LAKE AZUEI PROJECT, HAITI
FIELD REPORT

January 9-February 3, 2017

A project financed by the U.S. National Science Foundation
Grants EAR-1624583 and EAR-1624556

Citation: Cormier, M.H., H. Sloan, and the Lake Azuei Project Team. Lake Azuei Project, Haiti: Field Report, January 9 - February 3, 2017

CONTENT

1. SCIENTIFIC MOTIVATION

The January 12, 2010 M7.0 earthquake was catastrophic for Haiti, killing over 200,000 people and devastating the capital Port-au-Prince and surrounding regions. That earthquake was an unusual tectonic event. It initially was thought to have ruptured the Enriquillo-Plantain Garden Fault (EPGF), one of two strike-slip faults that accommodate the 2 cm/yr relative motion between the Caribbean and North American plates (Figs. 1 and 2). Instead, transpressional slip occurred on the Leogane Fault, an unsuspected blind fault that abuts the EPGF (*Calais et al., 2010; Mercier de Lepinay et al., 2011; Douilly et al., 2013*) and no significant slip occurred on the EPGF. Because the EPGF did not release any significant accumulated elastic strain in 2010, it remains a significant seismic threat for Haiti (*Symithe et al., 2013*).

The 2010 earthquake exemplifies the complex partitioning of transpressive motion on a network of structures along the Caribbean-North American plate boundary. In fact, the latest kinematic model derived from GPS monitoring east of Port-au-Prince predicts 6.8 ± 1.0 mm/yr of slip along the Enriquillo-Plantain Garden fault, but also 5.7 ± 1 mm/yr of fault-normal motion across it - significantly faster than previously estimated (*Symithe and Calais, 2016*).

Lake Azuei is located ~60 km east of the epicenter of the 2010 earthquake (Fig. 2), straddling this plate boundary. Its southern half lies across the eastward extension of the Enriquillo-Plantain Garden fault zone, and it is bound to the north and east by the compressional Haiti fold-and-thrust belt. This tectonic context, as well as the shallow depth and limited dimensions of this lake, make it an ideal target for investigating how transpressional motion is partitioned between strike-slip and compressional structures using seismic reflection methods. This survey collected high-resolution images of the structures beneath the lake bed with a combination of high-resolution multichannel seismic reflection profiles and sub-bottom seismic profiling (CHIRP). Three short cores were also collected to provide age constraints on the shallow stratigraphy. By unraveling the spatial and temporal relations between strike-slip and compressional features, the new dataset will document how transpressional motion is accommodated across a broad continental plate boundary.

