NOAA PISCES Cruise Leg4 Final Report

Period covered: 9/25/2010- 2300 hrs 10/4/2010

Overview:

The NOAA ship Pisces conducted cruise 10-5-Leg 4 from 9/25/2010 to 10/4/2010 as part of NOAA's response to the BP oil spill in the Gulf of Mexico. Aboard the vessel were scientists and technical staff representing NOAA, academia and other branches of the Federal Government. The vessel was equipped with four major capabilities to conduct response efforts. These included a multi-corer to collect sediment samples with a well preserved interface; a CTD rosette equipped with an SBE-43 oxygen sensor, Aquatracka flourometer and 21-24 ten liter Niskin bottles; a towed camera system for imaging of the sea floor; and an EK 60 split beam sonar capable of imaging hydrocarbon seeps. Each of these tools was utilized as determined by mission priorities, as described in the remainder of this report. An overview of the sampling stations is provided in Fig 1.

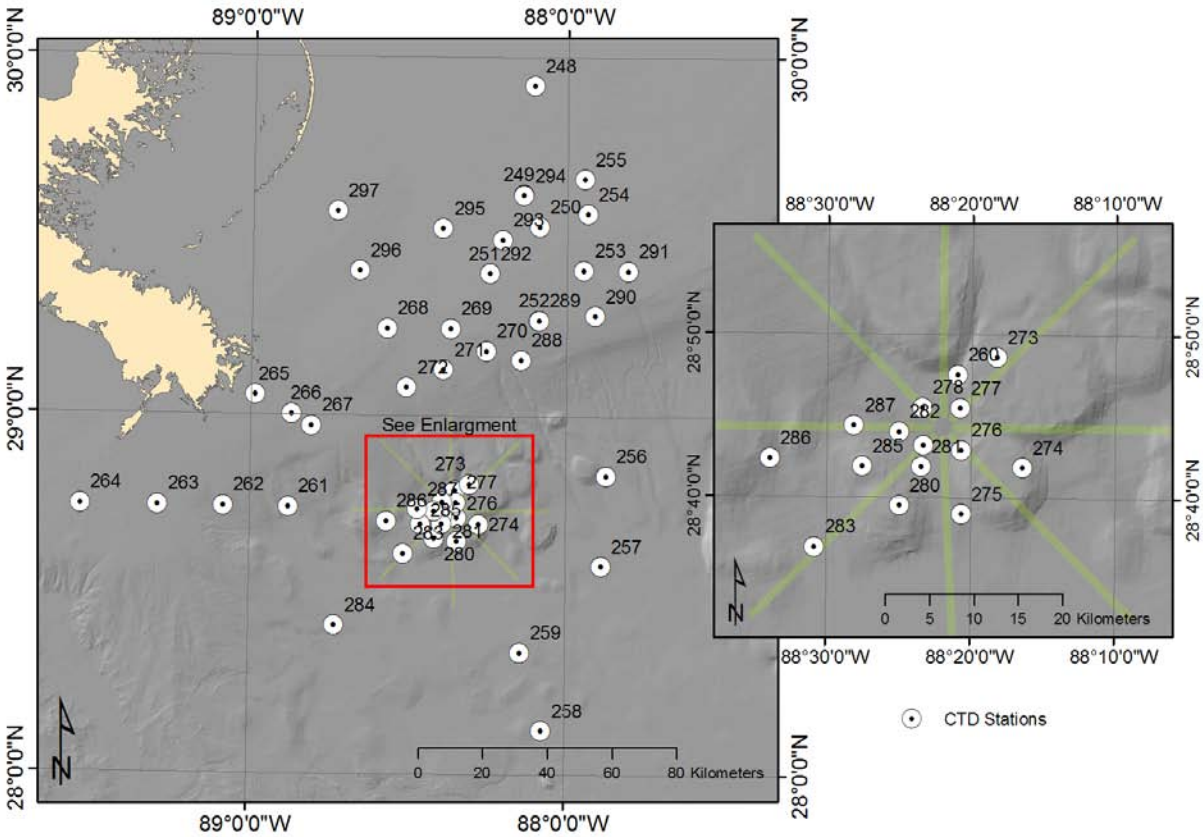

Figure 1. Overview of stations occupied and tow line permissions during the Subsurface Hydrocarbon Abundance and Mobility Study (SHAMS) of the R/V Pisces.

