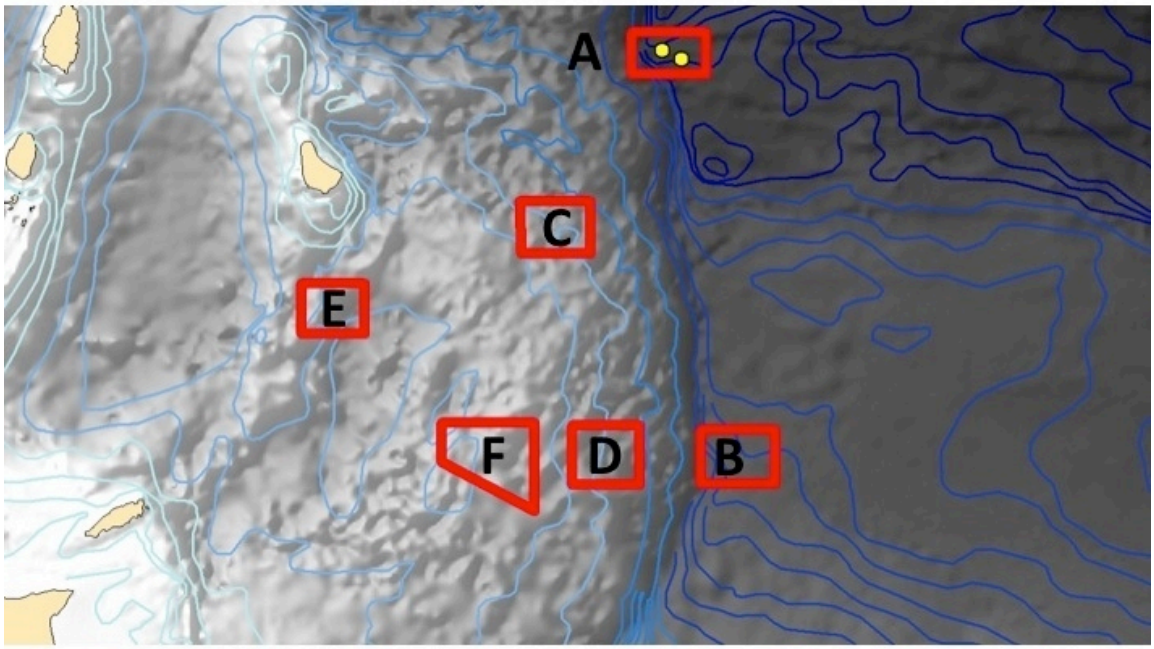

Figure 2. Modified study areas. Yellow circles in Box A are Atalante and Manon, (5000 m) for which clearance was originally approved. C, D are ~2500 m water depth; E, F are ~1500 m water depth.

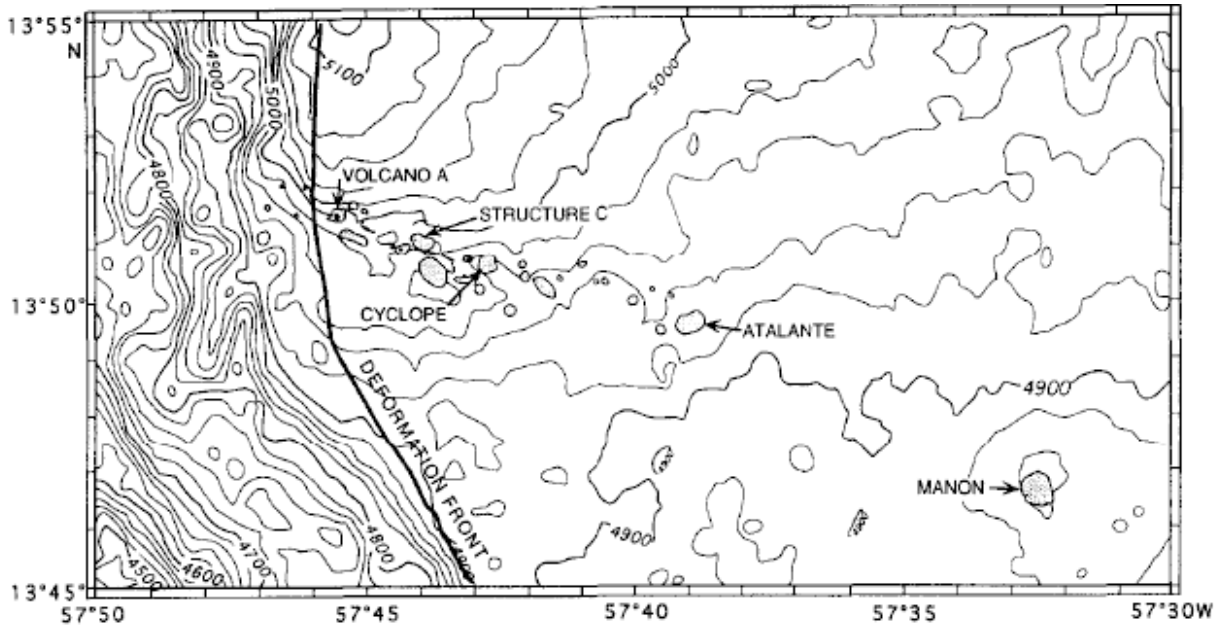

Figure 3 AT21-02 Leg 1 mud volcano study areas (Manon, Atalante, Volcano) east of the deformation front (Box A in figure 1). From Olu et al. 1997.

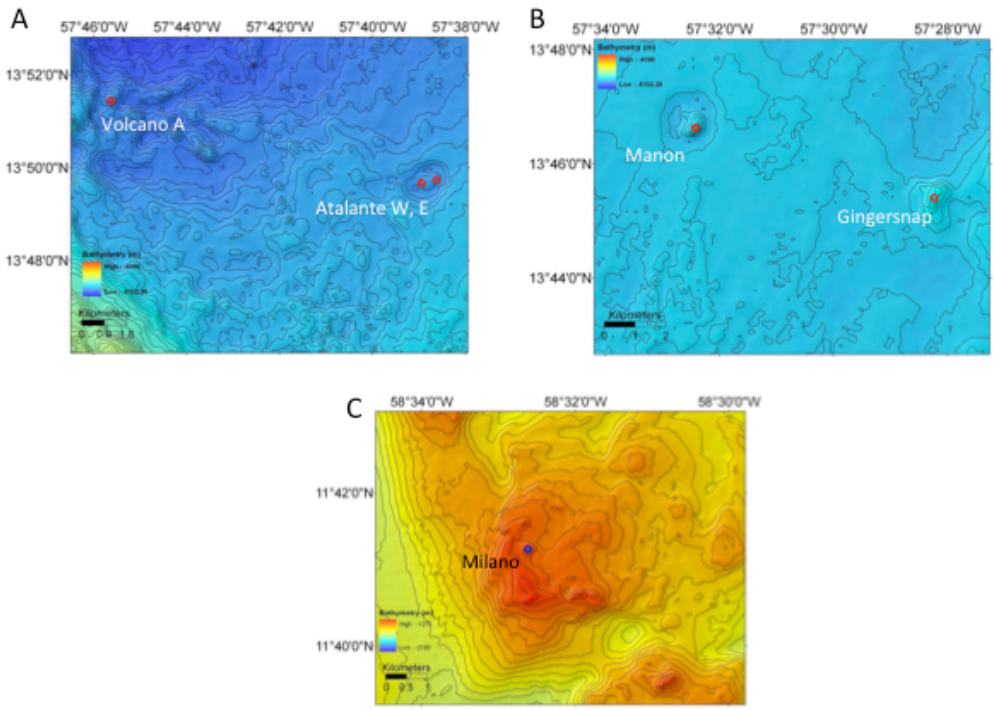

Figure 4. Location of seep study areas.

Primary Study Sites (EP, OA, OB coordinates are mooring deployments, May 2011); J635 was an engineering dive.

JASON DIVE #	Site	Dominant Bivalve	Latitude (N)	Longitude (W)	Depth (m)	Size, Target
J-632	Atalante West	*Abyssogena southwardae*	13° 49.567	57° 38.975	4933	600 m x 1000 m
J- 633	Manon	*Abyssogena southwardae*	13° 46.664	57° 32.553	4743	100 m diameter
J- 634	Volcano A	*Abyssogena southwardae*	13° 51.393	57° 45.641	4946	
J-636	Atalante East	*Abyssogena southwardae*	13° 49.685	57° 38.683	4930	
J-637	Gingersnap	*Abyssogena southwardae*	13 45.398	57 28.330	4841	Newly discovered seep site
J-638	Tim Tam	No seep system observed	13 41.861	57 34.783	4855	
	Cyclops	*Abyssogena southwardae*	13 50.809	57 43.272		Coordinates don't match Olu et al. 1997; based on 2012 multibeam of nearby mud volcano
J-639	Tagalong	Snails	11 45.217	58 25.516	1450	Snail park
J-640	Nilla	NA	11 38.640	58 25.545	1668	Fossil seep
J-641	Milano	*Lamellibrachia*	11 41.306	58 32.636	1327	Newly discovered seep site
J-643		Serpulids				
		Bathymodiolus clams				
J-642	Madeleine	No seep system observed				
	El Pilar	*Bathymodiolus* B	11°14.0	59° 20.75	1190	150 m x 15 m, Dome 2
	Orenoque A	*Bathymodiolus* B	10° 19.67	58° 53.325	1700	280 m x 45 m
	Orenoque B	*Bathymodiolus* A	10° 19.8	58° 37.4	2000	50 m patch, Dome 13

Approximate distances (nm) between sites (from Google Earth ruler); shaded = deep sites (~5000 m) east of deformation front.

	BT	VA	AT	MA	GS	TT	EP	OA	OB
BT Bridgetown	-	125	150	150	140	132	115	175	175
VA Volcano A		-	8	15	20	16	184	214	221
AT Atalante			-	7	10	8	215	220	185
MA Manon				-	5	6	5	216	186
GS Gingersnap					-	8	185	222	219
TT Tim Tam						-	180	216	210
EP El Pilar							-	60	70
OA Orenoque A								-	15
OB Orenoque B									-

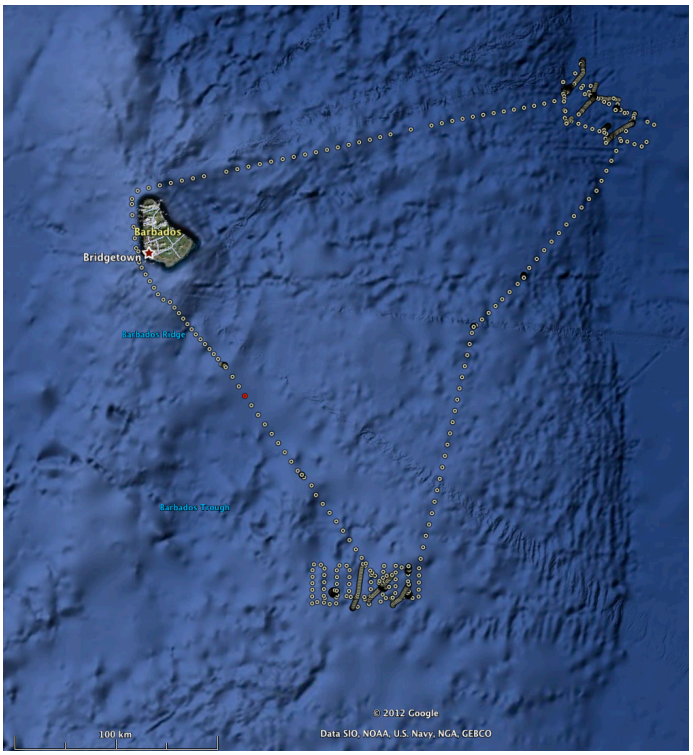

Figure 5. Leg 2 Cruise Tracks, June 2012

Jason Lowering Summary

JUNE	0000-0400	0400-0800	0800-1200	1200-1600	1600-2000	2000-2400
1			Transit 3h (140 nm; 13h)	Transit 4h	Transit 4h	Transit 2h Mapping (Atalante, Manon)
2	Shallow MOCNESS	Shallow MOCNESS	**J-632 Atalante West**			Deep MOCNESS
3	Deep MOCNESS	Deep MOCNESS	**J-633 Manon**			CTD (4h)
4	Transit SW 2 h (11 kts)	Transit 4h Mapping Mode (8 kts)	**J-634 Volcano A**			Deep MOCNESS
5	Deep MOCNESS	Deep MOCNESS	J-635 Engineering Dive (near Volcano A)			Deep MOCNESS
6	Deep MOCNESS	Deep MOCNESS	Transit/xbt	Tansit/xbt	Map (Area C)	Map (Area C)
7	transit	transit	transit	transit PORT PORT	transit	transit
8	transit	transit	Weather delay	**J-636 Atalante East**		Deep MOCNESS
9	Deep MOCNESS	Deep MOCNESS	**J-637 Gingersnap**			CTD (4h)
10	Mapping	Mapping	**J-638 Tim Tam (late recovery)**			Shallow MOCNESS
11	Shallow MOCNESS	Shallow MOCNESS	**Sorting/winch**	**Transit**	Winch Test	TRANSIT
12	CTD 2500 m (Area C)	TRANSIT	MAPPING/CTD	**J-639 Tagalong**		Mapping Area F
13	MOCNESS 1500 (1)	MOCNESS 1500 (2)	**J-640 Nilla**			MOCNESS 1500 (2)
14	MOCNESS 1500 (2)	MOCNESS 1500 (2)	**J-641 Milano**			Mapping Area F
15	Mapping Area F	Mapping Area F	**J-642 Madeleine**			CTD / MOCNESS 1500 (3)
16	MOCNESS 1500 (3)	MOCNESS 1500 (3)	**J-643 Milano**		TRANSIT	TRANS / CTD (2)
17	TRANSIT	TRANSIT	Arrive Barbados			

SEEPC Barbados Jason Sample Log

Time (UTC)	Vvan #	Sample No	Sample Type	Lat	Lon	Hdg (Deg)	Depth (m)	Comments
ATALANTE West, Jason 632, 2 June 2012								
17:23	724	01	Blue Slurp	13 49.569N	57 38.964W	291	4929	looks like *Sclerolinum* - chitinous tubes, very long, thread-like
17:44	1746	02	Biobox 21	13 49.566	57 38.977	297	4927	33 *Abyssogena*, anemones, Phymorhynchus
18:51	1851	03	PC 16	13 49.568	57 38.971	220	4929	taken adjacent to clams, to look for juveniles
18:55	1854	04	PC 10	13 49.568	57 38.971	220	4929	taken adjacent to clams, to look for juveniles
19:04	1906	05	Green Slurp	13 49.567	57 38.975	257	4928	squat lobsters, 3 clams, 2 anemones, tubeworms, amphipods
19:04	1906	05	Biobox 10	13 49.567	57 38.975	257	4928	*Abyssogena* and anemones
20:53	2053	07	Biobox 1E	13 49.521	57 38.987	098	4939	carbonate and worms
21:02	2102	08	Yellow Slurp	13 49.521	57 38.987	100	4933	squat lobster
MANON, Jason 633, 3 June 2012								
16:28	NA	01	Green Slurp	13 46.653	57 32.520	332	4743	sponge and associates
16:30	NA	02	Yellow Slurp	13 46.653	57 32.520	332	4743	sponge and associates
16:42	NA	03	Box 1E	13 46.653	57 32.520	332	4743	sponge and associates
16:44	NA	04	Box 1F	13 46.653	57 32.520	332	4743	sponge and associates
16:47	NA	05	Box 1D	13 46.653	57 32.520	332	4743	sponge and associates

								slurp push
17:20	NA	07	PC8	13 46.654	57 32.251	264	4743	bacterial mat (4 adjacent to one another, black sediment with white coloration)
17:21	NA	08	PC B16	13 46.654	57 32.251	264	4743	bacterial mat (4 adjacent to one another, black sediment with white coloration)
1:22	NA	09	PC B10	13 46.654	57 32.251	264	4743	bacterial mat (4 adjacent to one another, black sediment with white coloration)
17:24	NA	10	PC 9	13 46.654	57 32.251	264	4743	bacterial mat (4 adjacent to one another, black sediment with white coloration)
17:59	NA	11	Blue Slurp	13 46.664	57 32.553	316	4742	Clam suface slurp; 5 Phymorhynchus, 1 squat lobster, 1 Acharax shell, 1 scale worm
18:17	NA	12	BioBox 21	13 46.664	57 32.553	316	4742	~65 *Abyssogena*
18:46	NA	13	PC 6	13 46.670	57 32.527	325	4737	bacterial mat
Volcano A, Jason 634, 4 June 2012								
16:13	NA	01	Biobox 1B	13 51.385	57 45.639	044	4945	carbonate rock with very small attached organisms
16:38	NA	02	Biobox 21	13 51.393	57 45.641	062	4946	13 *Abyssogena*
17:15	NA	03	PC 6	13 51.390	57 45.639	104	4946	orange sediment near bacterial mat
17:19	NA	04	PC10	13 51.390	57 45.639	104	4946	white mat
17:20	NA	05	PC9	13 51.390	57 45.639	104	4946	over carbonate
17:55	NA	06	Blue Slurp	13 51.390	57 45.639	104	4946	5 squat lobsters