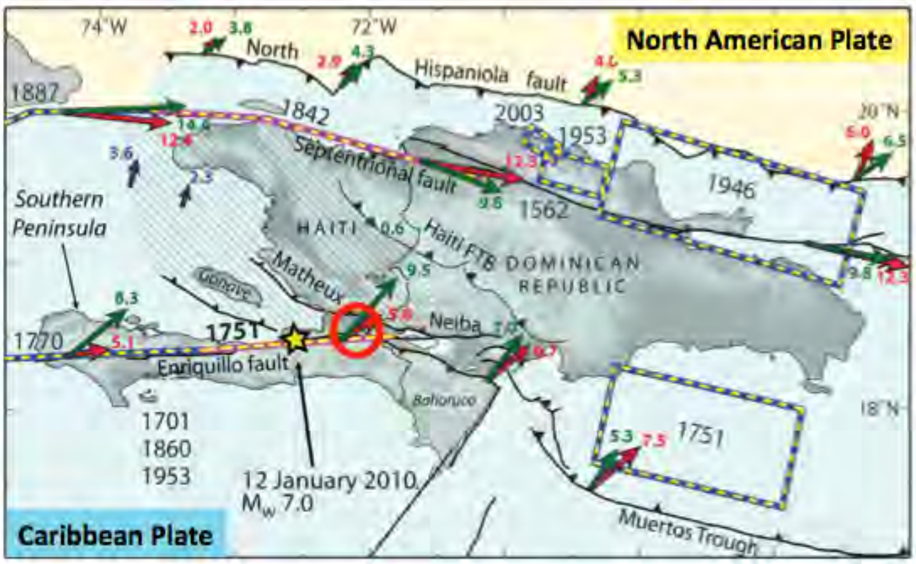


Figure 1. Plate boundary geometry across Hispaniola, including the left-lateral Enriquillo-Plantain Garden Fault and Septentrional Fault [*after Benford et al., 2014*]. Red circle locates the study area. Black numbers are dates of historical earthquakes; their estimated ruptures are displayed as colored lines (vertical strike-slip faults) or colored boxes (dipping thrust faults). Red and green arrows indicate the GPS estimates of relative velocities across the plate boundaries from *Calais et al.* (2010) and *Benford et al.* (2014), respectively. The updated velocity model (green arrows) assumes a diffuse deformation zone across the Haitian Fold-and-thrust belt. It predicts 6.8 ± 1.0 mm/yr of slip along the Enriquillo-Plantain Garden fault, but also 5.7 ± 1 mm/yr of fault-normal motion across it - significantly faster than previously estimated.

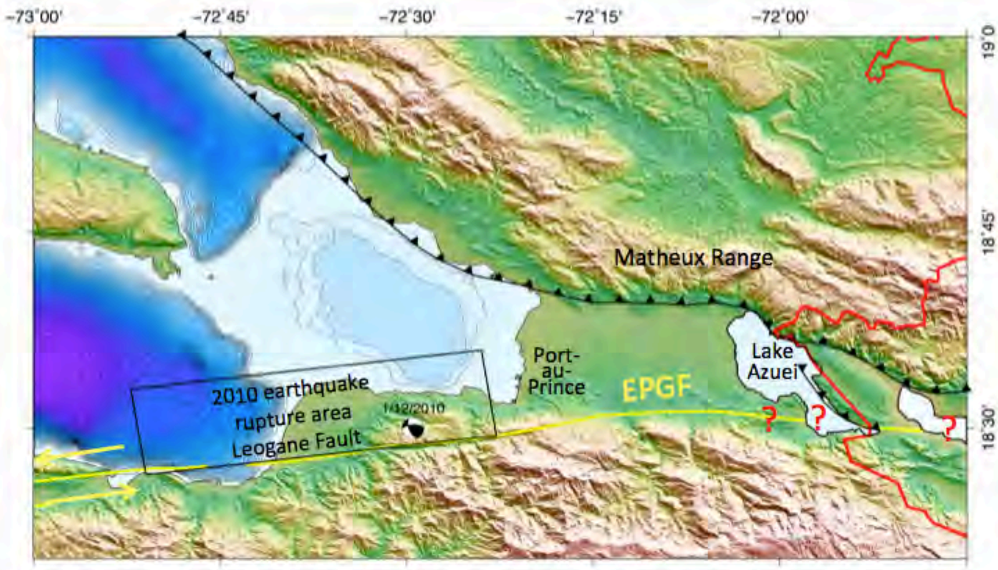


Figure 2. Physiography of central Haiti. The Enriquillo-Plantain Garden Fault (EPGF) is shown in yellow, with question marks where its presence is debated. Black box is the inferred 2010 rupture area of the unsuspected Leogane Fault (a blind thrust), which abuts the EPGF (Calais et al. 2010). 2010 Epicenter from Mercier de Lepinay et al. (2011). Red line marks the border with the Dominican Republic.