Table 1. Vessel science party

Name	Position	Email/Phone
David Valentine, Ph.D.	Chief Scientist	valentine@geol.ucsb.edu
JP Walsh, Ph.D.	Sediment team lead	805-729-5431
David Finlayson, Ph.D.	Accoustic team lead	
Roberta Hansman, Ph.D.	CTD team lead	
Ken Feldman	Camera Sled	
Erik Quiroz	Chemistry Technician	
John Nugent	NRDA Rep	
Ahnnie Lee	Data Manager	
Kevin Mouyard	Water Sampler	
Whitney Williams	Water Sampler	
Mary White	Water Sampler	
Laughlin Siceloff	Water Sampler	
David Newman	GCMS Tech	
Michelle Page	GCMS Tech	
Sam Waltman	Entrix Representative	
LT Liz Crapo	Blogger	

Table 2. Operations Performed

Data Collection	Collected (Y/N)?
CTD Casts	Y
Fluorometry	Y
Dissolved Oxygen	Y
Methane	Y
Sampling – TPH	Y
Sampling – VOA	Y
GCMS	N
Coring	Y
GCMS	Y
Sampling – TPH	N
Acoustics	Y
Camera Tow	Y

Water Column (CTD) Stations:

The Pisces occupied 36 of the requested water column stations with the stations and relevant analyses/samples shown in Table 3. Water samples were collected for hydrocarbon analyses beginning with PC 265, when the directive was received (except for one station where confusion at shift change prevented such sampling). The science party was not initially equipped for such sampling, but fortunately was able to identify sufficient spare bottles to conduct the needed sampling.

Table 3. Water Column Sampling Stations

Site ID	PC Station	Vessel	Lat	Lon	Hydrocarbon analysis sample	C1-C3	Winkler	NRDA
SW-68-PC	PC265	Pisces	29.056664	-88.968618	yes	yes	yes	
MW-03-PC	PC266	Pisces	29.002270	-88.870100	yes	yes	yes	
MW-04-PC	PC267	Pisces	28.969820	-88.805384	yes	yes	yes	
SW-01-PC	PC268	Pisces	29.247683	-88.572991	yes	yes	yes	
SW-58-PC	PC269	Pisces	29.258434	-88.390647	yes	yes	yes	
MW-06-PC	PC270	Pisces	29.180940	-88.253170	no	yes	yes	
MW-05-PC	PC271	Pisces	29.127103	-88.388876	yes	yes	yes	
DW-03-PC	PC272	Pisces	29.077879	-88.503813	yes	yes	yes	
DW-26-PC	PC273	Pisces	28.810442	-88.303914	yes	yes	yes	
DW-17-PC	PC274	Pisces	28.698915	-88.274679	yes	yes	yes	
DW-06-PC	PC275	Pisces	28.650912	-88.342173	yes	yes	yes	
DW-09-PC	PC276	Pisces	28.719600	-88.344700	yes	yes	yes	
DW-15-PC	PC277	Pisces	28.757800	-88.344800	yes	yes	yes	
DW-19-PC	PC278	Pisces	28.757200	-88.388800	yes	yes	yes	yes
DW-11-PC	PC279	Pisces	28.719800	-88.388400	yes	yes	yes	
DW-22-PC	PC280	Pisces	28.658852	-88.414719	yes	yes	yes	
DW-08-PC	PC281	Pisces	28.697911	-88.390141	yes	yes	yes	
DW-13-PC	PC282	Pisces	28.733530	-88.416233	yes	yes	yes	
DW-07-PC	PC283	Pisces	28.615298	-88.512875	yes	yes	yes	yes
DW-24-PC	PC285	Pisces	28.697111	-88.456948	yes	yes	yes	
DW-27-PC	PC286	Pisces	28.704874	-88.565128	yes	yes	yes	
DW-55-PC	PC287	Pisces	28.739131	-88.468275	yes	yes	yes	yes
DW-04-PC	PC288	Pisces	29.156960	-88.143310	yes	yes	yes	
MW-07-PC	PC289	Pisces	29.266036	-88.087740	yes	yes	yes	
MW-08-PC	PC290	Pisces	29.276820	-87.912600	yes	yes	yes	
MW-09-PC	PC291	Pisces	29.404640	-87.802294	yes	yes	yes	
SW-07-PC	PC292	Pisces	29.396282	-88.244406	yes	yes	yes	

SW-13-PC	PC293	Pisces	29.492210	-88.203740	yes	yes	yes	
SW-21-PC	PC294	Pisces	29.616450	-88.137820	yes	yes	yes	
SW-12-PC	PC295	Pisces	29.521086	-88.394224	yes	yes	yes	
SW-11-PC	PC296	Pisces	29.417429	-88.642381	yes	yes	yes	
SW-44-PC	PC297	Pisces	29.587115	-88.711985	yes	yes	yes	
DW-02-PC	PC261	Pisces	28.742365	-88.877609	no	yes	yes	
DW-01-PC	PC262	Pisces	28.743543	-89.082284	no	yes	yes	
MW-01-PC	PC264	Pisces	28.744378	-89.533757	yes	yes	yes	
MW-02-PC	PC263	Pisces	28.744428	-89.286962	no	yes	yes	

Seven stations assigned to the Pisces were not occupied. In one case this was because the site was occupied by one of the Development Drillers still on site, in one case because the water depth was too shallow for the vessel, and in five cases because of inclement weather.

Table 4. Stations not sampled

PLANNED STATIONS NOT SAMPLED			
Station	Lat	Long	
DW-16-PC*	28.738140	-88.365945	
SW-55-PC**	29.776698	-88.790034	
SW-26-PC***	29.783727	-88.397850	
SW-28-PC***	29.840116	-88.184413	
SW-30-PC***	29.916647	-88.086404	
SW-38-PC***	30.050105	-88.086130	
SW-40-PC***	30.046358	-88.401523	

* unoccupiable; wellhead

** station dropped due to depth

*** station dropped due inclement weather

In addition to the assigned stations several other stations were occupied. Many of these were coring stations, stations assigned by SMU under a now-defunct sampling scheme, casts of opportunity or shakedown casts.