18:12	NA	07	Biobox 21	13 51.411	57 45.621	131	4960	30 *Abyssogena*, 2 *Phymorhynchus, 1 anemone*
19:45	NA	08	marker #1	13 51.390	57 45.639	267	4945	Marker 1 (bucket lid on yellow nylon line) at sponge habitat
20:00	NA	09	Black Slurp	13 51.390	57 45.639	267	4945	1 sponge *Cladorhiza methanophila*
20:10	NA	10	Yellow Slurp	13 51.390	57 45.639	267	4945	4 (+?) sponges and associates
Atalante East, Jason 636, 8 June 2012								
18:51	2564	01	Blue Slurp	13 49.706	57 38.685	063	4930	amphipods (?) beneath dead sponge bush
19:06	2579	02	Green Slurp	13 49.706	57 38.685	119	4930	under llarge sponge bush
19:16	2600	03	Biobox 1E	13 49.706	57 38.685	120	4930	sponge
19:23	2628	04	Black Slurp	13 49.703	57 38.683	114	4930	under a second discrete bush of live sponge
19:23	2647	05	Biobox 1F	13 49.703	57 38.683	114	4930	Sponge
19:37	2667	06	Biobox 1C	13 49.703	57 38.683	107	4930	Sponge
19:42	2675	07	Biobox 1B	13 49.703	57 38.683	106	4930	Sponge
19:58	2701	08	Biobox 1D	13 49.703	57 38.683	227	4930	Sponge
20:13	2724	09	Biobox 21	13 49.685	57 38.684	190	4930	Abyssogena (5-8)
20:27	2767	09	Biobox 21	13 49.688	57 38.683	009	4930	Abyssogena (2-3)
20:44	2779	09	Biobox 21	13 49.693	57 38.683	011	4930	Abyssogena (3-5)
20:50	2796	09	Biobox 21	13 49.694	57 38.682	341	4930	Abyssogena (4-5)
20:59	2796	09	Biobox 21	13 49.694	57 38.682	324	4930	Abyssogena (4-5) [edit: only 5 live clams total in box]
Gingersnap, Jason 637, 9 June 2012								
16:51	2951	01	BioBox 21	13 45.537	57 28.180	241	4840	*Abyssogena* (3)

17:11	2981	02	Blue Slurp	13 45.514	57 28.198	217	4841	Sargassum, 2 squat lobsters, *Sclerolinum*
17:14	2987	03	PC14	13 45.514	57 28.198	217	4841	*Sclerolinum*
17:16	2989	04	PC12	13 45.514	57 28.198	217	4841	*Sclerolinum*
17:19	2996	05	Black Slurp	13 45.514	57 28.198	217	4841	squat lobster, *Phymorhynchus*
17:23	2998	06	BioBox 21	13 45.514	57 28.198	217	4841	*Abyssogena* (5), anemones
17:59	3090	07	Art	13 45.486	57 28.209	NA	NA	Clam and pogo horizon
Tim Tam, Jason 638, 10 June 2012								
16:48	3669	01	biobox 21	13 41.943	57 34.852	279	NA	Acharax?
18:02	3791	02	biobox 21	13 41.947	57 36.733	088	NA	mound poop
18:21	3802	03	biobox 21	13 41.947	57 36.733	088	NA	mound poop
18:37	3818	04	green slurp	13 41.949	57 34.716	089	NA	*Enypniastes eximia*
19:00	3868	05	blue slurp	13 41.953	57 34.790	340	NA	*Enypniastes eximia*
19:27	3906	06	black slurp	13 41.959	57 34.738	358	4837	*Enypniastes eximia*
19:45	3935	07	yellow slurp	13 41.969	57 34.753	226	4840	*Enypniastes eximia*
20:00	3963	08	biobox 21	13 41.963	57 34.741	124	4840	worm
Tagalong, Jason 639, 12 June 2012								
18:16	4063	01	Biobox 1D	bad fix			1453	coral
19:15	4197	02	Green slurp	11 45.217	58 25.516	095	1447	snails (~40), hermit crabs (4)
19:15	4224	03	PC14	11 45.217	58 25.516	095	1447	over snail
19:19	4227	04	PC12	11 45.217	58 25.516	095	1447	over snail
19:20	4229	05	PC8	11 45.217	58 25.516	095	1447	over snail
19:38	4287	06	Biobox 1E	11 45.237	58 25.502	053	1450	seastar
20:12	4332	07	Biobox 21	11 15.297	58 25.474	013	1450	unknown
20:52	4463	08	Biobox 21	11 45.290	58 25.586	240	1450	clam shell
Nilla, Jason 640, 13 June 2012								
13:39	4582	01	Blue Slurp	11 38.640	58 25.545	007	1668	crinoid, brittle star, onuphid
14:15	4656	02	slurp 3	11 38.680	58 25.537	021	1660	small clams, snails

Milano, Jason 641, 14 June 2012								
20:12	NA	01	Biobox 21	11 41.254	58 32.640	048	1301	rock
21:14	NA	02	Blue slurp	11 41.307	58 32.615	270	1327	tubworm slurp
21:27	6886	03	Biobox 21	11 41.306	58 32.636	270	1327	tubeworms
21:57	NA	04	Black slurp/yellow slurp	11 41.306	58 32.636	270	1327	slurp with tubeworms, shrimp
22:56	NA	05	Biobox 1E	11 41.306	58 32.636	286	1326	red ?ctenophore
23:11	NA	06	Biobox 1C	11 41.306	58 32.636	286	1326	tubeworm
Madeleine, Jason 642, 15 June 2012								
NO SAMPLES								
Milano, Jason 643, 16 June 2012								
12:45	8545	01	Blue Slurp	11 41.310	58 32.615	010	1325	vacuum of serpulids
12:53	NA	02	BioBox 21	11 41.310	58 32.615	010	1325	tubeworms (same place as J-641)
15:19	8951 9001 9046	03	BioBox 8	11 41.266	58 32.532	054	1328	clams
16:53	9066	04	PC12	11 41.266	58 32.532	054	1328	Bacterial mat
16:56	9073	05	PC 8	11 41.266	58 32.532	054	1328	Bacterial mat
16:58	9079	06	PC14	11 41.266	58 32.532	054	1328	Bacterial mat
18:05	9195	07	Biobox 1E	11 41.366	58 32.648	315	1342	Sargassum, next to live tubeworm
19:16	9375	08	Green Slurp	11 41.218	58 32.682	NA	NA	serpulid, shrimp, mussel
19:49	9434	09	Green Slurp	11 41.218	58 32.676	028	1317	galatheids assoc with mussels
20:18	9444	10	Biobox 21	11 41.218	58 32.676	028	1317	mussels

Population Genetics and Demography

1. A total of 1904 invertebrate specimens were collected, representing more than 80 (see table below and appendix).
2. We sampled four deep (5000 m) seeps (Atalante E &W, Manon, Volcano A, Gingers one of which (Gingersnap) was newly discovered.
    1. Dominant taxa shared across two or more sites:
    - *Monactis*
    - *Abyssogena methanophila*
    - maldanid polychaetes, *Sclerolinus*
    - *Amathys/Amphisamytha*
    - unidentified ampharetid
    - various isopods and amphipods
3. We sampled one shallow (1500 m) seep site (Milano), newly discovered.
    1. Dominant taxa:
    - *Laubiericoncha* sp.
    - Serpulid polychaetes
    - *Lamellibrachia* sp.
    - unidentified ampharetid
    - various isopods and amphipods
    - galatheid squat lobsters
    - ophiuroids
4. *Thyasirid* clams were collected from shallow and deep sites and from 'non-seep environments.
5. Some isopod and amphipod taxa appear to be found away from seep sites as part o 'typical' deep-sea community, shallow and deep.

LEG 1 Notes

- At each deep site sampled on Leg 1, only two species, the clam *Abyssogena* sp., an commensal anemone *Monactis* were consistently abundant. The pogonophoran *Sclerolinum* was found in abundance at Atalante and Manon. We saw a *Sclerolinum* at Volcano A, but were not able to return to it for sampling. The sponge *Cladorhiza* the same galatheid species were found at every site but not in large abundance, as the snail *Phymorhynchus*.
- Various amphipods and polychaetes were found in moderate to high abundance at three locations, but COI barcoding will be necessary to confirm how many species a shared between sites.
- Sponge assemblages: At two sites a sufficient number of amphipods were slurped *Cladorhiza* to have a rough idea of the composition of sponge commensals. Volcar sampling found no sponge commensals.

- Demography of *Abyssogena*. Size distributions revealed only one site (Atalante) with young individuals. At all three sites there were indications of missing year classes in the older cohorts (between 3 and 12 years old). This may also reveal inconsistency in annual recruitment.

Stable Isotope Samples

A set of subsamples were dried for stable isotope analysis of trophic relationships.

Summary of benthic invertebrates collected by Jason by location. AW: Atalante West; MA: Manon; VA: Volcano A; AE: Atlante E, GS: Gingersnap; TT: TimTam; NI: Nilla; MI1: Milano 1; MI2: Milano2.

Order per Vent Fauna handbook	Taxon	species	Phylum	Class	Order	AW	MA	VA	AE	GS	TT	TA	NI	MI1	MI2
1	*Cladorhiza*	sp.	Porifera	Demospongiae	Poecilosclerida		6	7	6						
1	Sponge	sp.	Porifera									3			12
2	Cnidarian	sp.	Cnidaria												1
2.1	Hydroid	sp.	Cnidaria	Hydrozoa										2	
2.2	Anemone	sp.	Cnidaria	Anthozoa	Actiniaria	18	1	5		7		3	7		1
2.3	Anthozoan, stoloniferous	sp.	Cnidaria	Anthozoa	Alcyonacea			1							
2.4	Coral, branching	sp.	Cnidaria	Anthozoa								1			
2.5	Coral, whip	sp.	Cnidaria	Anthozoa	Antipatharia							1			
2.9	Platyctenid	sp.	Ctenophora	Tentaculata	Platyctenida									2	
3	*Phymorhynchus*	sp.	Mollusca	Gastropoda		2	8	2		4					
3.1	Protolira	sp.	Mollusca	Gastropoda			1								
3.2	Snail	sp.	Mollusca	Gastropoda					1			26	9	2	4
3.3	Snail, Provannid	sp.	Mollusca	Gastropoda			5								
3.4	Snail, slit	sp.	Mollusca	Gastropoda											4
3.5	Snail, stubby reticulated	sp.	Mollusca	Gastropoda								8			
3.6	Snail, tall spired	sp.	Mollusca	Gastropoda											1
3.7	Snail, tall twisty	sp.	Mollusca	Gastropoda								2			
3.8	Gastropod, pearly	sp.	Mollusca	Gastropoda											3
3.9	Limpet	sp.	Mollusca	Gastropoda										5	6
4	Clam	sp.	Mollusca	Bivalvia		3									5
4.01	*Abyssogena*	*methanophila*	Mollusca	Bivalvia	Vesicomyida	67	45	44	7	15			12		
4.02	Clam, Vesicomyid	sp.	Mollusca	Bivalvia	Vesicomyida	1						4			
4.1	Clam, Tellinid-like	sp.	Mollusca	Bivalvia	Veneroida	2				2					1
4.15	Clam, Thyasirid	sp.	Mollusca	Bivalvia	Veneroida	6						17	3		7

4.3	Clam, Yoldia-like	sp.	Mollusca	Bivalvia	Nuculanoida	1									
4.3	Clam, Yoldia-like	sp. 2	Mollusca	Bivalvia	Nuculanoida		4								
4.4	Mussel	sp.	Mollusca	Bivalvia	Mytiloida									2	14
5	Nereid	sp.	Annelida	Polychaeta	Aciculata	1	2							1	
5	Syllidae or Tomopteridae	sp.	Annelida	Polychaeta	Aciculata or Phyllodocida						1				
6	Spionid	sp.	Annelida	Polychaeta	Canalipalpata					5					2
6	Serpulid	sp.	Annelida	Polychaeta	Canalipalpata									7	11
6	Oweniid	sp.	Annelida	Polychaeta	Canalipalpata						1				
7	Maldanid	sp.	Annelida	Polychaeta	Capitellida		41		51	2					2
7	Capitellid	sp.	Annelida	Polychaeta	Capitellida										4
8	Dorvilleid	sp.	Annelida	Polychaeta	Eunicida				50						
8	Onuphid	sp.	Annelida	Polychaeta	Eunicida								1		
9	Polynoid	sp.	Annelida	Polychaeta	Phyllodocida	1	3	1	6	2		1		2	3
9	Glycerid	sp.	Annelida	Polychaeta	Phyllodocida										7
9	Hesionid	sp.	Annelida	Polychaeta	Phyllodocida										
9	Nautiliniellid	sp.	Annelida	Polychaeta	Phyllodocida					6					
9	Phyllodocid	sp.	Annelida	Polychaeta	Phyllodocida									2	
10	*Lamellibrachia*	sp.	Annelida	Polychaeta	Sabellida									22	11
10	*Escarpia*	sp.	Annelida	Polychaeta	Sabellida									1	
10	Pogonophoran	sp.	Annelida	Polychaeta	Sabellida										
10	*Sclerolinum*	sp.	Annelida	Polychaeta	Sabellida	18	1	1		43					
10	Vestimentiferan	sp.	Annelida	Polychaeta	Sabellida									6	
11	*Amathys/Amphisamytha*	sp.	Annelida	Polychaeta	Terebellida		62		60						
11	Ampharatid	sp.											11		5
11.1	Ampharatid	sp. 1	Annelida	Polychaeta	Terebellida		24		100	11					
11.2	Ampharatid	sp. 2	Annelida	Polychaeta	Terebellida		14					5			
12	Polychaete, unknown	sp.	Annelida	Polychaeta		2						1		3	1
12	*Methanoaricia*	dibranchiata	Annelida	Polychaeta			1								
12	Orbiniid	sp.	Annelida	Polychaeta			11			1		12			
12.2	Worm, unknown	sp.										1			2

13	Pycnogonid	sp.	Arthropoda	Pycnogonida	Pantopoda										2
14	Barnacle	sp.	Arthropoda	Maxillopoda								3			
15	Cumacean	sp.	Arthropoda	Malacostraca	Cumacea							1	1	2	4
16	Tanaid	sp.	Arthropoda	Malacostraca						1					
17	Isopod	sp.	Arthropoda	Malacostraca	Isopoda	2	25	1	100	29	2	14		1	8
17.1	Isopod	sp. 2	Arthropoda	Malacostraca	Isopoda										
18	Amphipod	sp.					100	20	5	3		30	3	16	38
18.1	Amphipod	sp. 1	Arthropoda	Malacostraca	Amphipoda	60	2								
18.2	Amphipod	sp. 2	Arthropoda	Malacostraca	Amphipoda	6									
18.3	Amphipod	sp. 3	Arthropoda	Malacostraca	Amphipoda	9			50	12	1	2	12		
18.4	Amphipod	sp. 4	Arthropoda	Malacostraca	Amphipoda				20	1			1		8
18.5	Amphipod	sp. 5	Arthropoda	Malacostraca	Amphipoda				50						
18.6	Amphipod	sp. 6	Arthropoda	Malacostraca	Amphipoda							7			
19	Peracarid	sp.	Arthropoda	Malacostraca								11		3	
20	Shrimp	sp.	Arthropoda	Malacostraca	Decapoda									2	3
20	Crustacean, unknown	sp.													
21	*Galathea*	sp.	Arthropoda	Malacostraca	Decapoda	4	3	6		3					15
22	Megalopa	sp.	Arthropoda	Malacostraca	Decapoda				1				1		
22	Crab, hermit	sp.	Arthropoda	Malacostraca	Decapoda							5			
22	Crab, unknown	sp.	Arthropoda	Malacostraca	Decapoda		1						1		
23	Crinoid	sp.	Echino	Crinoidea									1		
24	Ophiuroid	sp.	Echino	Asteroidea	Ophiuroidea							2	2	2	15
24	Asteroid	sp.	Echino	Asteroidea								1			
25	*Benthodytes*	sp.	Echino	Holothuroidea	Elasipodida						1				
25	*Enypniastes*	sp.	Echino	Holothuroidea	Elasipodida						3				
25	*Psychropotes*	sp.	Echino	Holothuroidea	Elasipodida						1				
26	Turbellaria?	sp.	Platyhelmin	Turbellaria											1
26	Sipunculid	sp.	Sipuncula	Sipunculidea	Golfingiida									1	2
26	Priapulid	sp.	Priapulida												4
26	Flatworm	sp.	Platyhelmin												
26	Foram	sp.	Foram									30			
27	Fish, zoarcid	sp.													2

Mapping

The Barbados accretionary complex is a mature accretionary wedge resulting from the tec convergence of the Atlantic oceanic plate the Caribbean plate. The southern Barbados accretionary prism is known for an extensive active mud volcano field (Deville et al., 2006) while seaward of the deformation front, mud volcanoes also exist (Le Pichon et al., 1990). spatial distribution and frequency of these fluid mobilization features give insight to regio pore pressure, overburden, and gas hydrate conditions. From June 1-17, 2012 the R/V Atla mapped the seafloor and sub bottom in three targeted areas in the Barbados Accretionary Complex (Figure 1) using the hull-mounted Kongsberg EM122 and Knudsen 3.5 kHz system We mapped > 5000 km^2 of seafloor. L. Brothers edited and processed raw multibeam data shipboard using MB_system. Knudsen data were examined using Echo Post Survey. All sea mapping data were integrated into a Geographic Information System. The targeted areas described below.