2. FIELD PARTICIPANTS

<u>Scientific Party</u>
Marie-Helene (Milene) Cormier, URI-GSO, *Chief Scientist*
Heather Sloan, Lehman College-CUNY, *Co-Chief Scientist*
Dominique Boisson, UEH-URGéo
Britta Brown, Lehman College-CUNY
Kelly Guerrier, UEH-URGéo
Casey Hearn, URI-GSO
Clifford (Chip) Heil, URI-GSO
John King, URI-GSO, *NSF Co-Investigator (did not participate in the field survey)*
Paul Knotts, Lehman College-CUNY
Roberte Momplaisir, UEH-URGéo
Nigel Wattrus, U. Minnesota - Duluth

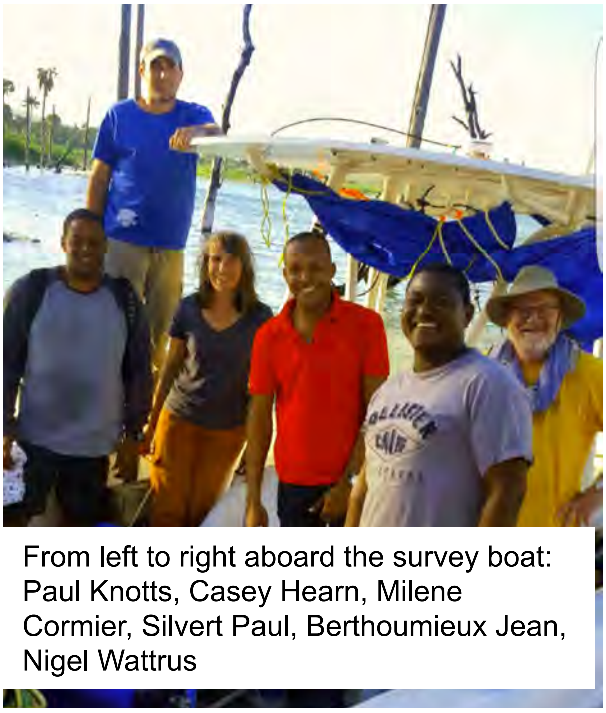
<u>Technical and Logistical Support</u>
Yves-André Adras, *Chauffeur*
Fred Hegg, *Designer of seismic source (BubbleGun), seismic reflection acquisition specialist*
Geffrard Jean, *Owner of Parc Naturel Quisqueya*
Ronald Jerome, *Chauffeur*
Betencea Mesadieux, *Chauffeur*
José Roy, *Owner and Pilot of the survey boat*
Reginald Sainfleur, *crew*

<u>Scientists who visited during field acquisition</u>
Ebdel Junior Alexis, UEH-URGéo
Jimmy-Heal Charlot, UEH-URGéo / INSOLFOR
Nadine Ellouz-Zimmerman, IFPEN
Berthoumieux Junior Jean, LNBTP
Sylvie Leroy, ISTeP-UPMC
Steeve Symithe, UEH-URGéo
Silvert Paul, LNBTP
Sophia Ulysse, UEH-URGéo / BME

<u>Acronyms</u>

BME	Bureau des Mines et de l'Énergie (Haitian Bureau of Mining and Energy)
CUNY	City University of New York
FDS	Faculté des Sciences (College of Sciences, State Univ. of Haiti)
IFPEN	Institut Français du Pétrole – Energies Nouvelles (French Inst. for Petroleum & New Energies)
ISTeP-UPMC	Institut des Sciences de la Terre de Paris, Université Pierre et Marie Curie, France
LNBTP	Laboratoire National du Bâtiment et Travaux Publics (Haiti Nat. Lab. Buildings & Public Works)
UEH	Université d'Etat d'Haïti (State University of Haiti)
URGéo	Unité de Recherche en Géoscience (Division of Geoscience Research)
URI-GSO	University of Rhode Island, Graduate School of Oceanography

From left to right: Casey Hearn, Paul Knotts, Britta Brown, Milene Cormier, Sophia Ulysse, Heather Sloan, José Roy, Reginald Sainfleur, Chip Heil. The pier at Taino Aqua Ferme is in the background.