Table 5. Additional CTD Stations

PISCES EXTRA STATIONS						
Station	Lat	Long	Hydrocarbon	C1-C3	Winkler	NRDA
PC248	29.920667	-88.105000				
PC249	29.618333	-88.137667				
PC250	29.527333	-88.086667				
PC251	29.396500	-88.243000				
PC252	29.266167	-88.088167				
PC253	29.406333	-87.944833				
PC256	28.833300	-87.871000				
PC254	29.564000	-87.933500				
PC255	29.660000	-87.943833				
PC257	29.618333	-88.137667		Yes	Yes	
PC258	28.112870	-88.076260		Yes	Yes	
PC259	28.340100	-88.140300		Yes	Yes	
PC260	28.791810	-88.349030		Yes	Yes	
PC284	28.414300	-88.728000	Yes	Yes	Yes	Yes

Coring Operations:

Sediment cores were collected as directed by SMU, until directives necessitated a halt to coring operations in favor of CTD casts. This summary describes the coring and sub-sampling procedures conducted aboard the R/V Pisces during this cruise. An Ocean Instruments MC800 Multicore (with 8 sub-cores) obtained from Woods Hole Oceanographic Institution was used during this cruise to sample the uppermost portion of the seabed. Dr. J.P. Walsh oversaw coring operations and sub-sampling, under the direction of the Chief Scientist. The Captain and crew directed deployment and recovery of the multicorer.

Deployment Procedure

Core tubes were cleaned and rinsed with seawater thoroughly before deployment and were secured to core shuttles with a collar, clips and electrical tape. The multicore shuttles were then mounted onto the multicore spider with a bolt and cotter pin. Depending on the number of samples required, 4-6 shuttle assemblies were secured to the corer, including 1-3 extra barrels per deployment in case of corer malfunction or difficult-to-core sediment (e.g., coarse sands). After cores were cocked and the ship was on station, the corer was deployed using the trawl wire through the stern A-frame (Fig. 1). A slack in the trawl cable and/or drop in cable tension were used as indications that the corer reached the seabed. Approximately 5 m of cable was spooled after seafloor impact to allow the weight of the corer to force the multicore spider into the sediments without the influence of ship heave. Cores were attempted at fourteen sites during the cruise (Table 1, Fig. 2), and all were successful except for two attempts at site

12 (Table 1) when the core impact could not be discerned because of the depth. The corer came up empty on these two occasions.

Tag lines were used to recover the core safely from the ocean. After the first day of operations, pressure-treated wood beams were secured between four leg pairs to prevent the cores from over penetrating the seabed. Coring operations had to be suspended on day 4 due to winch problems. The Pisces' traction winch had never been used prior to this cruise, and during a core recovery the level wind fed the trawl wire off of the spool leading to major cable tangle that required significant time for repair. Following this event and from direction from SMU, ship time focused on water sampling. The next and final core (~1380 m depth) was collected on day 7 (2 October GMT) of the cruise without complication.

Subsampling

When one or more good quality core(s) were obtained from a core deployment, they were prioritized for analysis in the following order: 1) Gas Chromatography Mass Spectrometry (GCMS), 2) sub-core for archiving, 3) core samples for microtoxicity testing or other environmental analyses, and 4) samples for interested scientists. The sub-sampling for the aforementioned analyses are described in the specific sections below:

Onboard GCMS and NRDA Sampling

On several cores, a sample of the water-sediment mixture above the seabed interface (typically 0-2 cm) was collected where a "flocculation layer" was evident. Using a stainless steel spoon rinsed with supernatant fluid, the water-sediment mixture was placed in a new 250-ml glass jar and homogenized. Then half of this material was placed into another jar for a duplicate sample. The primary jar was used for onboard GCMS analysis while the secondary jar was stored as a NRDA sample. After removal of the supernatant and flocculation layer, a sample of the surface sediment (0-2 cm) was placed into a jar using a stainless steel spoon and spatulas rinsed with supernatant fluid. The sample was then thoroughly homogenized and approximately half of the material was placed into another jar for a duplicate. Again, the primary jar was used for onboard GCMS analysis while the secondary jar was stored as a NRDA sample.

Sub-core

For most cores, a sub-core was collected from one of the core tubes. A 5-cm plastic core tube rinsed with seawater was inserted, capped, and extracted. Sub-core lengths ranged in size. The majority of supernatant was removed from the sub-core before it was stored in the ship's walk-in -20°C freezer. The samples have been stored in the sample archive.