Site A

On June 1st, 2nd, 3rd, and 10th we conducted a total of 12 hours of seafloor mapping operations at 7 knots. We collected 128 km of 3.5 kHz data and 2000 km^2 of multibeam da ~5000 m water depths (Figure 2). We reoccupied mud volcanoes Atalante, Manon, Volcan and identified new mud volcanoes Gingersnap and Tim Tam (Figures 2-4).

Site C

On June 6th, 7th we conducted 10 hours of seafloor mapping operations at 7 knots in a previously unmapped area, Site C. We collected 138 km of 3.5 kHz data and 2310 km^2 of multibeam data. We identified linear anticlinal ridges in the bathymetry data (Figure 3). W Depth ranged from m-m, swath width was approximately 10 km.

Site F. On June 12th, 14th, and 15th we conducted 14 hrs of seafloor mapping operations knots in a new area, Site F. We collected 185 km of 3.5 kHz data and 960 km^2 of multibeam (Figure 6). From these data we selected dive sites Tagalong, Nilla, Milano, and Madeleine (Figure 7).

Transit

While transiting at 11-12 knots 870 km of data were collected. Due to the poor signal-to-n ratio within these data, shipboard processing was not a priority. At the time of this report data were not fully edited and processed.

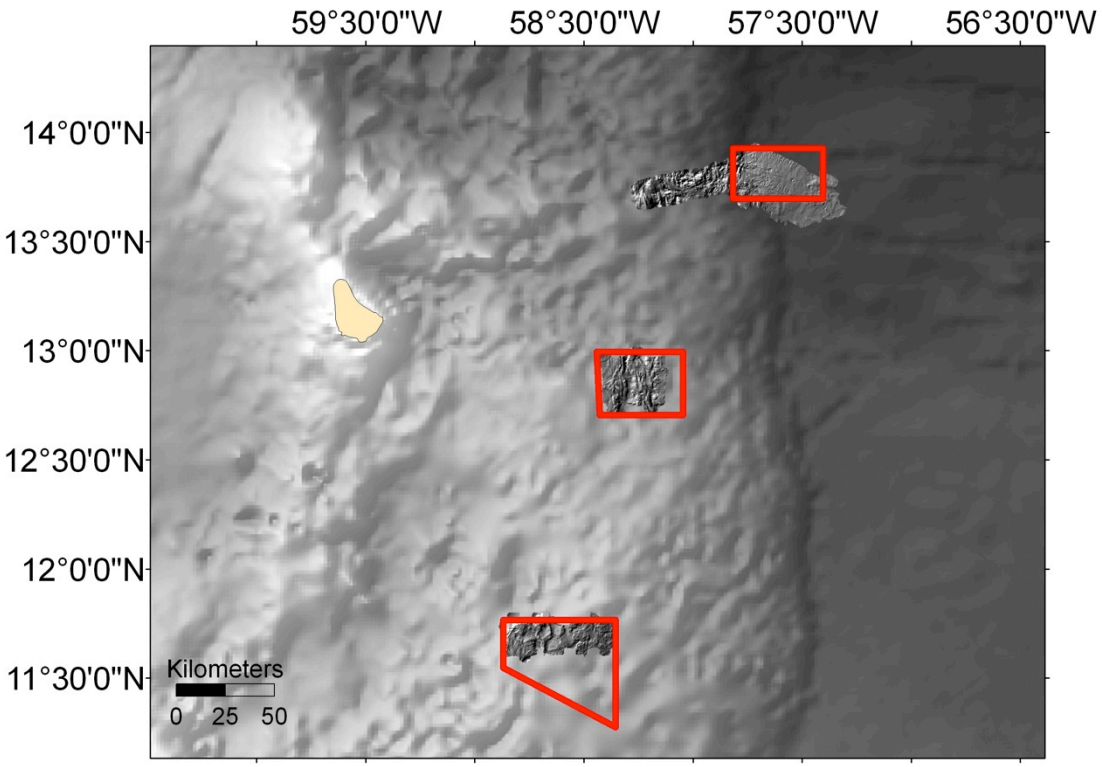

Figure 1. Location map showing Barbados (beige), general bathymetry (Amante and Eakins, 2009) and the three survey sites (red boxes).

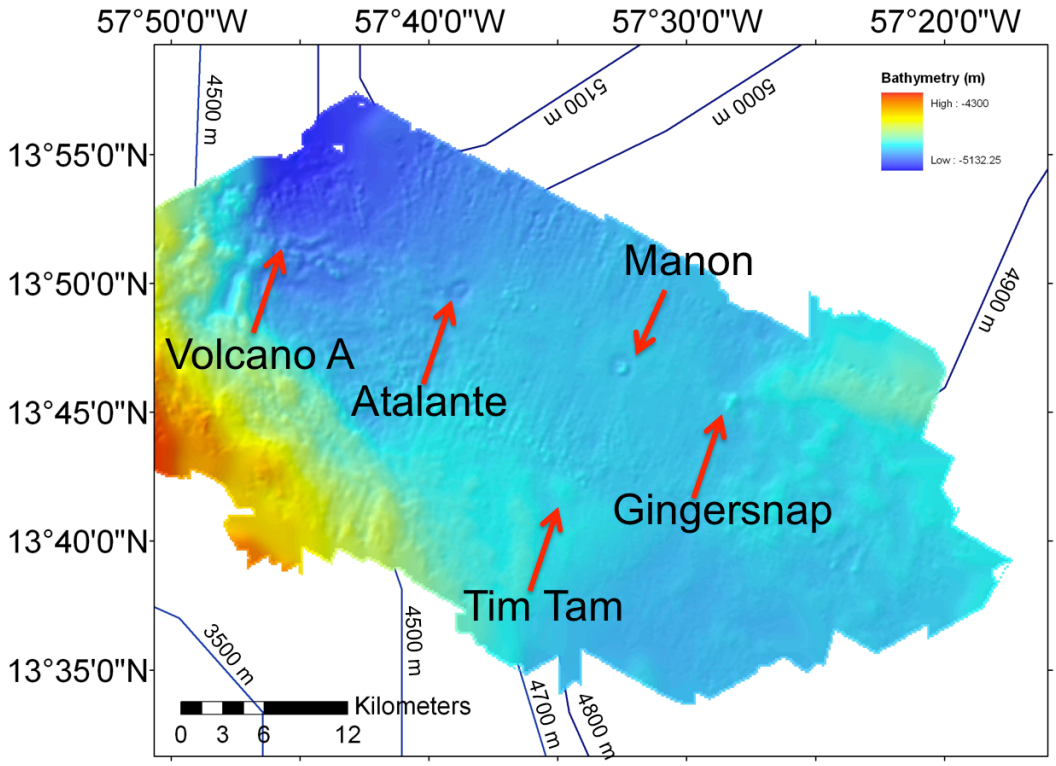

Figure 2. Site A bathymetry with labeled mud volcano locations.

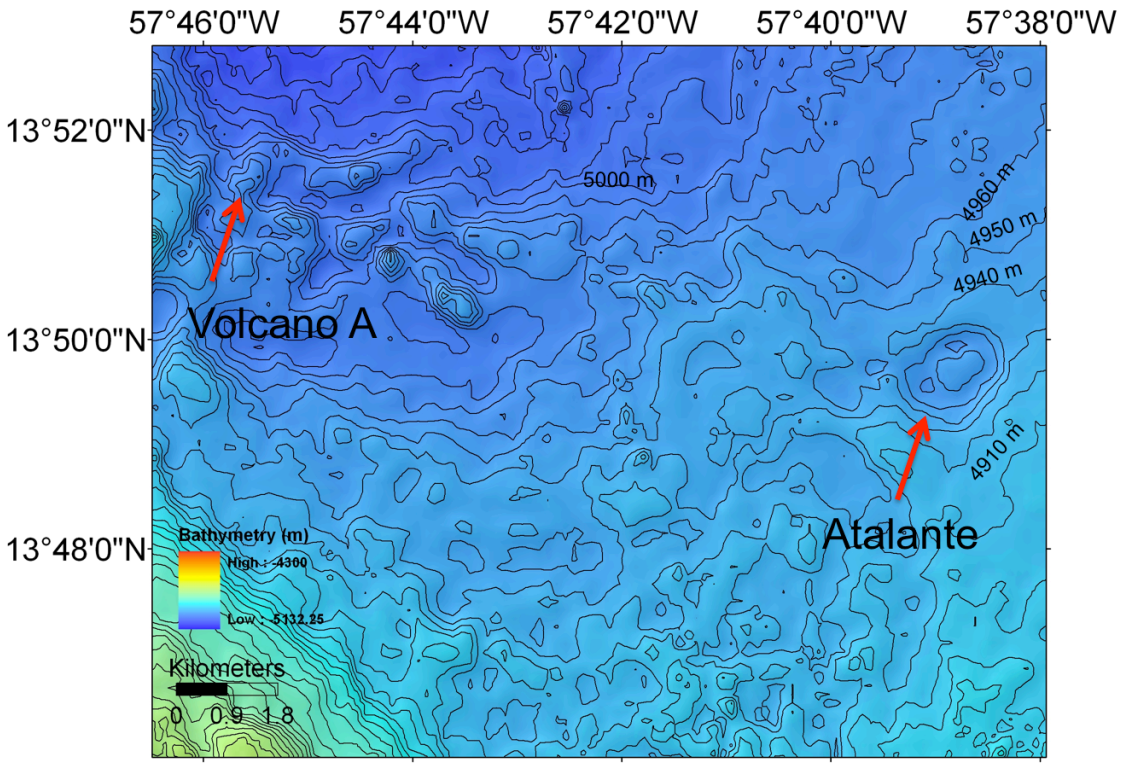

Figure 3. Detailed bathymetry of mud volcanoes Volcano A and Atalante. Contours are every 10 m.

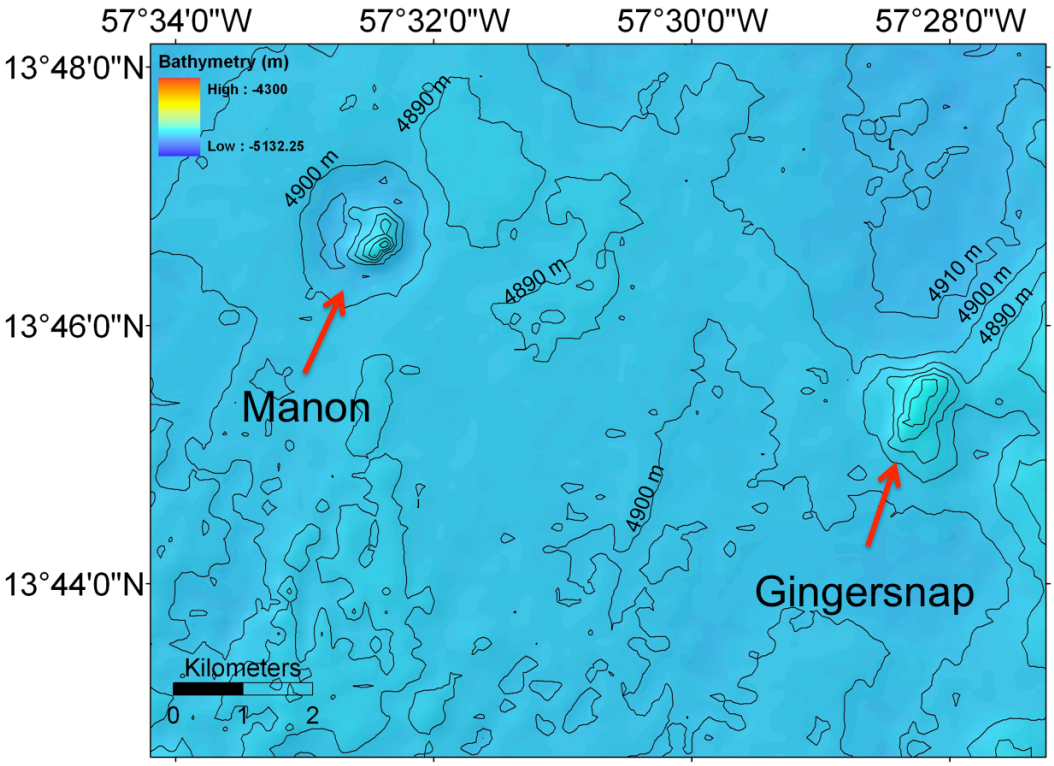

Figure 4. Detailed bathymetry of mud volcanoes Manon and Gingersnap. Contours are every 10 m.

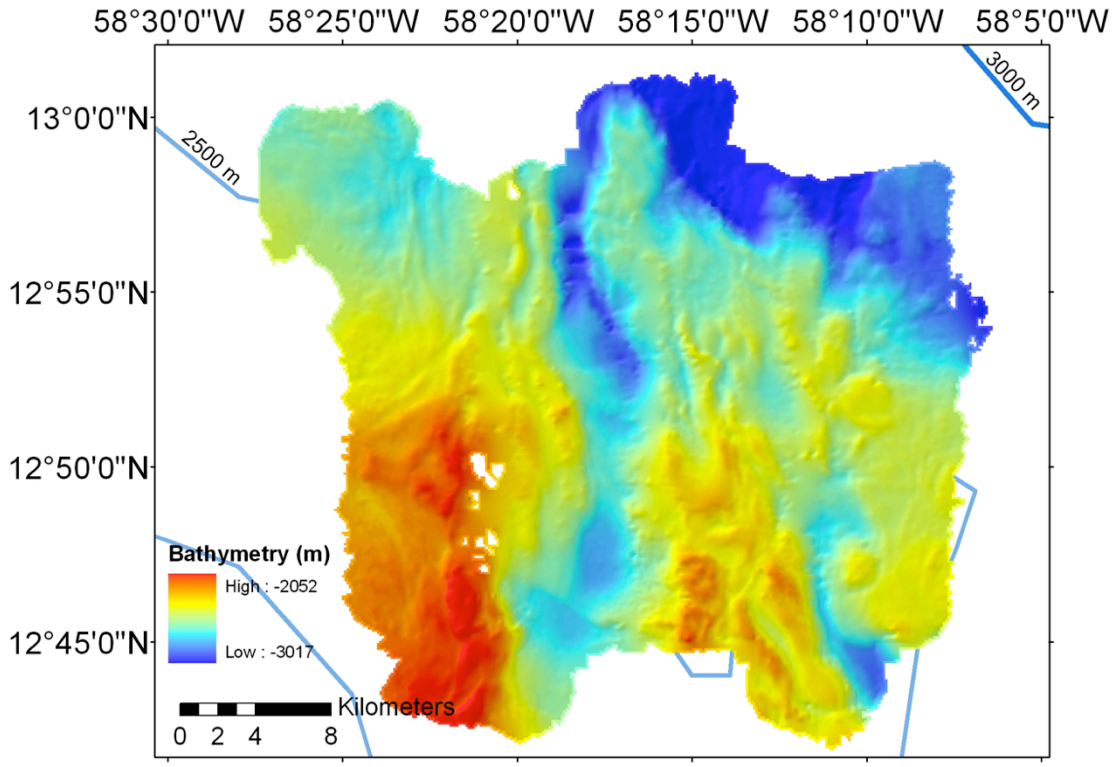

Figure 5. Newly acquired multibeam data at Site C. Anticlinal ridges with N-S orientations are apparent as bathymetric highs.

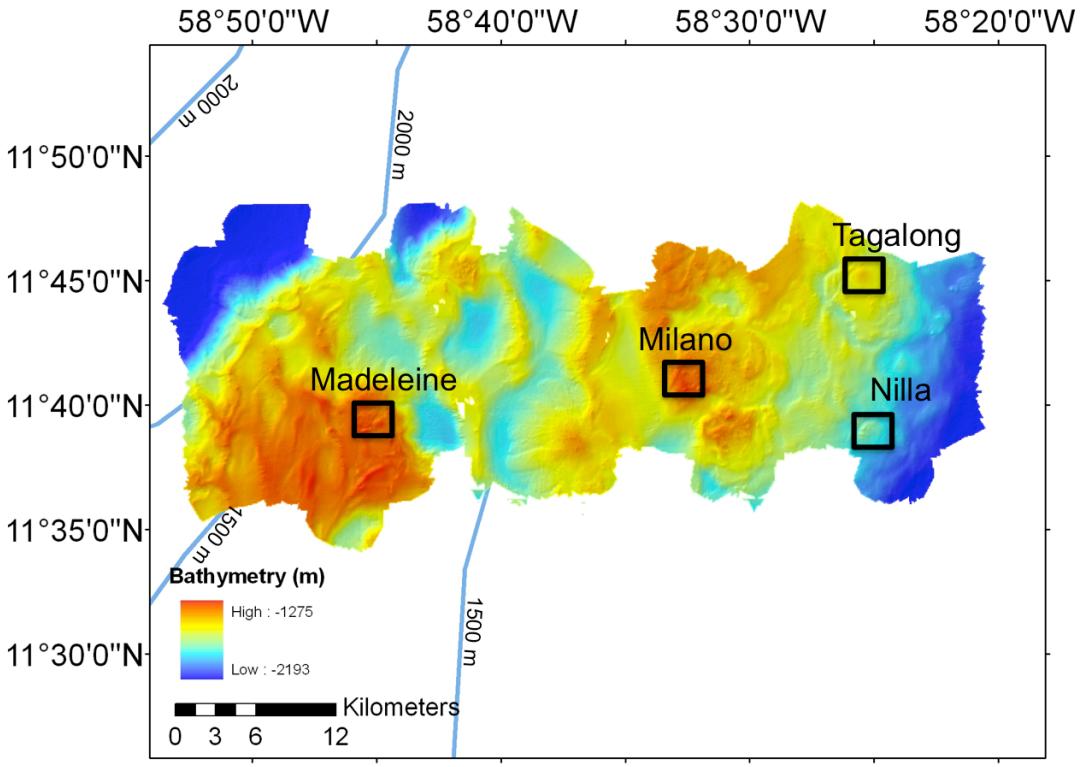

Figure 6. Site F bathymetry with labeled dive sites.