From left to right aboard the survey boat: Paul Knotts, Casey Hearn, Milene Cormier, Silvert Paul, Berthoumieux Jean, Nigel Wattrus

From left to right, with Lake Azuei and the Matheux Range in background:
Kelly Guerrier, Dominique Boisson, Steeve Symithe, Roberte Momplaisir, Sophia Ulysse, Milène Cormier (October 2016).

.

From left to right, aboard the survey boat:
Jimmy-Heal Charlot, Casey Hearn, Britta Brown, Nigel Wattrus

From left to right, aboard the survey boat:
Paul Knott, Milene Cormier, Britta Brown,
Casey Hearn, Ebdel Alexis, Steeve Symithe

Paul Knott, Britta Brown, and students from the
State University of Haiti

Parc Naturel Quisqueya: Heather Sloan, Casey Hearn, Nigel Wattrus, Sylvie Leroy inspect the equipment recently delivered.

Parc Naturel Quisqueya: Sleeping cabins

3. CONTACT INFORMATION

Dominique BOISSON, *Professor*
Unité de Recherches en Géosciences, Université d'Etat d'Haïti, 270 rue Mgr. Guilloux, Port-au-Prince HT-6111
dmboisson@yahoo.com; +509 3711-1198

Britta BROWN, *student*
Earth, Environmental and Geospatial Sciences, Lehman College - CUNY, 250 Bedford Blvd West, Bronx NY 10468
brittany.brown2@lc.cuny.edu

Marie-Hélène (Milène) CORMIER, *Research Scientist* and *Chief Scientist*
Graduate School of Oceanography, University of Rhode Island, South Ferry Road, Narragansett RI 02882
mhcormier@uri.edu; milenecormier@gmail.com; Work: +1 (401) 874-9497; Cell: +1 (401) 294-8486

Kelly GUERRIER, *Professor*
Unité de Recherches en Géosciences, Université d'Etat d'Haïti, 270 rue Mgr. Guilloux, Port-au-Prince HT-6111
kelly.guerrier@fds.edu.ht; kellyguerrier4181@gmail.com; Work: +50937132209; Cell: +50942128390

Casey HEARN, *graduate student*
Graduate School of Oceanography, University of Rhode Island, South Ferry Road, Narragansett RI 02882
caseyhearn@uri.edu

Clifford (Chip) HEIL, *PhD and coring specialist*
Graduate School of Oceanography, University of Rhode Island, South Ferry Road, Narragansett RI 02882
chiph@uri.edu; Work: +1 (401) 874-6182

Berthoumieux Junior JEAN, *Professor*
Laboratoire National du Batiment et des Travaux Publiques
and
Unité de Recherches en Géosciences, Université d'Etat d'Haïti, 270 rue Mgr. Guilloux, Port-au-Prince HT-6111
berthoumieux.jean@fds.ueh.ht; berthjun@yahoo.fr

Géffrard JEAN, *Co-owner of Parc Naturel Quisqueya*
Parc Naturel Quisqueya, Société d'Exploitation du Parc SODEPA, S.A., Route Nationale 8, Fonds Parisien
geffrardjean1@yahoo.ca; +509 3608-0505 / 4212-9686

John KING, *Professor (Co-Investigator)*
Graduate School of Oceanography, University of Rhode Island, South Ferry Road, Narragansett RI 02882
jwking@uri.edu; Work: +1 (401) 874-6182

Paul KNOTTS, *student*
Earth, Environmental and Geospatial Sciences, Lehman College - CUNY, 250 Bedford Blvd West, Bronx NY 10468
paulknotts@gmail.com; Cell (646) 287-6235

Roberte MOMPLAISIR, *Professor*
Unité de Recherches en Géosciences, Université d'Etat d'Haïti, 270 rue Mgr. Guilloux, Port-au-Prince HT-6111
roberte.momplaisir@laposte.net; Work: +509 3730-2491

José ROY, *Boat owner and pilot*
Pegasus Diving & Services, Kaliko Beach Marina
www.facebook.com/pegasusmarina; Haitidivingpegasus@yahoo.com; Haitipegasusservices@gmail.com
Cell: +509 3411-4775; Cell: +509 3389-9633