Microtoxicity or Other Analyses

The supernatant (1 L where available) and surface sediment (0-3 cm) was removed from a core tube and placed in a new amber (typically 1 L) and clear (250 ml) glass jar, respectively. Seawater-rinsed Tygon tubing and stainless utensils were used to transfer materials. The supernatant jar was initially rinsed with the supernatant, then after overflowing the jar, it was capped to avoid air space. These samples may be used for microtoxicity or other analyses (grain size, TOC, TIC). The supernatant sample was

stored in the 4°C refrigerator and the sediment sample was frozen (-20°C). The intended distribution of collected sediment samples from cores were noted in the log sheets as appropriate. These samples may be used for a variety of analyses

Samples for Interested Scientists

Drs. Walsh and Valentine collected sediment samples from several cores. Walsh collected surface sediments (0-2 cm) from all sites, and the underlying 2-10 cm (2-cm intervals) at several locations. For the last two coring sites (PC 13 and PC14), an entire multicore tube was sectioned at 2-cm intervals. These sediment were placed in Whirlpak sample bags and stored in the 4°C environmental room. This material may be examined for grain-size distribution, water content, and radionuclide activities. At the last two core sites, a sub-sample of the homogenized microtoxicity surface sediment (see above) was placed into a new 50 cc centrifuge tube and placed in the -80°C freezer, for potential use in determining microbial community structure.

Table 6: Information for cores collected during the Pisces 10-5-leg 4 cruise.

Core Site	Latitude	Longitude	Depth	Date	Core Length (cm)
1	30.0504	-88.088	21.56	9/25/2010	33
2	29.9152	-88.0983	32.05	9/25/2010	14.5
3	29.62077	-88.1386	37.1	9/26/2010	13
4	29.52852	-88.08488	42.7	9/26/2010	18
5	29.39837	-88.24027	58.7	9/26/2010	29
6	29.27001	-88.09147	170	9/26/2010	66
7	29.40604	-87.94654	79	9/26/2010	42
8	29.56376	-87.93311	45	9/26/2010	14
9	28.83317	-87.86685	1984	9/26/2010	63
10	28.58287	-87.87568	2366	9/27/2010	52
11	28.09293	-88.06811	2424	9/27/2010	50
12	28.30762	-88.16023	2210	9/27/2010	No core, 2 attempts
13	28.804	-88.34385	1402	9/28/2010	43
14	28.40267	-88.7304	1383	10/2/2010	56

Figure 2: A photograph of the MC800 multicorer being deployed during the Pisces 10-5-leg 4 cruise.

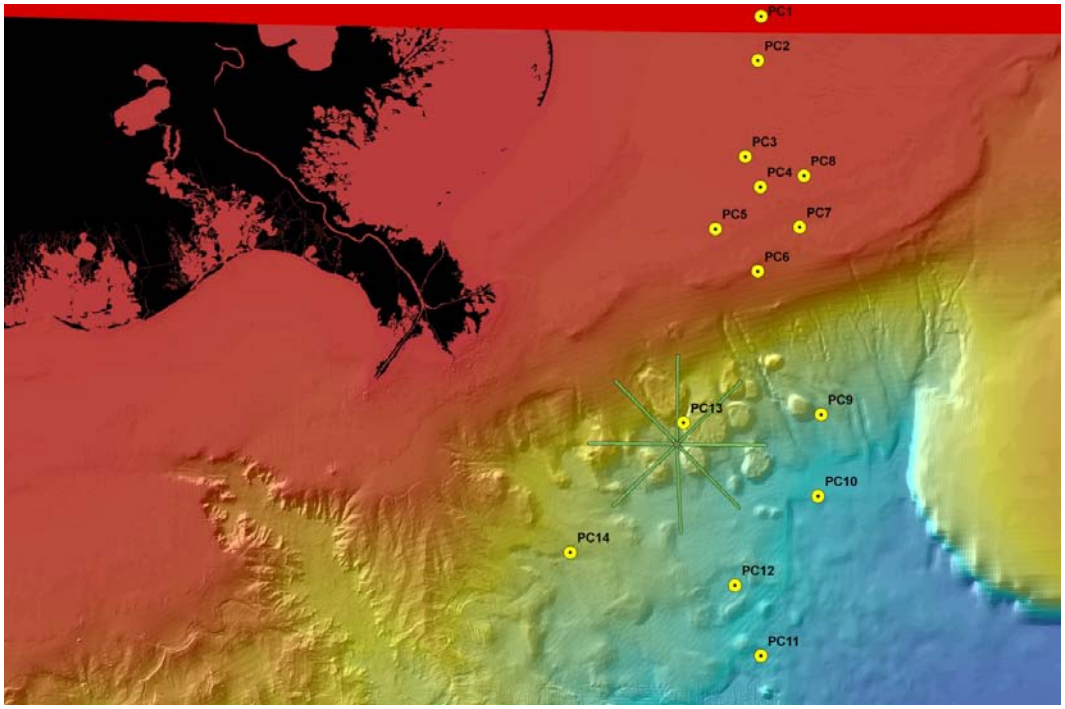

Figure 3: Cores collected during the Pisces 10-5-leg 4 cruise.

Acoustic Survey

This report describes sonar data acquired by the NOAA ship *Pisces* in the Gulf of Mexico as part of the emergency response to the Deepwater Horizon (DWH) Oil Spill between the dates of 25 September 2010 and 4 October 2010. The acoustic survey consists of an acoustic survey of a previously identified seep field. The acoustic team consisted of David Finlayson dfinlayson@usgs.gov with USGS, and worked with input form the Chief Scientist and other members of the science party.