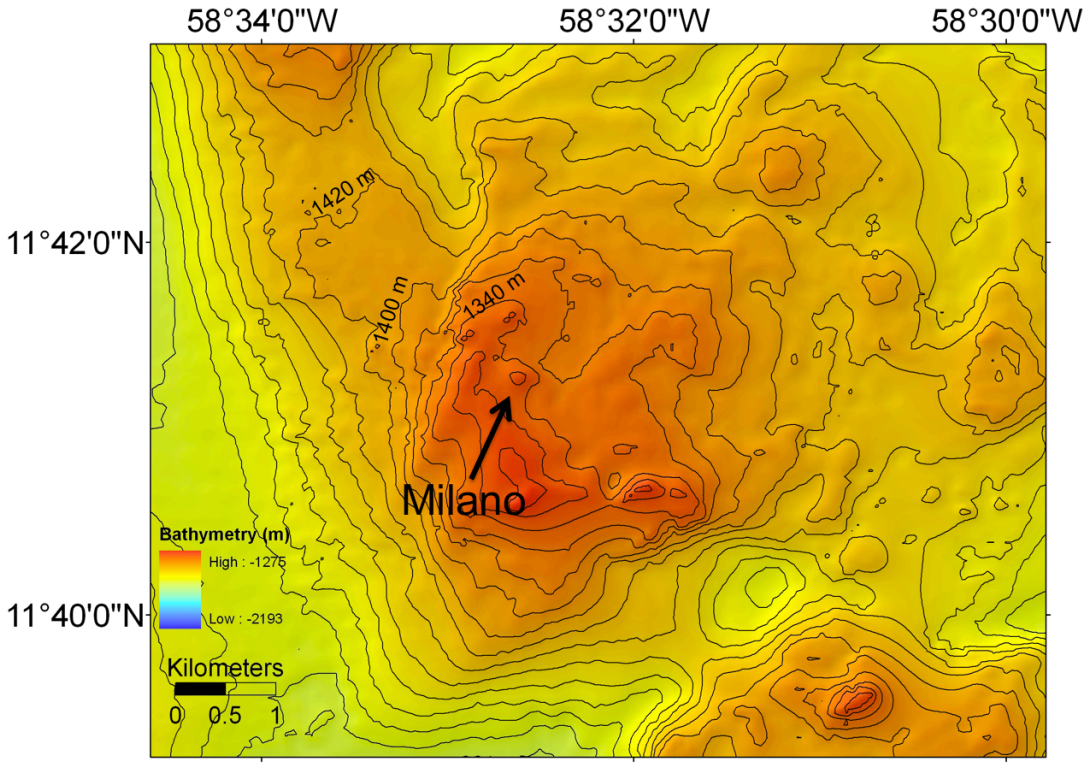

Figure 7. Detailed bathymetry of dive site Milano. Contours are every 20 m.

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Le Pichon X., J. P. Foucher, J. Bouli~Gue, P. Henry, S. Lallemant, M. Benedetti, F. Avedik And A. Mariotti, 1990. Mud volcano field seaward of the Barbados accretionary complex: a submersible survey. Journal of Geophysical Research, B, 95, 8931-8943.

Larval Biology

The larval biology team from University of Oregon completed nine MOCNESS tows, sorting all of the planktonic invertebrate larvae that were found in every sample. The MOCNESS coordinates and depth ranges sampled are summarized in the following table. The water column was divided into 350m increments that were sampled with oblique tows using 150 um mesh. The water column was divided into 175m increments at shallower sites (tows 7-9). The net was pulled in at 10-15m/minute.

Tow #	Data File	Date	starting coordinates	ending coordinates	depth range sampled
1	M1	2-Jun-12	14N48.94, 57W 32.65	not recorded	0-200m
2	M2	3-Jun-12	13N45.00, 57W 42.64	13N 52.835, 57W38.199	1250-3350m
3	M3	5-Jun-12	13N50.65, 57W 46.04	13N 59.135, 57W 41.69	550-1250, 3300-4700m
4	M4, M5	6-Jun-12	13N42.41, 57W 45.92	13N 49.16, 57W 40.65	2250-4650m
5	M6	9-Jun-12	13N 42.77, 57W 48.55	13N 48.97, 57W 42.69	2600-4500m
6	M7	11-Jun-12	13N 37.72, 57W 35.10	13N 71.34, 57W 47.08	0-2650m
7	M9	13-Jun-12	11N 36.22, 58W 29.45	11N 69.03, 58W 42.48	0-1425m
8	MA	14-Jun-12	11N 35.3, 58W 40.1	11N 77.65, 58W 62.73	0-1400m
9	MB	16-Jun-12	11N 37.22, 58W 35.86	11N 43.88, 58W 29.94	0-1200m

Technical problems, including a damaged cable and unreliable sensors, resulted in a number of data gaps. On tow 1, only a single net tripped, yielding only a composite sample that covered the upper 200m of the water column. The remainder of the water column down to 4700m (approximately 300m above the bottom) was sampled in two tows (2,3) and a final tow was used to resample the deepest portions of the water column. The temperature sensor produced unreliable data on some of the tows, and the flow meter did not work at all during tows 1-4, so the volumes filtered by each net will be difficult to calculate.

The 6-person larval sorting team (Hiebert L, Hiebert T, Jarvis, Oates, Peteiros, Young on Leg 1; Emlet, Dlouhy, Hiebert L, Hiebert T, Maslakova, Valley on Leg2) which did not include the MOCNESS tech (Siddon and Burgess on Leg 1; Burgess on Leg2) worked for periods ranging from 3 hours to 16 hours after each tow, depending on the depths sampled. The entire sample was sorted in most cases. Several very dense samples were subsampled, as summarized in the following table:

Tow #	Date	Depth range	Subsample

6	11-Jun-12	200-10m	1/4 the volume of sample
6	11-Jun-12	550-200m	1/2 the volume of sample
7	13-Jun-12	200-25m	1/4 the volume of sample
7	13-Jun-12	375-200m	1/4 the volume of sample
7	13-Jun-12	550-375m	1/2 the volume of sample
8	14-Jun-12	200-10m	1/8 the volume of sample
8	14-Jun-12	375-200m	1/4 the volume of sample
8	14-Jun-12	550-375m	1/2 the volume of sample
9	16-Jun-12	200-0m	1/4 the volume of sample
9	16-Jun-12	375-200m	1/4 the volume of sample
9	16-Jun-12	550-375m	1/2 the volume of sample

Individual larvae were removed from the samples, photographed with either bright-field or dark-field illumination under a Leitz Laborlux K compound microscope using Optronics Microfire camera or Olympus dissecting microscope using Grasshopper camera, then preserved for either DNA-barcoding (in 95% ETOH) or Scanning Electron Microscopy (in 2.5% glutaraldehyde made up in filtered sea water or Millonig's phosphate buffer). Larvae were assigned into morphotypes, based on morphology. Photos of the various larval morphotypes were printed and mounted on the walls of the laboratory to aid subsequent identification (Fig. L1).

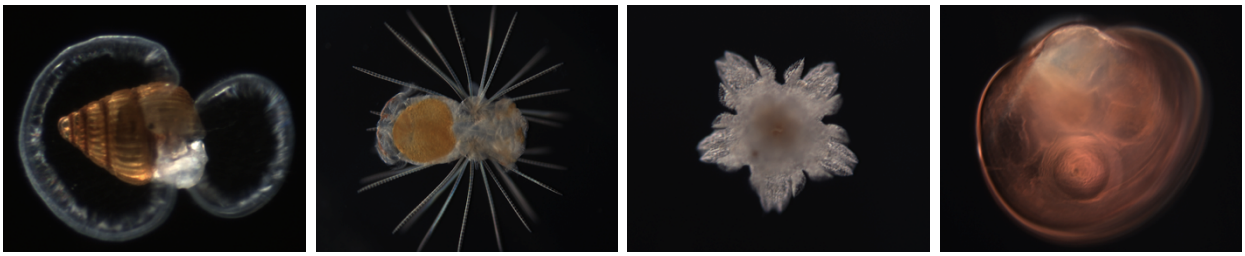


Figure L1. Examples of larval morphotypes. A. Gastropod veliger, morphotype GV8; B. Polychaete larva, morphotype NE78; C. Ophiuroid juvenile, morphotype OJ2; D. Bivalve veliger, morphotype BV5.

All larvae were given a unique individual number and retained, with few exceptions. A total of 4005 larvae were found in the nine tows, spanning most invertebrate phyla. Larval densities in the deeper portions of the water column were extremely low, with only a few larvae typically found in each sample. Nevertheless, the deep-water samples included bivalves, gastropods and polychaetes that could potentially have originated in the deep-sea benthos. Bivalve larvae, which are of particular interest to this project, were represented by a total of 28 individuals (across all tows), assorted into 14-16 morphotypes. We were surprised to find live cyphonautes larvae throughout the water column, since they probably come from anascan bryozoans on floating *Sargassum* plants. Cyphonautes larvae were extremely common, and comprise nearly

half of all the larvae we recorded. We were also surprised to find several juvenile sea urchins, including one that had probably undergone metamorphosis some weeks before capture, in the middle of the water column, 2000m or more above the sea floor.

Certain very common larval morphotypes (e.g. cyphonautes CY5, represented by 1702 individuals), were recorded, and all individuals counted, but not all were retained. Such cases are identified by a "-" in the columns E, F in the MOCNESS data spreadsheet (Appendix 1).

Some of the initially recorded morphotypes were eventually recognized as likely representing holoplanktonic species - mostly polychaetes from families Lopadorhynchidae, Typhloscolecidae, Alciopidae and Tomopteridae, but also thecosome pteropods (Fig. L2); once recognized as such,

Figure L2. Examples of morphotypes likely representing holoplanktonic species. A. Morphptype GV9, thecosome pteropod. B Morphotype NE81, Polychaeta, Fam. Lopadorhynchidae. C. Morphotype NE7, Polychaeta, Fam. Typhloscolecidae. D. Morphotype NE43, Polychaeta, Fam. Alciopidae.

they were nor longer recorded, and are excluded from the total larval counts (black fill in column L, Appendix 1).
The OIMB team was assisted by participants from Eggleston and He teams during MOCNESS deployment and recovery: Joe Zambon, Brandon Puckett, Ashlee Lillis, Jessica Lowder, as well as Karen Jacobsen (an artist). The OIMB team assisted with one 5000m CTD cast, hourly XBT deployments during two transits, and logging of the video data during Jason dives.

Clams and mussels

The visceral masses of all clams (*Abyssogena southwardae*) collected by Jason II at Atalante site were preserved in 10% formalin for gonad histology for two days, then transferred to 70% ETOH for storage. Six clams from Volcano A were injected (1 cc each, into the anterior adductor muscle) with serotonin. Four of the individuals released sperm within minutes of injection, but no eggs were obtained. The sperm appeared to be conincal ect-aquasperm of the kind that would be expected of free-spawning externally-fertilizing species. We again attempted to induce spawning by injecting five clams collected by Jason on June 9, 2012 from Atalante East (Jason Dive 636) with 1-2 cc serotonin each, with similar results (two males released a little sperm, but not eggs were obtained). No clam gonads were retained from this particular dive. Similarly we attempted to induce spawning in 6 mussels (*Bathymodiolus*) collected during Jason dive 643 on June 16, 2012. None of the injected individuals released

gametes in response to serotonin. We dissected and preserved (in 10% formalin, with subsequent transfer to 70% EtOH for storage) a slice of gonad tissue from all clams and mussels collected during Jason dive 643.

Polychaetes

Three gravid polychaetes (Family Amphinomidae) collected from the sponge bushes at Manus were preserved for electron microscopy. Primary oocytes in the coelomic cavity were clearly visible through the body wall. One additional polychaete (family unknown, but initially identified as a maldanid) was also preserved. Eggs released from this individual underwent germinal vesicle breakdown. Ten secondary oocytes measured with an ocular micrometer ranged in size from 190-200 um in diameter. *Atalante East (Jason dive 636, June 8, 2012)*: One polychaete provisionally identified as a maldanid (posterior end missing) released positively bouyant oval eggs (mean diameter x microns, n=27), filled with large lipid droplets. A large polynoid released whitish liquid, but no sperm was observed upon closer examination. Ampharetid number 1: single individual, observed oocytes of different sizes through the body wall, free oocytes are negatively buoyant. *Gingersnap (Jason Dive 637, June 9, 2012)*: Examined a female polynoid with eggs coming out of breaks in body wall near parapodia. Eggs were different in size, largest about 250 micron in diameter, rounded, opaque, negatively buoyant.

Gastropods

Gingersnap (Jason Dive 637, June 9, 2012): Van Dover team passed on two gastropod egg capsules (saucer shaped, semi-transparent, with one flat side, normally attached) possibly belonging to *Phymorhynchus sp*. At least two of the nautiliniellid polychaetes found inside mantle cavity of *Abyssogena* clams observed to have visible coelomic oocytes (largest about 150 micron in diameter), oocytes negatively buoyant. Van Dover team passed a single tube of a tube worm with two small saucer shaped egg capsules - attached by their sides. One with apparently cleaving white opaque embryos. Cleavage spiral, unequal. Micromeres sunstantially smaller than macromeres. Likely a gastropod. *Tagalong (Jason Dive , June 12, 2012):* Van Dover team passed several gastropod egg capsules attached to small rocks. Individual capsules were white, shaped as semi-spheres (~0.5 cm in diameter) with a small round opening in the middle. The opening is covered by a clear parchment-like covering during embryonic development. Many veligers hatched overnight from these capsules. Larvae were photographed, preserved for genetics in 95% EtOH and SEM (in 2.5 Glutaraldehyde in Millonig's Buffer), others kept alive at 4C, and brought back to OIMB live to asses swimming speed and direction.

Rhyzocephalans on galatheids

Atalante: The egg masses of parasitic barnacles, found below the telsons of three galatheid crabs (Munidopsis sp.) were photographed and preserved for scanning electron microscopy. Egg masses from one individual contained zygotes that were apparently completing meiotic divisions (polar bodies were extruded in nearly all of them) and egg masses from the other two individuals contained well-formed but unhatched cyprid larvae. The zygotes were much

smaller than the larvae, indicating that the embryos are nourished by the mother during development. This probably takes place through the tubular attachment of the egg mass. Multiple rhyzocephalan externas observed on galatheids from *Gingersnap mud volcano*. Externas are pear shaped, each with a single opening in the center on one side - opening of the mantle cavity, through which presumably a male penetrates the externa. Extrernas filled with brooded embryos (until cyprid stage - visible thoracic appendages, somewhat bivalve carapace). Preserved embryos dissected from two of the externas, and one whole externa in 2.5 % glutaraldehyde in Millonig's buffer for morphological observations. Externas leave a round raised scar on the abdomen of the crab as they break off.

Lamellibrachia

Jason Dive 643, June 16, 2012: Six large tube worms (*Lamellibrachia*) were dissected from this site. None of the individuals possessed obvious ovisacs in vestimental region. Three individuals contained ovaries and three - testes in the trophosome region. Dissected oocytes were 120 micron in diameter, and contained a germinal vesicle. Dissected testes contained spermatocytes and spermatozoa at a range of stages of spermatogenesis, including actively moving spermatozoa. Suspended oocytes from three females in pre-chilled filtered surface sea water (5 micron) without addition of sperm. Cultures kept in finger bowls at 4 C. Observed polar bodies on few of the oocytes in one of the three cultures some 20 hours later. About 50% of the eggs are cleaving (2-cell stage, unequal cleavage) by 36h post-dissection at 4C. Eggs are positively buoyant, often rupture upon contact with water surface. Live cultures transported back to OIMB for subsequent studies of embryonic development and larval behaviour.