Heather SLOAN, *Professor and Co-Chief Scientist*
Earth, Environmental and Geospatial Sciences, Lehman College - CUNY, 250 Bedford Blvd West, Bronx NY 10468
heather.sloan@lehman.cuny.edu; +1-718-960-8008; +1-845-751-9115

Steeve SYMITHE, *Ph.D. and Lecturer*
Unité de Recherches en Géosciences, Université d'Etat d'Haïti, 270 rue Mgr. Guilloux, Port-au-Prince HT-6111
symithesteevej@gmail.com

Sophia ULYSSE, *graduate student*
Unité Technique de Sismologie| Bureau des Mines et de l'Énergie
and
Unité de Recherches en Géosciences, Université d'Etat d'Haïti, 270 rue Mgr. Guilloux, Port-au-Prince HT-6111
sophiaulysse@gmail.com

Nigel WATTRUS*, Professor*
U. Minnesota, Large Lake Observatory, Dpt. Earth & Environmental Sciences, 2205 E 5th Street, Duluth, MN 55812
nwattrus@d.umn.edu; Work: +1 (218) 726-7154

4. DAILY LOG

October 23-29, 2016 Milene Cormier made a preliminary visit to present the project and discuss logistics with Colleagues at UEH. Together they visited Parc Naturel Quisqueya (a possible base camp for the survey), the Town Hall of Ganthier (the town within which the survey is located), and took a geology field trip to nearby quarries where fault planes are well exposed. Another objective for this visit was to find and negotiate for a boat that could be trucked to Lake Azuei for the geophysical survey and coring operations. This objective was met in a meeting with Jose Roy, owner of *Pegasus Diving Services* located next to Kaliko Beach (between Arcahaie and Montrouie.)

8 January Heather Sloan, Britta Brown, and Paul Knotts arrive in Port-au-Prince. Milene Cormier's and Casey Hearn's arrival is delayed as their flight out of Fort Lauderdale has been canceled.

9 January Milene Cormier and Casey Hearn arrive early in Port-au-Prince. The US team meets at the Université d'Etat d'Haïti (UEH) with Dominique Boisson, Kelly Guerrier, and Sophia Ulysse, and is also introduced to the administrators of the College of Science. Lehman students, Paul Knotts and Britta Brown, interview UEH students for a student-initiative documentary on the project. The geophysical equipment arrives in Port-au-Prince (it was picked up at URI on January 6), and Dominique Boisson and Kelly Guerrier work with the aid of administrators at UEH to ensure its speedy clearance through customs.

10 January Working all day on a brochure about the project for distribution to the general public in Haiti (see appendix). The NSF-sponsored National Facility *LacCore* ships the coring equipment to Haiti.

11 January Work continues on the brochure and by 5pm both the French and Creole versions are ready for printing. The US and Haitian teams have a nice lunch at the restaurant of the MUPANAH (Musée du Panthéon National Haïtien). The effort by Haitian colleagues to clear the geophysical equipment through customs continues.

12 January The geophysical equipment clears customs and arrangements are made to have it delivered directly to the base camp (Parc Naturel Quisqueya) on Saturday 1/14. Brochures are printed and ready. The US team visits the local Town Hall in Ganthier (about two hours east of Port-au-Prince), where the base camp will be established. The Director of the Town Hall gives us a warm welcome, which Paul and Britta capture on camera. We explain the objectives of the project and provide him with a stack of brochures. We then visit Géffrard Jean, the owner of the Parc Naturel Quisqueya where we will establish base camp and find preparations for our stay in full swing.

13 January Visit with José Roy, the owner of the boat that will be used for the project. His

base is in Kaliko Beach near Arcahaie, about a 2hr drive NW of Port-au-Prince. Together, we inspect the boat and discuss how to best rig the geophysical equipment. Back at UEH in the afternoon for further discussions about overall logistics.