Survey Planning

The SMU provided the locations of previously mapped marine hydrocarbon emission seeps and early in the cruise encouraged the Pisces to conduct an acoustic characterization survey. The science team aboard the *Pisces* selected a high-density seep field 13 km southwest of the DWH location for acoustic characterization in approximately 1400 m water depth. This field shows the highest density of mapped seeps close to the DWH well site and is has a favorable orientation along a NW-to-SW strike that can be efficiently surveyed by a large vessel with only a single-beam sonar system.

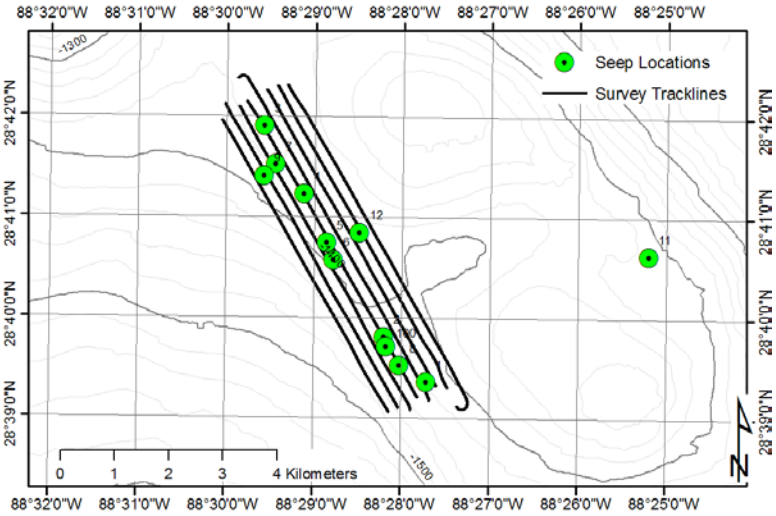

Figure 4: Survey plan of a hydrocarbon seep field 13 km southwest of the Deepwater Horizon Well Location in the Gulf of Mexico. The location of previously mapped seeps is shown along with the realized ship tracks during the survey operations. The survey area is approximately 6 km x 2 km.

Geodetic Control

The vertical datum of the survey is relative to the ship's waterline. Horizontal position was provided by an Applanix POS M/V in DGPS mode. Geographic coordinates are in the WGS 1984 (G1150) reference frame, projected coordinates used during post processing are Universal Transverse Mercator (UTM) Zone 16 north (meters).

EK60 Sonar Scientific Echosounder

The NOAA Ship *Pisces* is outfitted with a Simrad EK60 Scientific echosounder. The system is multi-frequency with 18 kHz, 38 kHz, 120 kHz and 200 kHz split-beam transducers installed. These transducers can detect the seafloor at maximum ocean depths of approximately 10200 m, 3600 m, 1100 m and 840 m respectively. The split-beam targeting capabilities of the system were not evaluated on board the vessel.

Only the lower two frequency transducers were monitored for the seep filed acoustic survey (18 kHz, 38 kHz) because the higher frequencies had no bottom detections. During the first few minutes of line 1, the transducers were adjusted to a short pulse width of 512 um and 256 um for the 18 kHz and 38 kHz transducers respectively. On line 8 the water was deep enough that the 38 kHz sonar echogram was losing the bottom, so the pulse width was adjusted longer. Ship speed was set at 6 knots throughout.

Sonar Processing

Raw sonar data files (*.raw) were processed and visualized in IVS Fledermaus (Version 7.2.0, Build 411 Beta, 32-bit Edition) aboard the ship. The 8 survey lines were imported into FM Midwater and concatenated into a single Generic Water Column file (*.gwc). The file was bottom-tracked and the upper portion of the echogram was clipped to remove noise and artifacts from the water surface down to about 500 m depth. Next, the gas plumes were manually digitized and exported as individual point files and projected into UTM zone 16 N. The individual point files were concatenated into a single file then visualized in Fledermaus along with NGDC bathymetry.

Results

Most seep plumes appeared prominently in the 18 kHz sonar echogram while only a few were visible in the higher 38 kHz frequency system (Figure 5). Interestingly, the few that did show well in the 38 kHz system were not strong in the lower frequency. In general the previously mapped seep locations were accurate (Figure 4). It is likely that individual plumes apparent in the EK60 echograms are actually distinct features or the same plume mapped in multiple passes.

The individual plumes apparent in the 18 kHz system are difficult to extract with simple algorithms. This is a result of the strong seafloor multiple (more discussion on this below) and because the volume return in the upper portion of the water column is about the same magnitude as the plumes. Nevertheless, several of the plumes were impressive with heights above the seafloor of more than 900 m. Many of the plumes appeared diffuse and columnar, with little indication of current. Two of the plumes were different. The first was the first large plume mapped in the 18 kHz system. This plume shows a thickening about 180 m above the seafloor. In the 38 kHz echogram (far left bottom in figure 5), this plume is faint and extremely linear. The second interesting plume is the second and strongest plume visible in the 38 kHz echogram. This plume is hardly visible at all in the lower frequency system. It is

possible that the two frequencies are resonating different bubble populations hence seeps will show up preferentially in either the 18 or 38 kHz echograms.