JASON WATCH ASSIGNMENTS and sample processing summary					
	0800-1200h	**1200-1600h**		**1600-2000h**	
Pilot	Tito	Scott		Akel	
Navigator	Hugh	Korey		Darra	
Watch Leader **Rank Abundance** **Sample Log** **Basket Log**	Cindy	Sophie		Abbe	
Video Leg 1	Wagner	Burgess	Young	T Hiebert	L Hiebert
Video Leg 2	Puckett	Ball		Lowder	
Data Leg 1	Bailey	Cunningham		Carlsson	
Data Leg 2	Wagner	Clarke		Jollivet	
Science Leads	Emlet, Maslakova, Zambon				
Artists Leg 1	Jacobsen, Fraser, Mok				
Artists Leg 2	Jacobsen, Minik, Moise, Kermani				
Others Leg 1	Brothers (mapping), Siddons (MOCNESS), Peteiros, Oates, Jarvis/,				
Others Leg 2	Brothers (mapping), Lillis (CTD), Valley, Dlouhy				
Basket	ABBE				
Chilled Water	SOPHIE				
Sample Processing	SOPHIE/Abbe, Didier, Jens, Cliff, Jake Recording, photography, measuring, dissection, labeling				
	SAMPLE TYPES Vouchers Artists (best specimens) Symbionts Cohorts Stable Isotopes Reproductive Studies Blood Shells/Bone – Thiomargarita SEM Postlarvae - geochemistry Cores Souvenirs		**PRESERVATION STYLES** Live (eggs) RNALater Ethanol Frozen Drying oven Formalin Paraformaldehyde Glutaraldehyde		
Dive and Basket Plan	CINDY				

Physical Oceanography – Hydrographic Sampling

1. Model simulated sea surface height and currents

Data assimilative HyCOM ocean model predictions were used to provide daily ocean surface currents and sea surface height information for our sampling area. The model shows Barbados was surrounded by a large warm core (anticyclonic) eddy that gradually intensified over the course of our survey (Figure 1). At the same, a weak cold (cyclonic) eddy was also forming to the north of Barbados, outside of our sampling area.

The science team decided to conduct underway XBT and CTD casts along the cruise track to at least partially sample the hydrographic conditions of the warm core eddy and quantify its vertical scale.

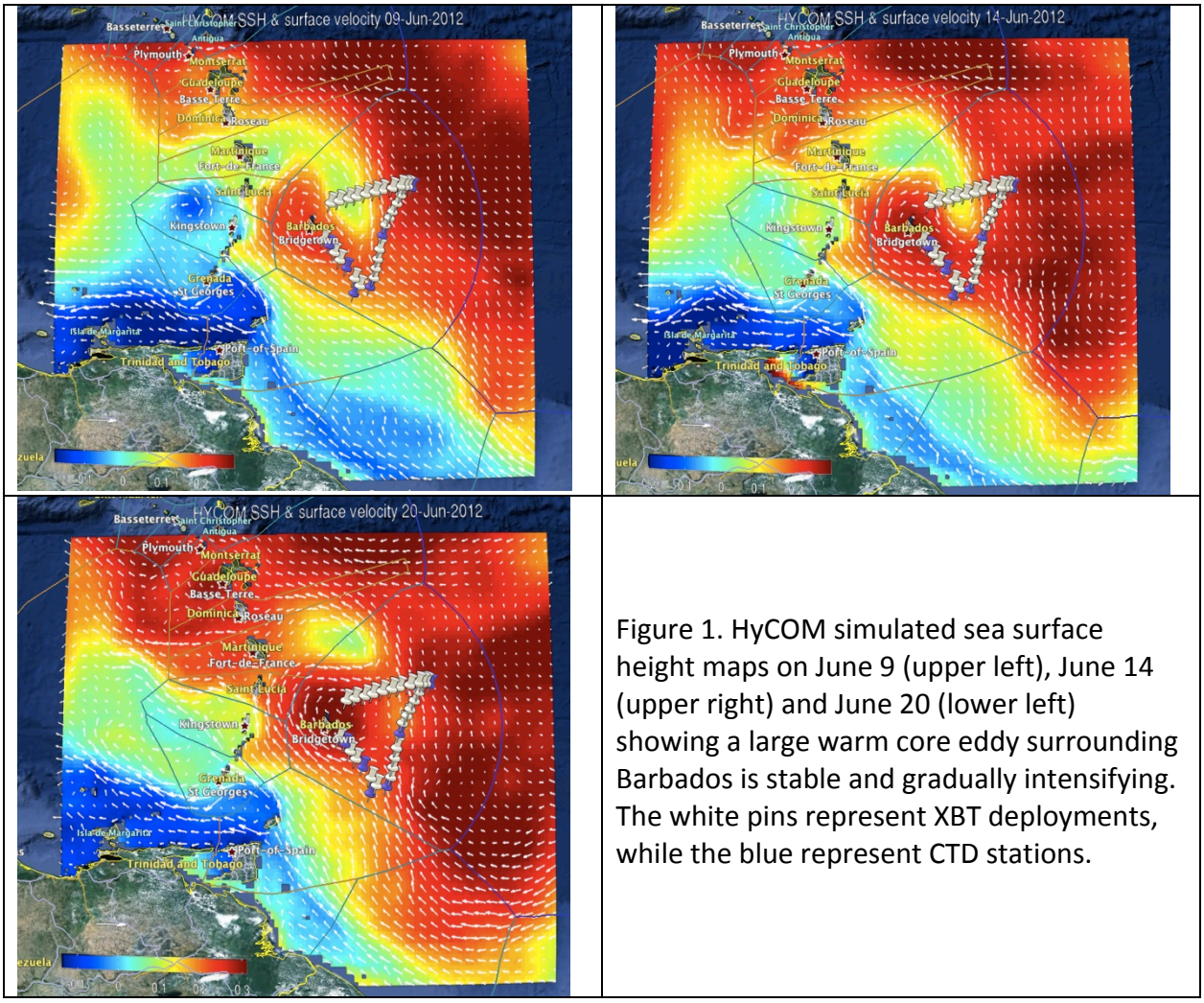


Figure 1. HyCOM simulated sea surface height maps on June 9 (upper left), June 14 (upper right) and June 20 (lower left) showing a large warm core eddy surrounding Barbados is stable and gradually intensifying. The white pins represent XBT deployments, while the blue represent CTD stations.

A complete archive of model simulated SSH and surface current maps are available at:
http://omglnx11.meas.ncsu.edu/yanlin/barbados/

2. XBT Survey

Starting 1-June, 18:14 GMT, We began underway XBT casts roughly every hour (~ every 10 nm apart between stations). A total of 25 XBT casts were made during the survey. Figure 2 shows their locations, while Table 1 provides exact coordinate and time (in GMT) of each cast.

A total of 4 transects were captured at various times during the cruise:

1) A west-east transect (Figure 3) was captured between 1-June 18:14 GMT and 2-June 3:04 GMT from Barbados to the northern most study site (A).
2) The first north-south transect (Figure 4) was captured between 6-June 15:09 GMT and 20:09 GMT from Site A to the central study site (C).
3) A second north-south transect (Figure 5) was captured from 12-June 8:02 GMT and 10:58 GMT between Site C and the southwestern study site (F).
4) While cruising back to port, a final transect (Figure 6), oriented southeast to northwest, and was captured between 16-Jun 22:27 GMT and 17-Jun 8:46 GMT.

Data in all transects show a consistent ocean thermocline at a depth of ~ 120 m. The signature of a warm core eddy surrounding Barbados is evident in the southeast-northwest transect (Figure 6) with a steadily deepening thermocline. Here the thermocline deepens by 50-75 meters, reaching approximately 200m depth. Detailed temperature profiles from all 27 XBT stations are provided in an Appendix.

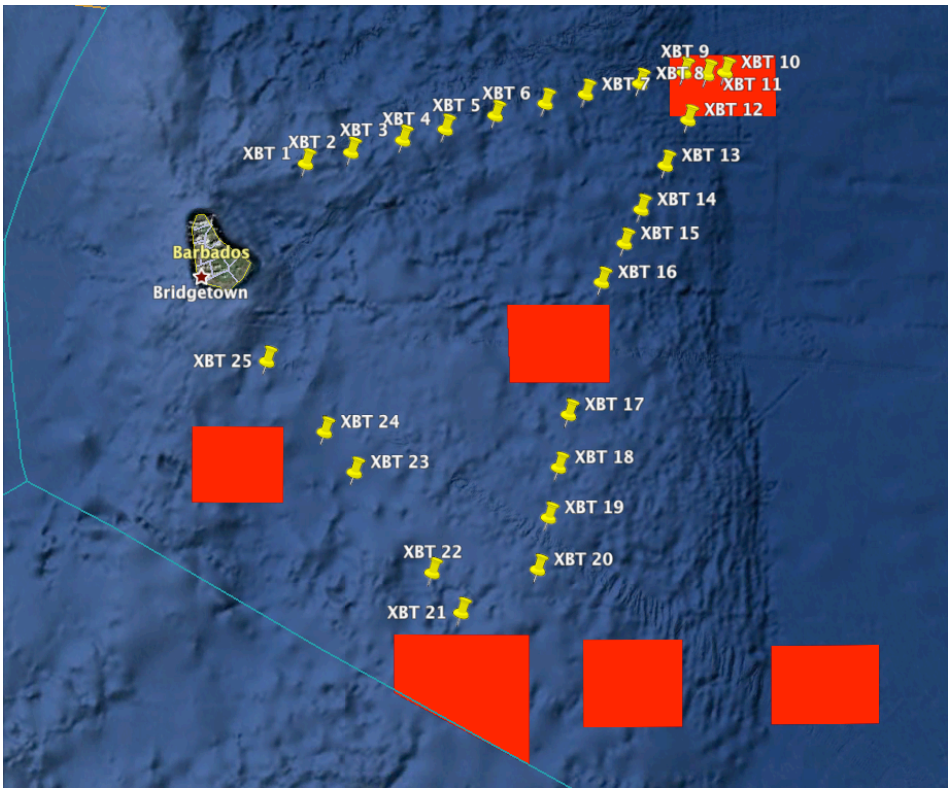


Figure 2. A map showing locations of 25 XBT cast.

Table 1: Time (in GMT) and coordinate of each XBT cast.

Station	Date	Time (GMT)	Latitude	Longitude	Filename
XBT 1	1-Jun-12	18:14	13.4744	-59.2289	T6_00002.EDF
XBT 2	1-Jun-12	19:06	13.5161	-59.0541	T6_00003.EDF
XBT 3	1-Jun-12	20:07	13.5613	-58.8547	T6_00004.EDF
XBT 4	1-Jun-12	20:58	13.602	-58.6919	T6_00005.EDF
XBT 5	1-Jun-12	22:01	13.6533	-58.5	T6_00006.EDF
XBT 6	1-Jun-12	23:04	13.6978	-58.3083	T6_00007.EDF
XBT 7	1-Jun-12	23:55	13.732	-58.1533	T6_00008.EDF
XBT 8	2-Jun-12	1:03	13.7725	-57.9455	T6_00009.EDF
XBT 9	2-Jun-12	2:00	13.8145	-57.7746	T6_00010.EDF
XBT 10	2-Jun-12	3:04	13.8142	-57.6176	T6_00011.EDF
XBT 11	6-Jun-12	15:09	13.8059	-57.6874	T6_00012.EDF
XBT 12	6-Jun-12	16:11	13.6356	-57.7606	T6_00013.EDF
XBT 13	6-Jun-12	17:13	13.4651	-57.8483	T6_00014.EDF
XBT 14	6-Jun-12	18:14	13.3006	-57.9419	T6_00015.EDF
XBT 15	6-Jun-12	19:14	13.1742	-58.0057	T6_00016.EDF
XBT 16	6-Jun-12	20:09	13.0298	-58.0932	T6_00017.EDF
XBT 17	12-Jun-12	8:02	12.5378	-58.2201	T6_00018.EDF
XBT 18	12-Jun-12	9:03	12.3416	-58.2583	T6_00019.EDF
XBT 19	12-Jun-12	9:59	12.1553	-58.297	T6_00020.EDF
XBT 20	12-Jun-12	10:58	11.9615	-58.3382	T6_00021.EDF
XBT 21	16-Jun-12	22:27	11.8001	-58.6301	T6_00022.EDF
XBT 22	16-Jun-12	23:25	11.9491	-58.7401	T6_00023.EDF
XBT 23	17-Jun-12	3:41	12.3228	-59.0368	T6_00024.EDF
XBT 24	17-Jun-12	4:37	12.4724	-59.1516	T6_00025.EDF
XBT 25	17-Jun-12	8:46	12.7356	-59.3737	T6_00026.EDF

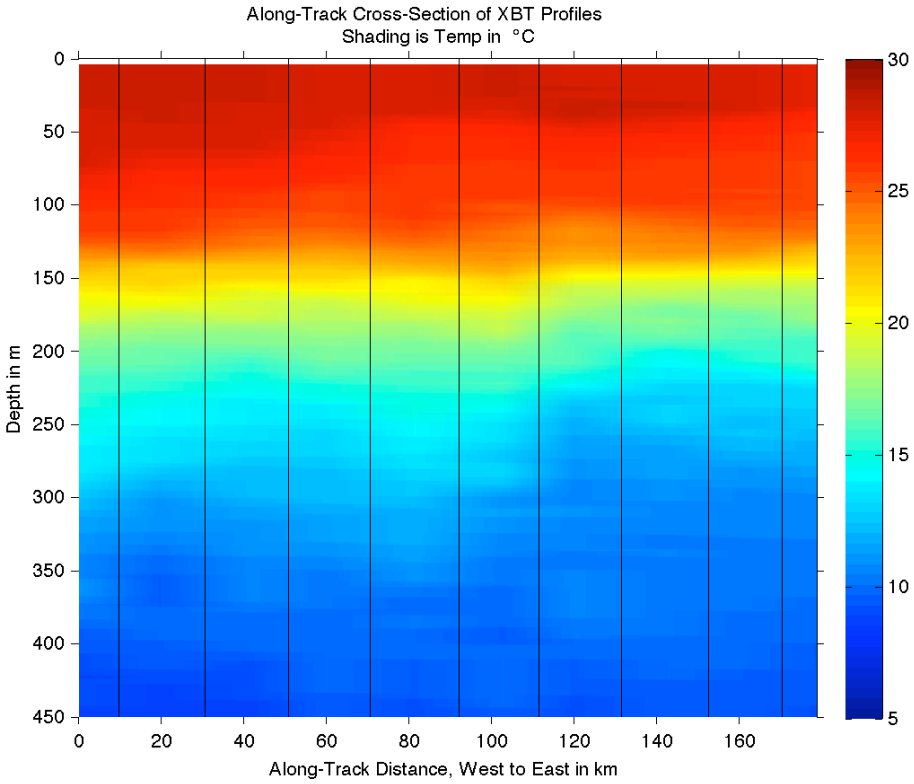


Figure 3. The subsurface temperature field along the west-east transect.

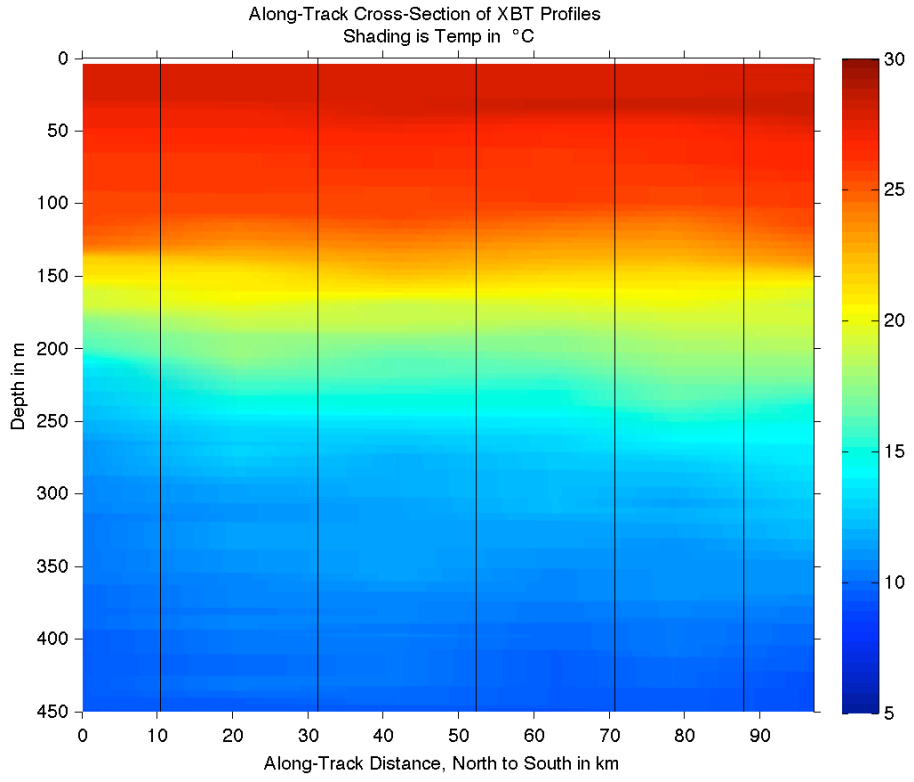


Figure 4. The subsurface temperature field along the first north-south transect.