14 January Cell phones and internet USB keys are purchased in Port-au-Prince to ensure effective communication from the remote survey area. The US team moves to Parc Naturel Quisqueya in Fonds Parisien, timing the trip to arrive there at the same time as the geophysical equipment. Nigel Wattrus arrives in Port-au-Prince.

15 January Casey Hearn starts testing the geophysical equipment at the Parc in the morning. Nigel Wattrus and Sylvie Leroy arrive at base camp around noon. José Roy arrives at the Taino Aqua Ferme in Fonds Parisien early afternoon and the boat is put in near the pier, where it will be docked overnight during the project. We run more tests with a generator that José Roy has brought along.

16 January The geophysical equipment is installed on the boat and the first wet tests are conducted. First, we run a series of tests to evaluate the precision of three Star-Oddi depth sensors strapped to the streamer, and assess the behavior of the streamer at speeds ranging from 2.9 to 3.5 knots. Fred Hegg arrives at base camp. The coring equipment has arrived in Port-au-Prince and awaits custom clearance. There is an issue with some chemicals (zorbitrol and a patch kit) included with the shipment, which makes it necessary for the Ministry of Agriculture to be involved. Dominique Boisson, Kelly Guerrier, and UEH administrators work toward securing customs clearance for that equipment.

17 January We balance the streamer at the correct water depth (~90 cm) during the morning and then acquire a few single channel seismic (SCS) test lines in the afternoon. After some adjustment, we get the combination of the new UPS, four marine batteries, and power inverter to work well for powering the geophysical equipment. As we had hoped, the use of a generator will not be needed. Meanwhile, training in data processing begins with CUNY students at base camp. Sophia Ulysse arrives in the afternoon.

18 January Roberte Momplaisir arrives in the morning. The morning is spent troubleshooting various issues with the MCS system at the pier, with successful acquisition of a few MCS test lines in the afternoon.

19 January Routine MCS data acquisition begins (“Day 1” of acquisition), and the weather is perfect – absolutely no wind. Fred Hegg, Roberte Momplaisir, Sophia Ulysse, and Sylvie Leroy leave for Port-au-Prince around noon, and the team aboard the boat rotates for the afternoon. Berthoumieux Jean and Silvert Paul arrive at base camp.

20 January Full day of MSC data acquisition. Perfect weather in the morning, but the wind

picks up by mid-afternoon and white caps develop. Berthoumieux Jean and Silvert Paul leave in the evening.

21 January — Calm weather in the morning. We successfully acquire CHIRP concurrently with the MCS. Wind picks up by mid-afternoon, but data quality remains fine. Jimmy-Heal Charlot arrives.

22 January — Wind has died down, by mid-morning all is calm and the lake surface is like a mirror. MCS and CHIRP data acquisition proceeds smoothly. Jimmy-Heal Charlot leaves in the evening.

23 January — It is quite windy and the last survey line for the day is improvised where the wind is not so strong at the southern end of the lake, sailing with the wind from E to W toward the pier. Kelly Guerrier and Nadine Ellouz-Zimmermann arrive at base camp and most of those present hike to the area east of the Parc to examine uplifted reefs, collecting fossils - and thorns.

24 January — Continuing the acquisition of the MCS and CHIRP data. Roberte Momplaisir arrives in the morning with a television crew from *Télé Quisqueya,* Channel 14. Roberte has arranged for a small boat to meet the survey boat on the lake to film the geophysical operations and interview the scientific party. Footage appears on the 9pm news and the videographer plans to integrate the footage in a Haitian documentary on geoscience investigations in the area. Roberte Momplaisir, Nadine Ellouz-Zimmermann, and Kelly Guerrier leave in the evening.

25 January — Continuing the acquisition of the MCS and CHIRP data. Steeve Symithe and Ebdel Junior Alexis arrive at base camp. Chip Heil arrives in Port-au-Prince.