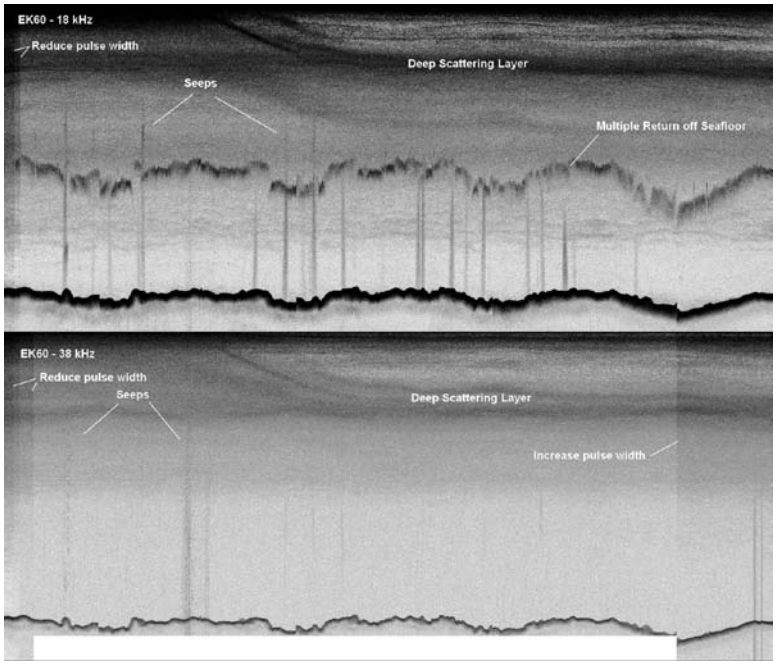

Figure 5: EK60 Echogram from 09:44 to 15:10 UTC, 29 September 2010. The upper plot shows the 18 kHz backscatter, the lower plot shows the 38 kHz backscatter. All 8 collected lines are concatenated into as single strip here. Note that while most seeps show better in the 18 kHz sonar, a few are more prominent at the higher 38 kHz frequencies.

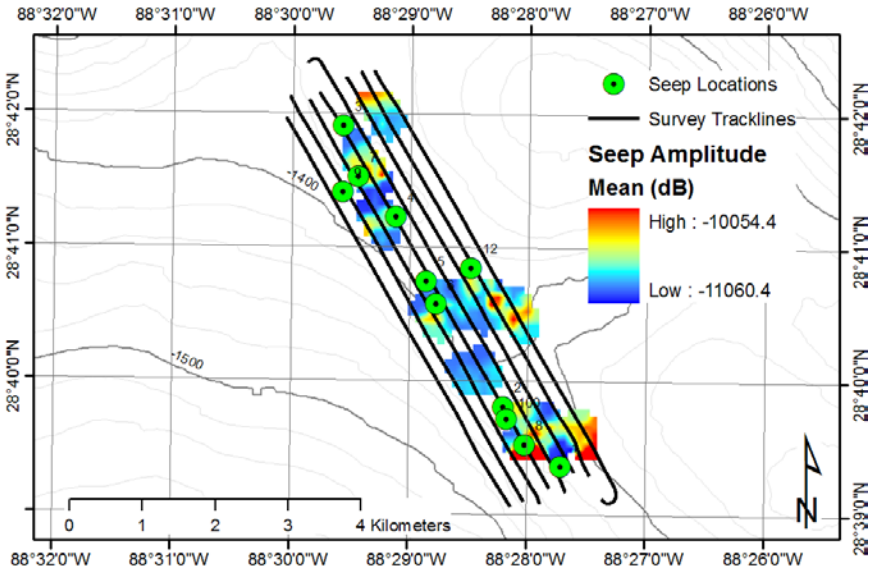

Figure 6: Map of mean amplitude of seep plumes observed from the EK60 - 18 kHz sounder.

The 18 kHz echogram has a strong multiple of the seafloor appearing about 700 m above bottom. This could have been reduced by slowing the ping rate until the multiple disappeared. At 14:27 the 38 kHz pulse width was modified when the seafloor dropped below the detection range of the 38 kHz system---in the Ek60 the pulse width and sample rate (hence range) are synchronized---and the next plume the 38 kHz mapped appeared prominently (not in the 18 kHz, though). It seems likely that future surveys of the area using this system should use longer pulse widths on the 38 kHz and pay attention to ping rate to reduce the damaging effects of multiple returns in the area of interest.

The ability to visualize and extract EK60 water column data with the FM Midwater tool developed by IVS for use in Fledermaus is extremely useful and relatively easy to do. Mapping seep plumes using a wide-angle single beam seems like a good first-effort approach, but ideally a multibeam would be preferable due to its better spatial resolution.