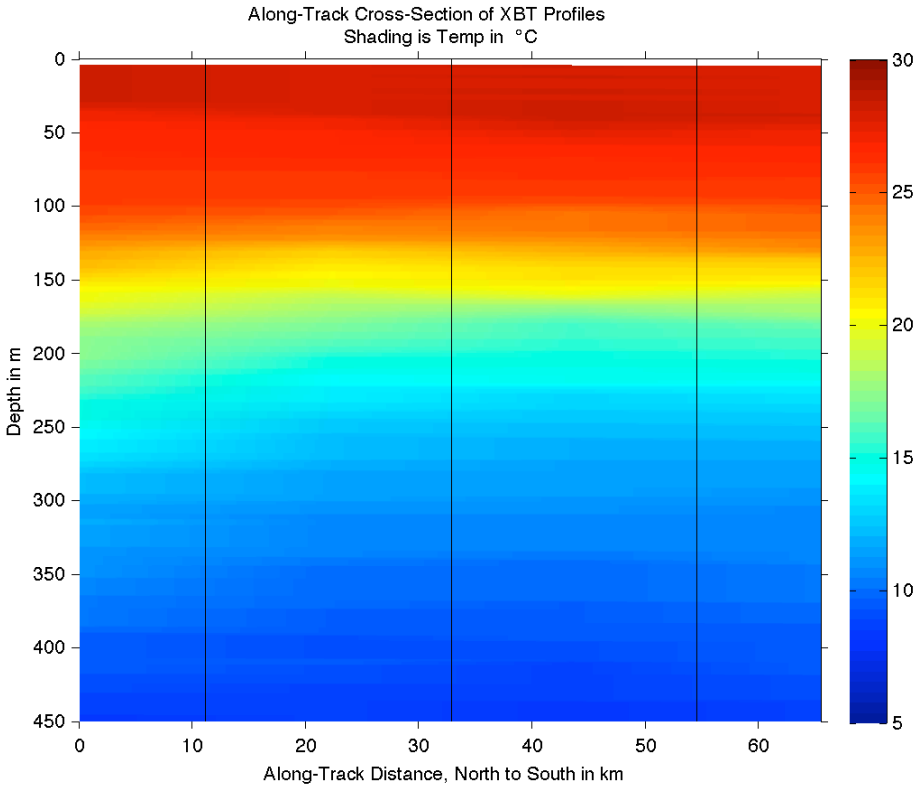


Figure 5. The subsurface temperature field along the second north-south transect.

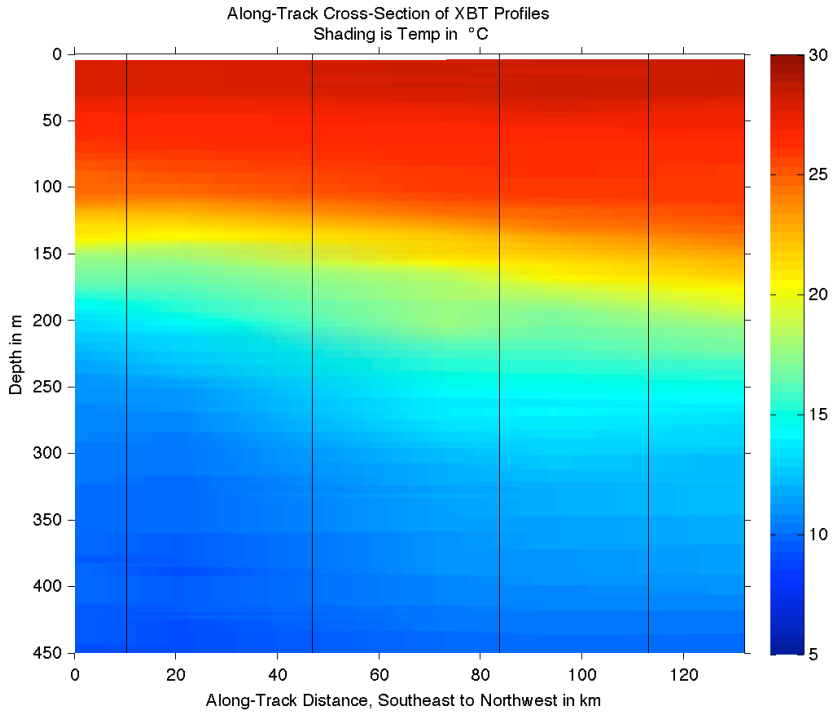


Figure 6. The subsurface temperature field along the southeast-northwest transect.

3. CTD Survey

Because XBTs only provide temperature measurement, 7 CTD casts were made to observe vertical profiles of other physical and biochemical properties. The first 2 casts were made at the same location (Manon in Site A) over the course of one week to search for temporal variability. Minimal variability was found in temperature, salinity, and oxygen concentration. CTD stations 2, 3, and 4 were single casts completed at study sites after the completion of MOCNESS tows and Jason dives. The remaining casts at stations 5 and 6 were completed en route to Barbados in conjunction with XBT casts to enhance the temperature transects and provide a salinity profile. Figure 7 shows their locations, while Table 2 lists the exact location and time of these casts. The time for each CTD cast varied from 4 hours for the deep water stations to 2 hours for the shallower stations.

CTD profiles for the entire columns and their upper 500-m zoom-in (Figure 8-22) at all 6 stations show some common features:

(1) the thermocline is at ~ 120 m;
(2) there is a subsurface (~150 m) salinity maxima, which is about 3-4 unit saltier than surface salinity;
(3) there is a subsurface chl-a maxima at about 50-75m;
(4) profiles from downcast and upcast agree to each other very nicely, suggesting a rather stable vertical structure in hydrographic condition.

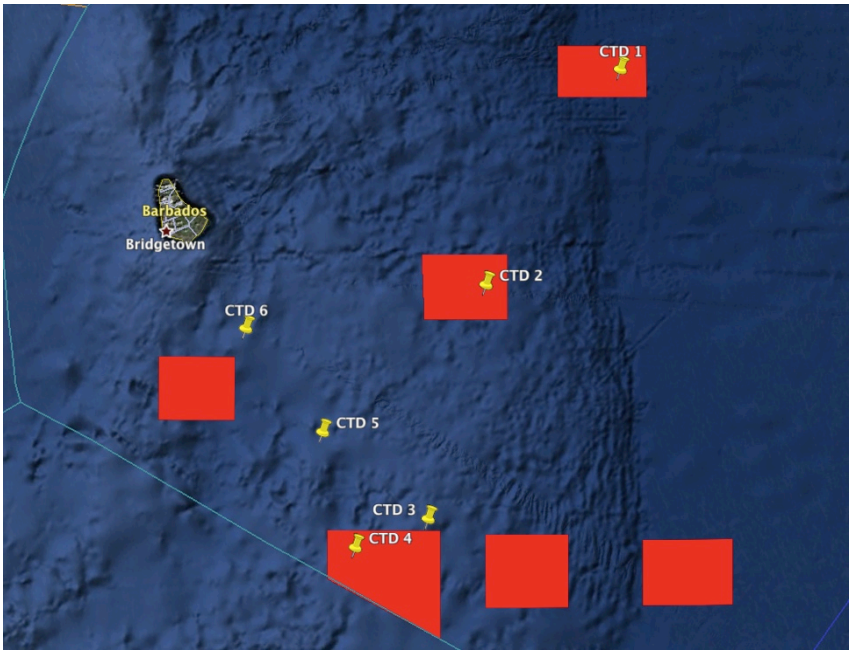


Figure 7. Locations of 6 CTD stations.

Table 2 Location and time (in GMT) of each CTD cast.

Station	Date	Time (GMT)	Latitude	Longitude	Depth	Filename	Notes
CTD 1	3-Jun-12	22:20	13.7753	-57.543	4854m	at21-02001.cnv	Site Manon
CTD 1	10-Jun-12	0:50	13.7752	-57.543	4865m	at21-02002.cnv	CTD comparison at Manon after 7 days
CTD 2	12-Jun-12	4:08	12.8142	-58.1612	2406m	at21-02003.cnv	Site C
CTD 3	12-Jun-12	14:50	11.7718	-58.4257	1535m	at21-02004.cnv	Western Site F
CTD 4	16-Jun-12	0:30	11.6435	-58.7578	1317m	at21-02005.cnv	Eastern Site F
CTD 5	17-Jun-12	0:55	12.158	-58.9062	1666m	at21-02006.cnv	Transit
CTD 6	17-Jun-12	5:36	12.619	-59.259	1321m	at21-02007.cnv	Transit

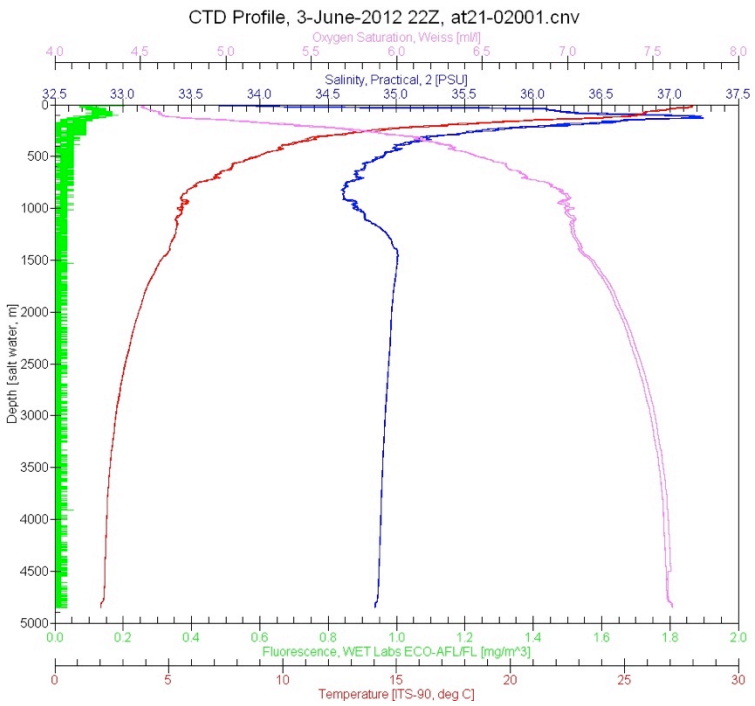


Figure 8. Profiles of temperature, salinity, oxygen and florescence at CTD station 1.

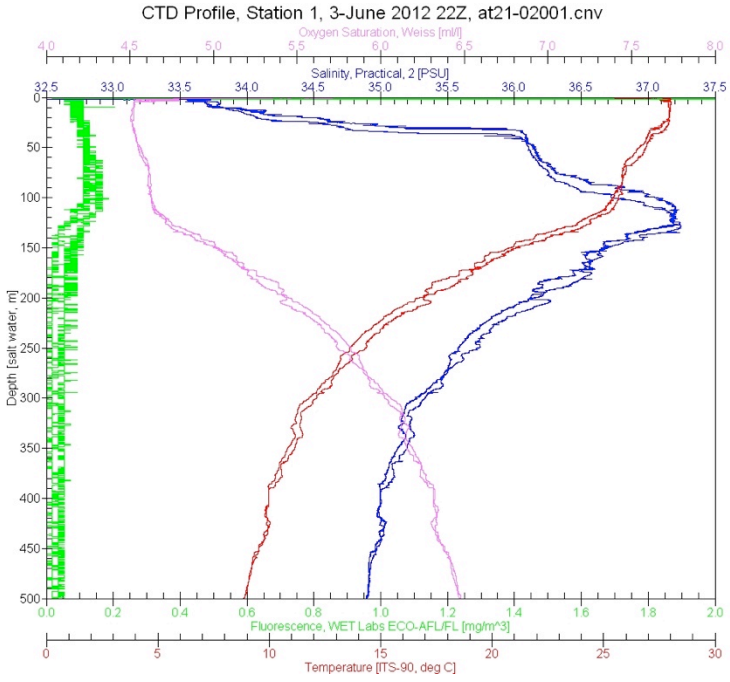


Figure 9. Profiles of temperature, salinity, oxygen and florescence at CTD station 1, first 5

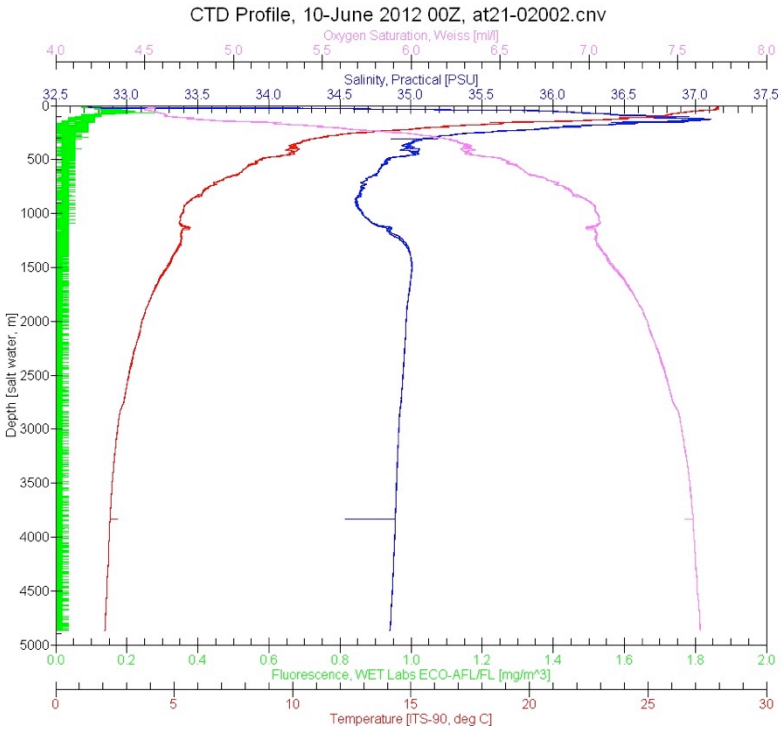


Figure 10. Profiles of temperature, salinity, oxygen and florescence at CTD station 1.

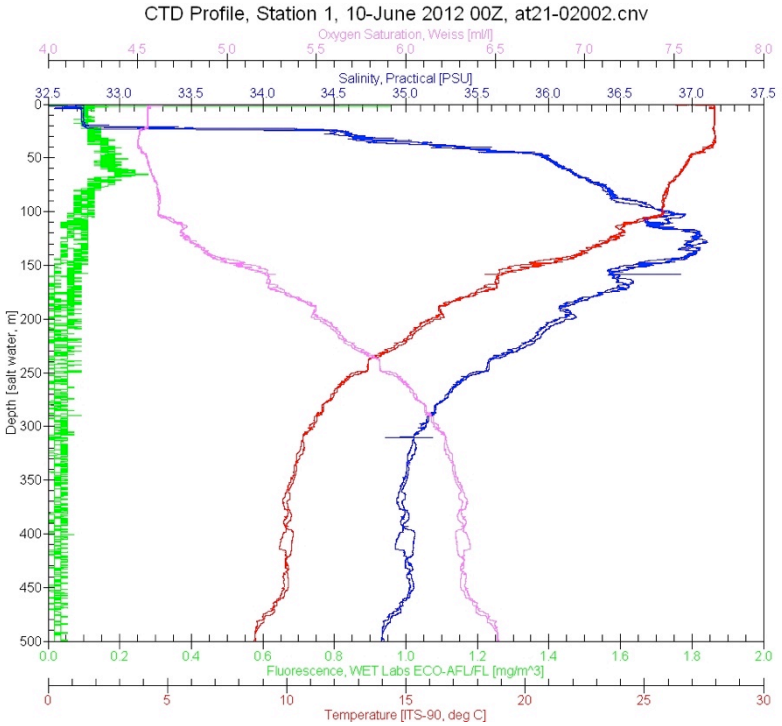


Figure 11. Profiles of temperature, salinity, oxygen and florescence at CTD station 1, first 500m.

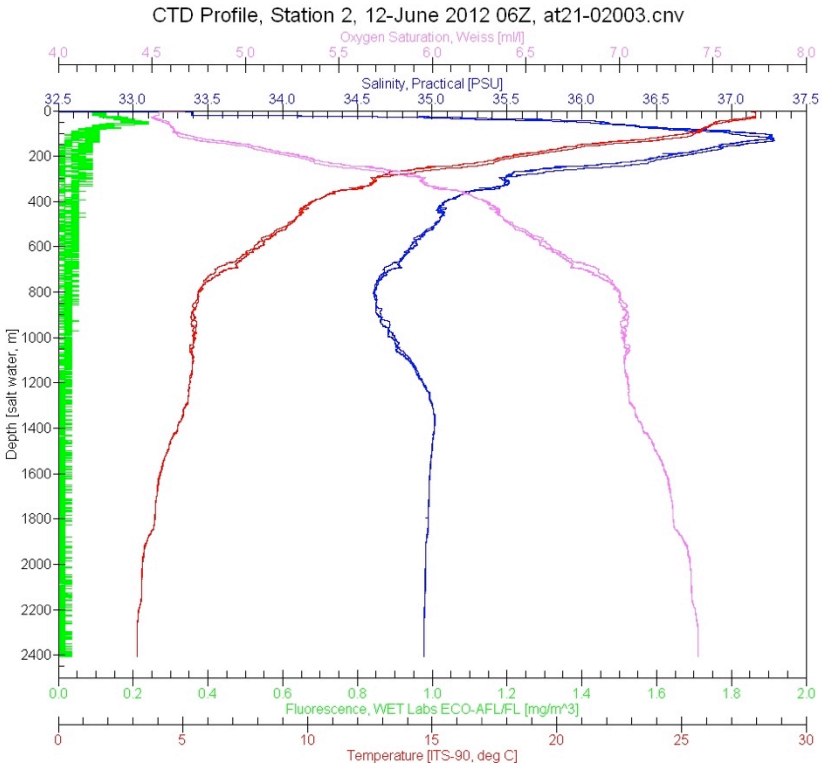


Figure 12. Profiles of temperature, salinity, oxygen and florescence at CTD station 2.