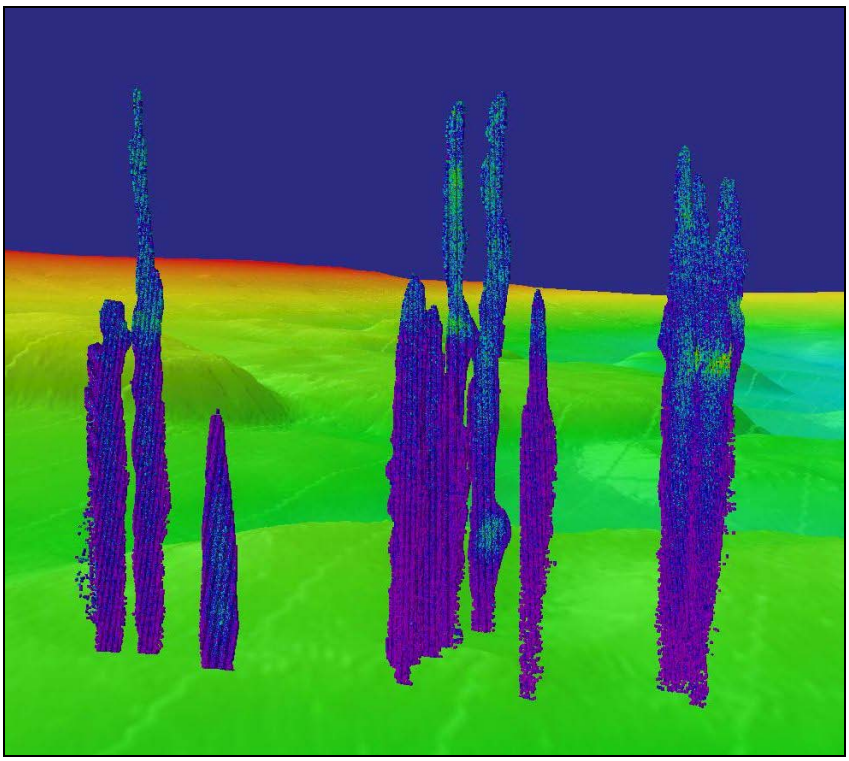

Figure 7: 3D rendering of seep plumes on seafloor. Amplitude values range from low (purple) to high (red). The plumes are approximately 800 to 1000 m above the seafloor. It is likely that adjacent plumes in the image are actually a large single plume that spans more than 1 track line.

Towed Camera

The WHOI-MISO (http://www.whoi.edu/page.do?pid=13576) TowCam deep-sea camera system (http://www.whoi.edu/page.do?pid=17619) employed for this work came from Woods Hole Oceanographic Institution and was used to image the sea floor in search of benthic oil deposits and natural seepage. The system was packed and shipped on Sept. 22 and arrived in Pascagoula, MS at the NOAA ship Pisces on Sept. 23, whereupon two TowCam engineers (Feldman and Swartz) assembled the system, tested the components and ensured that all was ready for seagoing data collection. TowCam set up was completed in the evening of Sept. 24 and the ship departed on the morning of Sept. 25.

The TowCam was set-up with the SeaBird SBE25 CTD to acquire basic water properties data at 1 Hz update rate (conductivity, temperature, depth, altitude, turbidity) and the digital camera was set to update at 10 sec rate. Each image is a 3.3 megapixel color image in JPEG format with the file name converted to correspond to date-time in GMT that the image was acquired (e.g., MM/DD/YYYY HHMMSS.JPG). Altitude of image acquisition varied between ~2-5 m, and correspondingly image area varied between ~2 m x3 m for lower altitude images to ~4 m x 6 m for high altitude images. A separate .txt file of each image time, altitude and depth is provided as part of the processed CTD data delivered at the end of each tow.

Table 7. Field of view in seawater for DSPL DigiSeaCam.

Altitude above Bottom	**3 meters**	**5 meters**	**7 meters**
Field of View in Seawater	3.49m x 2.62m	6.06x4.54m	8.03mx6.02m
Pixels/Meter	586	338	255

A total of 5 TowCam surveys were performed during this cruise. The first survey was initially intended to be a quick subsea test to verify CTD communications through the sea cable after replacement of the termination splice. Other equipment on the ship was being repaired at that time so a longer tow was requested. Tow 1 took place in an area of the shelf where depth was approximately 46 m. All other tows took place along one of 8 pre-approved lines extending 30km radially away from the Deepwater Site. Figure 8, below shows the locations of tows 2-5.

Table 8. Listing of details for imagery collected during each TowCam lowering.

Tow #	Date	Start Location (Dec. Deg N/W)	End Location (Dec. Deg N/W)	Number of Photos
1	09/26 /10	29.65664, -87.94074	29.65662, -87.93512	973
2	09/28 /10	28.72677, -88.36621	28.77795, -88.36623	1907
3	09/29 /10	28.75360, -88.38420	28.77202, -88.40499	1927
4	10/01 /10	28.65376, -88.46707	28.66975, -88.44692	1927
5	10/02 /10	28.73850, -88.28621	28.73845, -88.34375	1975

N.B. - Tow 5 used camera s/n 6003. All other tows used camera s/n 6004. Cameras were swapped when the memory card in 6004 failed.

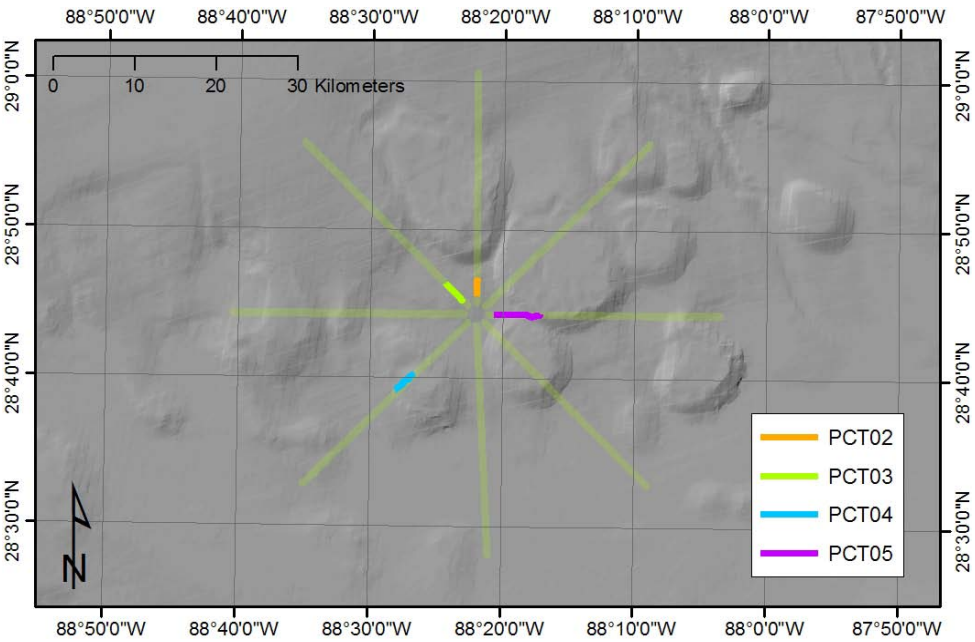

Figure 8. TowCam survey locations in reference to the Deepwater Horizon spill site (at center).

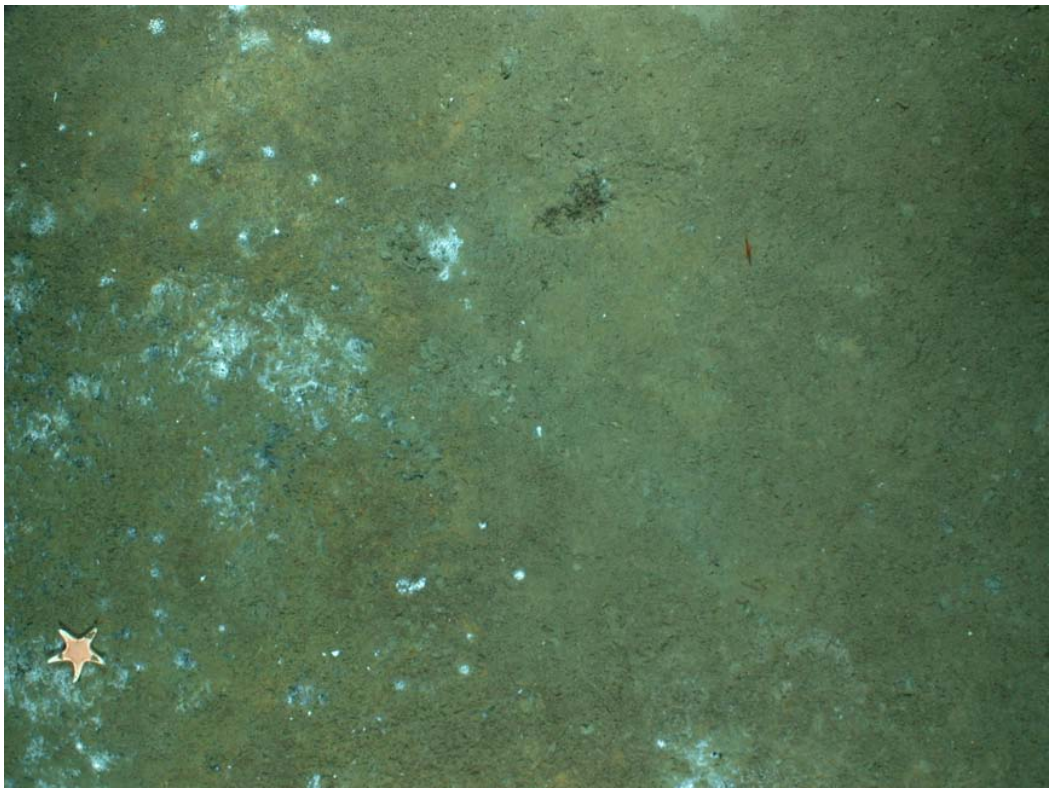

Figure 9. Image of the sea floor collected by the TowCam in the area of natural seepage identified in Fig 7, and located to the SW of the well head.