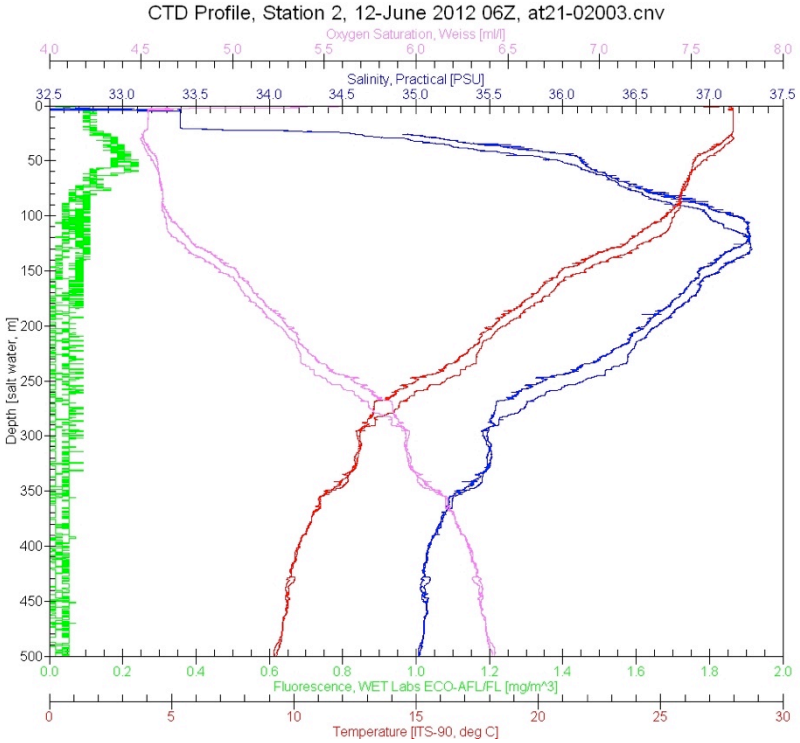


Figure 13. Profiles of temperature, salinity, oxygen and florescence at CTD station 2, first 500m.

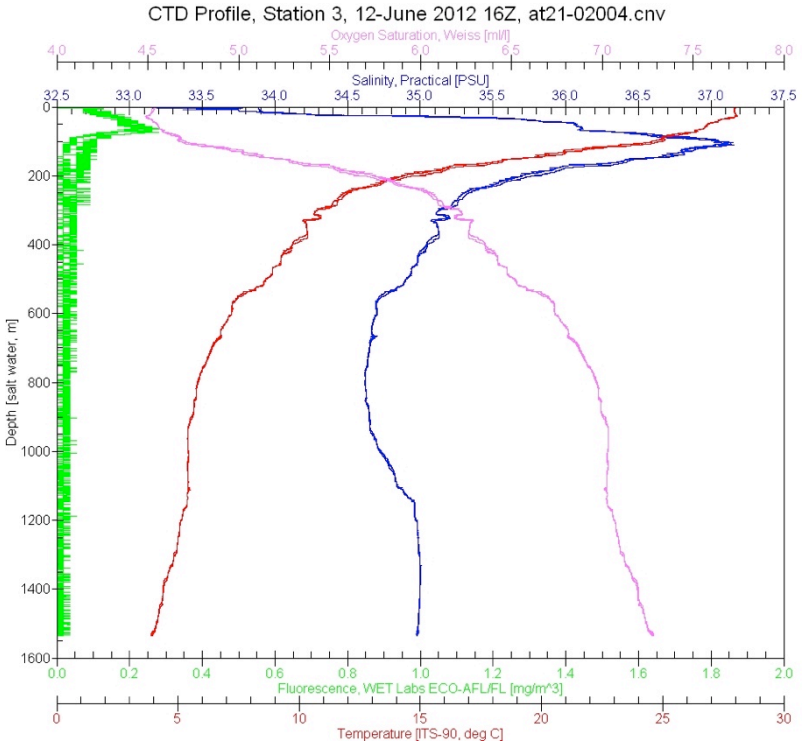


Figure 14. Profiles of temperature, salinity, oxygen and florescence at CTD station 3.

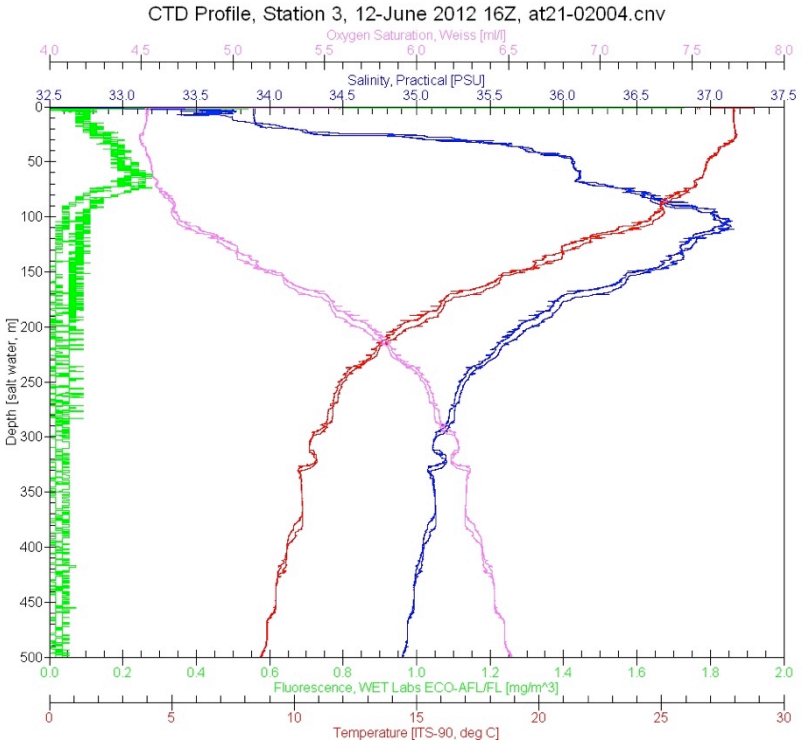


Figure 15. Profiles of temperature, salinity, oxygen and florescence at CTD station 3, first 500m.

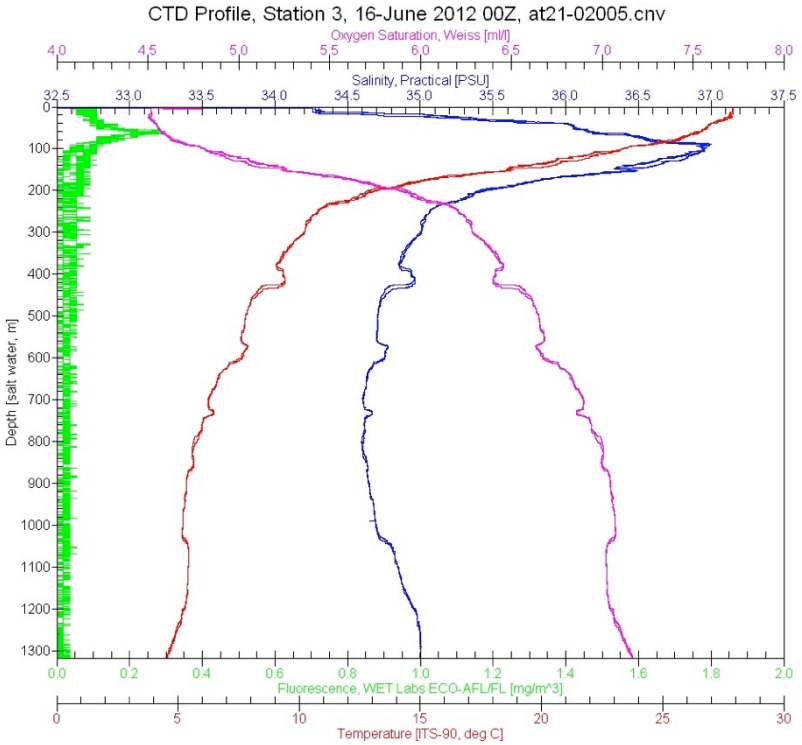


Figure 16. Profiles of temperature, salinity, oxygen and florescence at CTD station 4.

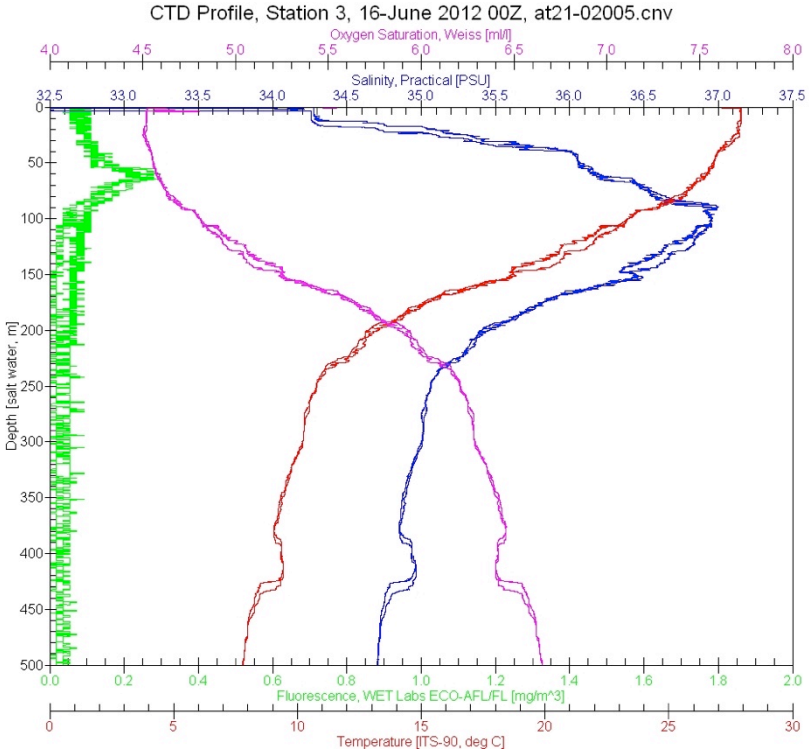


Figure 17. Profiles of temperature, salinity, oxygen and florescence at CTD station 4, first 500m.

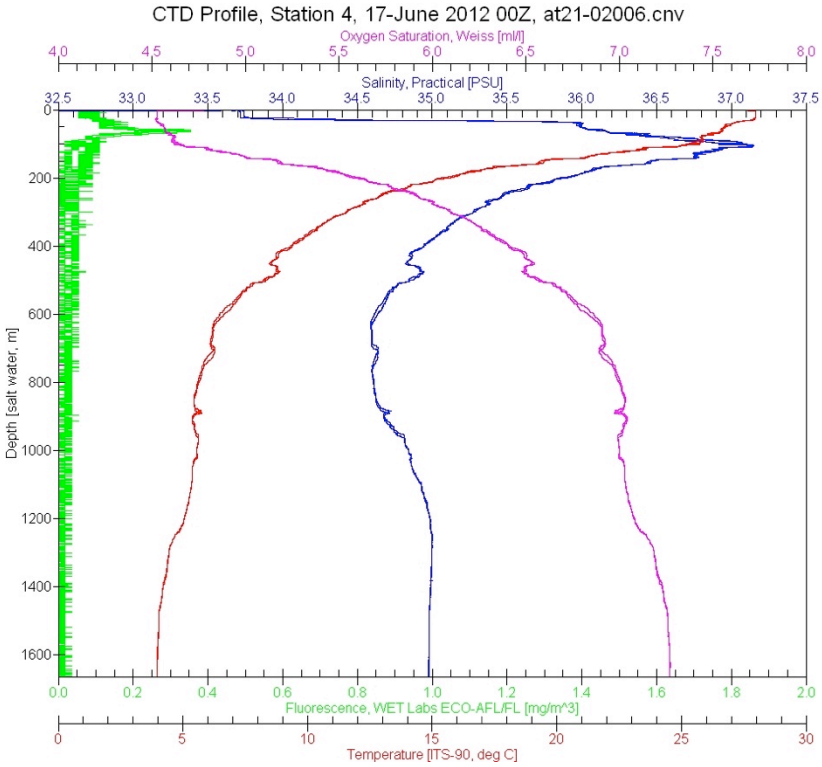


Figure 18. Profiles of temperature, salinity, oxygen and florescence at CTD station 5.

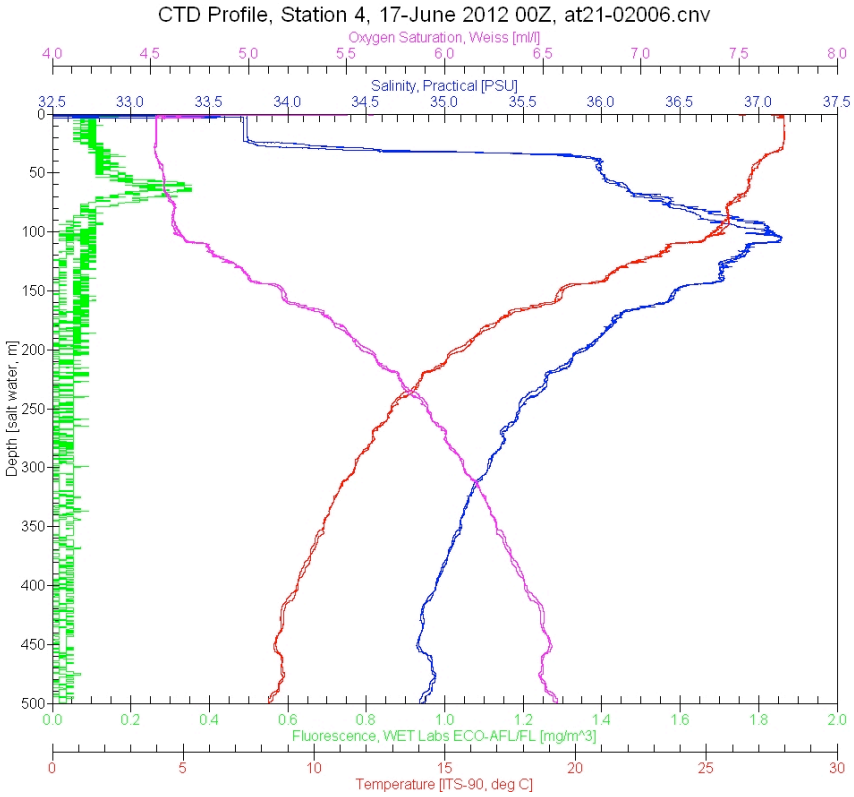


Figure 19. Profiles of temperature, salinity, oxygen and florescence at CTD station 5, first 500m.

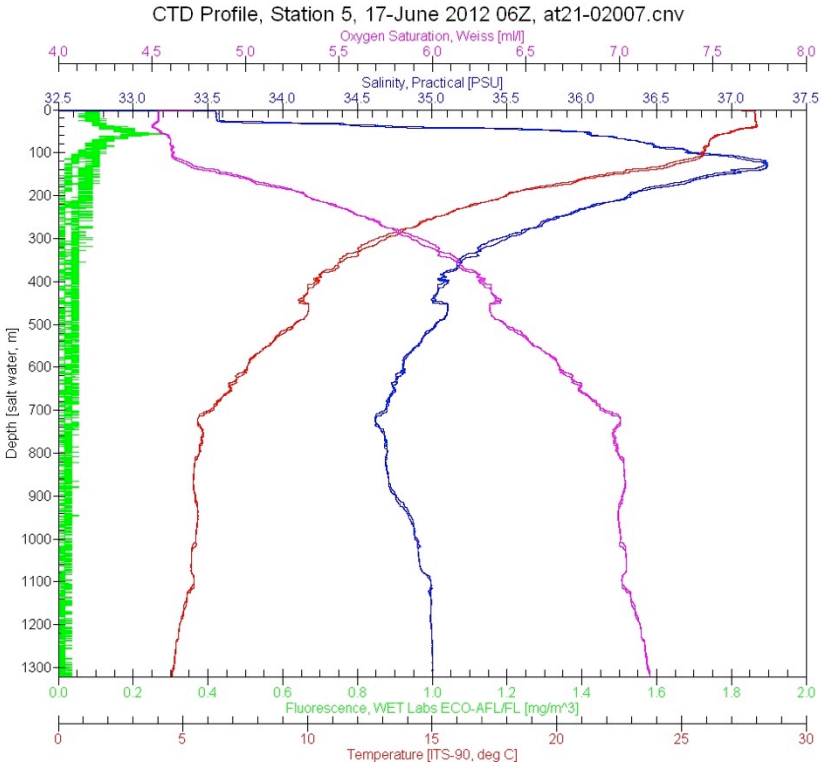


Figure 20. Profiles of temperature, salinity, oxygen and florescence at CTD station 6.

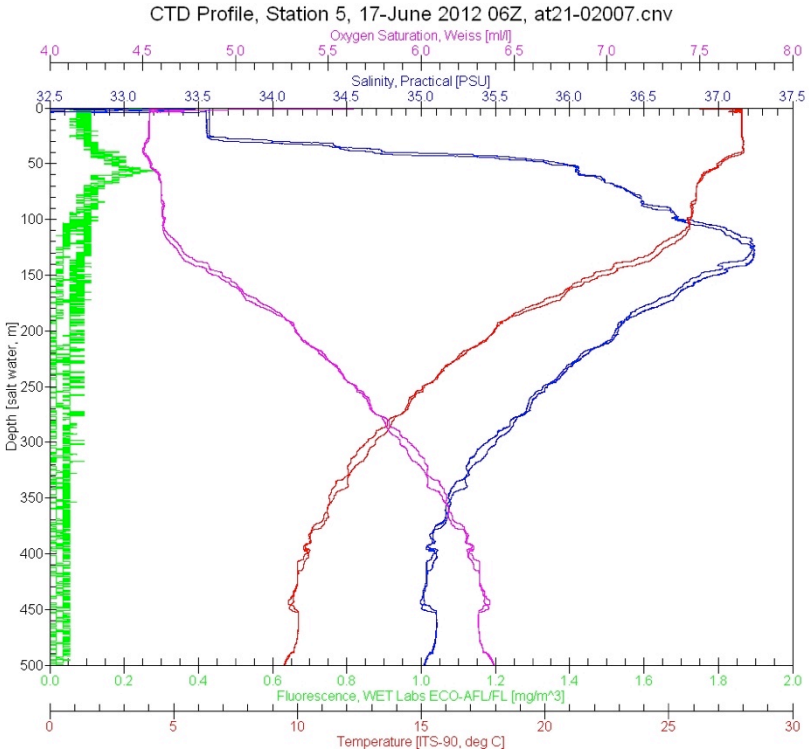


Figure 21. Profiles of temperature, salinity, oxygen and florescence at CTD station 1, first 500m.

Mooring Team

(David Eggleston, Brandon Puckett, Ashlee Lillis, Becky Gericke; NC State University)

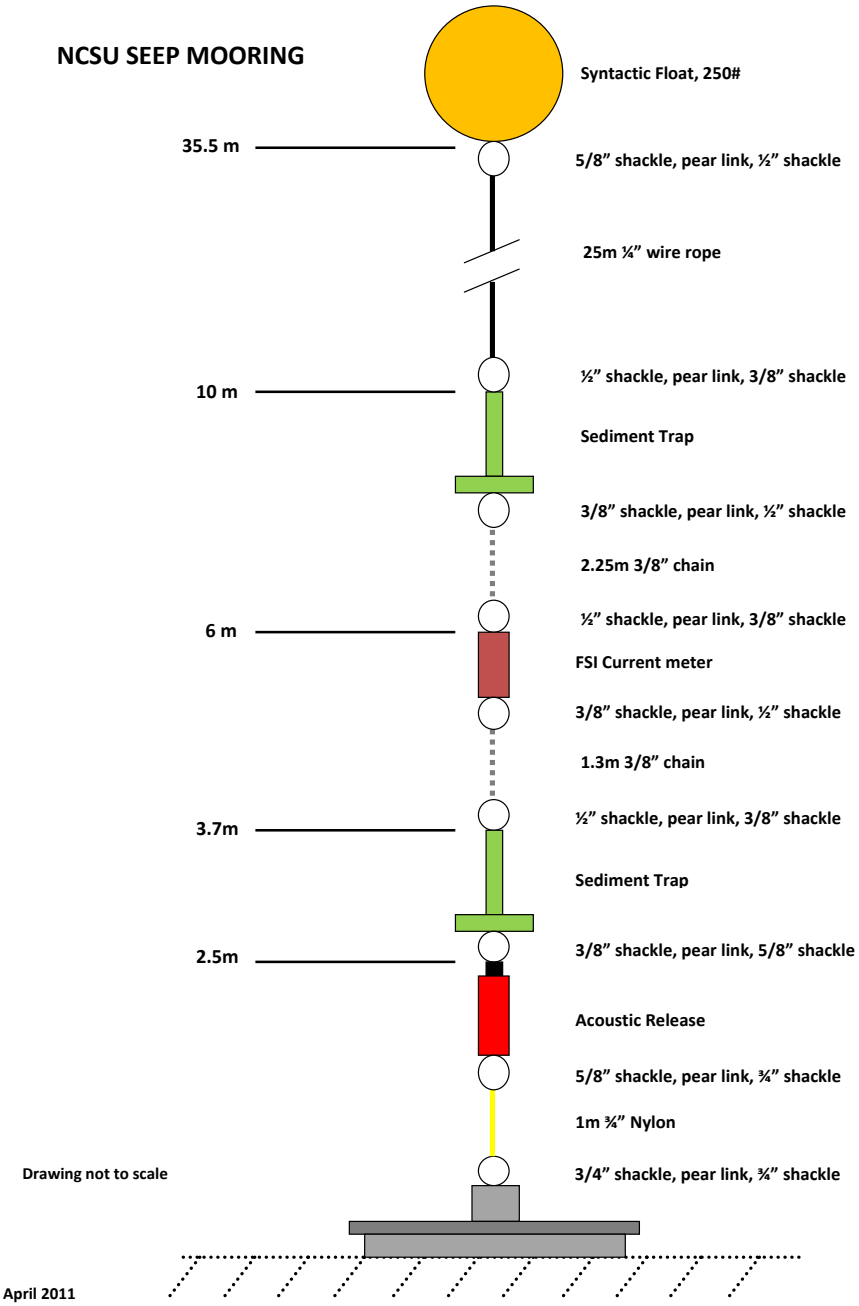
Summary of Objectives: The main objective was to retrieve moorings deployed during mid-May 2011 at 3 seep sites (El Pilar, Orenoque A, and Orenoque B) located ~100-200 nm south of Barbados. During leg 2 (June 7-17, 2012) of the cruise, we were unable to retrieve the moorings because they were deployed in Trinidad and Tobago waters where we do not have clearance. We are currently seeking clearance and Mooring Team personnel (Ms. Becky Gericke) participated in a subsequent cruise (June 21-July 11, 2012; PI: Debbie Smith) that was poised to recover the moorings for transit back to WHOI, with subsequent shipment to Raleigh, NC for refurbishment for subsequent August or September deployment in the Gulf of Mexico.

The Mooring Team did not receive clearance to retrieve moorings on the "Debbie Smith" cruise. We are investigating other options to retrieve moorings.

Because we were unable to retrieve the moorings due to international clearance issues, the Mooring Team participants that joined leg 2 of the cruise assisted all other teams with their specific scientific objectives. Mooring Team participants assisted with (1) MOCNESS (larval sampling net) deployment, retrieval, and winch operations, (2) processing, identification, and cataloging of larval samples, (3) CTD and XBT deployment and retrieval, (3) ROV (JASON) exploration and video recording, and (4) biological sample sorting of deep sea invertebrates for genetic analyses. The Mooring Team also collected juvenile bivalve samples of opportunity for subsequent geochemical analyses to compliment the genetic and hydrodynamic modeling components of this project.

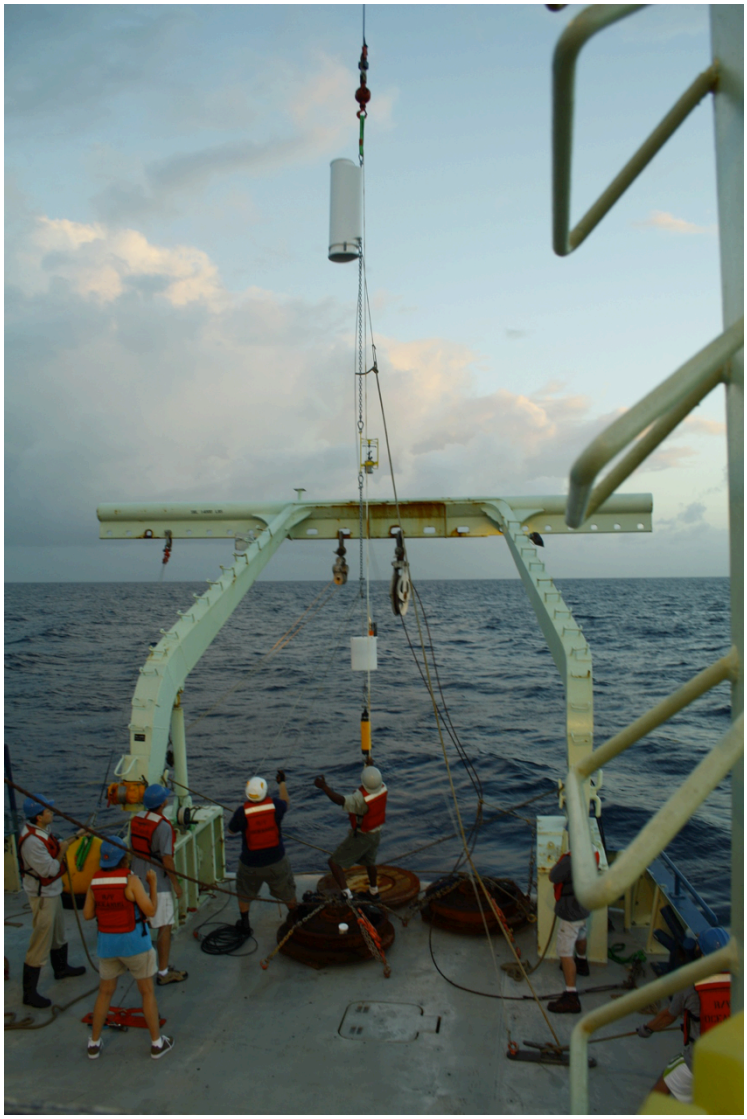
The Mooring Team participated in the "Art and Science at the Moment of Discovery" initiative implemented by Cindy Van Dover. The Mooring Team (Brandon Puckett) took photos for a photo essay themed "All Hands on Deck" that was later presented to the ship's crew, scientists, and artists.

Moorings


NCSU SEEP MOORING
Syntactic Float, 250#
35.5 m
5/8” shackle, pear link, ½” shackle
25m ¼” wire rope
10 m
½” shackle, pear link, 3/8” shackle
Sediment Trap
3/8” shackle, pear link, ½” shackle
2.25m 3/8” chain
6 m
½” shackle, pear link, 3/8” shackle
FSI Current meter
3/8” shackle, pear link, ½” shackle
1.3m 3/8” chain
3.7m
½” shackle, pear link, 3/8” shackle
Sediment Trap
2.5m
3/8” shackle, pear link, 5/8” shackle
Acoustic Release
5/8” shackle, pear link, ¾” shackle
1m ¾” Nylon
Drawing not to scale
3/4” shackle, pear link, ¾” shackle
April 2011

Component/Element	Length (cm)	Wt. in water (lb.)	Buoyancy	HOB (m)	NOTES
Syntactic Float	N/A	N/A	250	35.4	MSI SF-30
5/8" Sh-Sl-Sh 1/2"	23.5	3.1			**Sh**ackle-**Sl**ing Link-**Sh**ackle
Wire Rope 1/4" dia.	2500	7.8			
1/2" Sh-Sl-Sh 3/8"	21.1	2.2			
Sediment Trap	130	30.9		9.9	
3/8" Sh-Sl-Sh 1/2"	21.1	2.2			
3/8" Chain	225	9.3			
1/2" Sh-Sl-Sh 3/8"	21.1	2.2			
FSI Current Meter	55	11		5.9	
3/8" Sh-Sl-Sh 1/2"	21.1	2.2			
3/8" Chain	130	5.3			
1/2" Sh-Sl-Sh 3/8"	21.1	2.2			
Sediment Trap	100	13.2		3.7	
3/8" Sh-Sl-Sh 5/8"	22.4	3.1			
Acoustic Release	66	11		2.4	5/8" shackles coupled to release via 5/16" shackles
5/8" Sh-Sl-Sh 3/4"	25.9	4.8			
3/4" Nylon	100	0.5			w/ Thimbles
3/4" Sh-Sl-Sh 3/4"	27	5.7			
	TOTAL	116.7	**NET** 133.3		**All Sling Links 5/8"**
1-Wheel Anchor	25.4	783			**All heights are to top of component**

5/8" Sling Link	9
5/8" Shackle	3
1/2" Shackle	6
3/8" Shackle	6
3/4" Shackle	3
All with SS cotter pins	18
1/4" Wire Rope 25m	1
3/8" Chain 2.25m	1
3/8" Chain 1.3m	1
3/4" Nylon w/Thimbles 1m	1



Mooring Shipment
Crate 1: 75 " L X 40 " H X 44" deep
Crate 2: 74" L X 55" H X 30 " deep

Mooring Specs
Water weight (w/o train wheel): ~116 lbs
Air weight: ~165 lbs

Personnel

Science

Dr. Cindy Lee Van Dover, Chief Scientist
Dr. Jacob Bailey, University of Minnesota
Mr. Bernard Ball, Jr. , Duke University
Dr. Laura Brothers, U.S. Geological Society
Ms. Amy Burgess, University of Oregon
Mr. Jameson Clarke, Duke University
Dr. Clifford Cunningham, Duke University
Dr. Jens Carlsson, University College Cork
Ms. Brittany Dlouhy, University of Oregon
~~Dr. David Eggleston, North Carolina State University~~
Dr. Richard Emlet, University of Oregon
Mrs. Mary Edna Fraser, Artist/Observer
~~Dr. Ruoying He, North Carolina State University~~
Ms. Laurel Hiebert, University of Oregon
Ms. Terra Hiebert, University of Oregon
Ms. Karen Jacobsen, In Situ Science Illustration
Ms. Marley Jarvis, University of Oregon
Dr. Didier Jollivet, CNRS Station Biologique de Roscoff
Ms. Natasha Kermani, Guest – Duke University
Ms. Abigail LaBella, Duke University
Ms. Ashlee Lillis, North Carolina State University
Ms. Jessica Lowder, North Carolina State University
Dr. Svetlana Maslakova, University of Oregon
Ms. Natalie Minik, Duke University
Ms. Sharon Moise, Barbados Community College
Ms. Chung Mok, Guest – Duke University
Mr. Mark Oates, University of Oregon
Ms. Laura Peteiro, Oregon Institute of Marine Biology
Dr. Sophie Plouviez, Duke University
Mr. Brandon Puckett, North Carolina State University
Ms. Elizabeth Siddon, University of Alaska Fairbanks
Ms. Jenna Valley, University of Oregon
Dr. Craig Young, University of Oregon
Ms. Jamie Wagner, Duke University
Mr. Joseph Zambon, North Carolina State University

SSSG

Ms. Allison Heater, Woods Hole Oceanographic Institution
Ms. Catie Graver, Woods Hole Oceanographic Institution

JASON

Mr. Scott McCue, Woods Hole Oceanographic Institution

Mr. Dara Scott, Woods Hole Oceanographic Institution
Mr. Hugh Popenoe, Woods Hole Oceanographic Institution
Mr. Scot Hansen, Woods Hole Oceanographic Institution
Mr. Korey Verhein, Woods Hole Oceanographic Institution
Mr. Nile Kevis-Stirling, Woods Hole Oceanographic Institution
Mr. Edward Dow III, Woods Hole Oceanographic Institution
Mr. Alberto Collasius, Jr., Woods Hole Oceanographic Institution
Mr. Robert Elder, Woods Hole Oceanographic Institution

Crew

Captain AD Colburn
Peter Leonard, Chief Mate,
Logan Johnsen, Second Mate
Rick Beam, Third Mate
Tim Logan, Comm E
Patrick Hennessy, Bosun
Jerry Graham, AB
Jim McGill, AB
Patrick Neumann, AB
Ronnie Whims, AB
Mark Anderson, Ordinary Seaman
Chris Morgan, Chief Engineer
Marcel Vieira, First Assnt Eng
JT Walsh, Second Assnt Eng
Mike Spruill, Third Assist Eng
Darren Whittaker, Oiler
Matthew Slater, Oiler
David Christensen, Oiler
Leroy Walcott, Wiper
Larry Jackson, Steward
Mark Nossiter, Cook
Janusz Mlynarski, Mess Attendant

BARBADOS SCIENCE PERSONNEL BY LEG

BERTHS	**Leg 1**	**Leg 2**
1	Van Dover	Van Dover
2	Cunningham	Ball
3	Carlson	Clarke
4	J Bailey	Moise
5	LaBella	LaBella
6	Plouviez	Plouviez
7	Jacobsen	Jacobsen
8	Jollivet	Jollivet
9	ME Fraser	N Kermani
10	Brothers	Brothers
11	Wagner	Wagner
12	Mok	Minik
13	~~Eggleston~~	Jessica Lowder
14	~~Ashlee Lillis~~	Ashlee Lillis
15	~~Ruoy He~~	Brandon Puckett
16	~~Zambon~~	Zambon
17	Young	Maslakova
18	Siddon	
19	Laura Peteiros	Richard Emlet
20	Amy Burgess	Amy Burgess
21	Laurel Hiebert	Laurel Hiebert
22	Mark Oates	Janna Valley
23	Terra Hiebert	Tara Hiebert
24	Marley Jarvis	Brittney Dloughy

Artists

Seven artists joined the expedition and were invited to respond to the following prompts:

1) Create one piece revealing the essence of the moment of discover, with a short narrative about the piece.
2) Collaborate with a scientist chosen by the artist to create a piece that reflects the science that inspired the artist, with a short narrative about the piece.
3) Artists all share the same visual experience (in the control van) and create a piece from this shared experience.

The art team included: professional artists Karen Jacobsen, Mary Edna Fraser, Natasha Kermani, art students Natalie Minik, Jolene Mok, and Sharon Moise (Sharon is from St Lucia, studying in Barbados), and Brandon Puckett, a scientist/photographer from NCSU. Artwork will be presented in an on-line exhibition and will be the basis for a proposal for a traveling exhibition.