26 January — Continuing the acquisition of the MCS and CHIRP data in the morning, but acquire only CHIRP in the afternoon along a tight zig-zag pattern that straddles what is commonly believed to be the main fault zone. Sophia Ulysse and Chip Heil arrive at base camp.

27 January — The coring equipment clears customs and is delivered directly to the *Taino Aqua Ferme* where the boat is docked. Chip Heil, Heather Sloan, and Milene Cormier assemble the coring platform (“cataraft”) while Casey Hearn, Paul Knotts, Britta Brown, and Sophia Ulysse survey with the CHIRP only. Steeve Symithe, and Ebdel Alexis leave for Port-au-Prince in the morning, Nigel Wattrus and Sophia Ulysse leave in the evening.

28 January — Roberte Momplaisir, Dominique Boisson, Fritz Deshommes - Rector of UEH, and 42 engineering students from UEH arrive at the pier at ~10am, for a demonstration of operations. A TV crew from *Télé Metropole* also arrives from Port-au-Prince to interview several members of the scientific team. Chip Heil, Casey Hearn, and Milene Cormier launch from the dock soon after; the TV crew,

the UEH Rector, and Roberte Momplaisir follow in a smaller boat to film the coring operations. By then it has become quite windy, which makes coring operations difficult. We collect two cores (duplicates) at the SE corner of the lake. Heather Sloan, Paul Knotts, Britta Brown, and the 42 students leave at around noon for Port-au-Prince.

29 January — The day starts quite windy. We try to collect a core near the underwater extension of an active fold along the East shore, but it is just too windy at that location. Instead, we move to an area that we expect to be somewhat sheltered from the E wind, close to the fish farm and to Parc Quisqueya. We manage to collect one core, although with difficulty, and make plan to extend the survey by one additional day. Heather Sloan, Paul Knotts, and Britta Brown leave Port-au-Prince for New York City.

30 January — The morning starts too windy for any coring operations. Instead, Milene Cormier, Casey Hearn, and Chip Heil spend the day packing the equipment.

31 January — Milene Cormier, Casey Hearn, and Chip Heil leave base camp early in the morning for Port-au-Prince, following a truck loaded with the equipment to the DHL head office near the airport. We are not allowed to unload the equipment at DHL. Kelly Guerrier sends a custom agent hired by the university, who greatly facilitates interaction with DHL. The cores are taken back to UEH for safe-keeping until ready to be shipped. The afternoon is spent working on shipping-related paperwork.

1 February — Chip Heil leaves for the US. The entire day is spent working on paperwork for shipping back the equipment.

2 February — Milene Cormier and Casey Hearn spend the morning at UEH to deal with paperwork, and then meet with the custom agent, Mr. Harry André, at the DHL office in the early afternoon. At 3pm, Milene Cormier gives a summary presentation at UEH about the Lake Azuei survey.

3 February — Milene Cormier and Casey Hearn meet with Kelly Guerrier and Dominique Boisson at UEH in the morning. Kelly Guerrier arranges for a van to transport the cores back to DHL headquarters. Milene Cormier and Casey Hearn meet there with the custom agent and more paperwork is pushed through with his help. Both are invited by UEH colleagues for a nice dinner at the Restaurant La Reserve.

4 February — Milene Cormier and Casey Hearn leave for the US. The geophysical and coring equipment will be delivered in the US on February 6. The sediment cores will be delivered at URI on February 27, after an official letter from the BME authorizing their export from Haiti is submitted to customs.

5. BOAT, POWER SUPPLY, AND POSITIONING

5.1 Boat

The boat used for this survey was a 30-feet center-console boat equipped with two 250hp Yamaha 4-stroke outboard engines (Fig. 3). The boat, owned and operated by Jose Roy of *Pegasus Diving*, was trucked from *Kaliko Beach Club* west of Arcahaie to the *Taino Aqua Ferme* in Fonds Parisien, where it was docked overnight for the duration of the project. To the best of our knowledge, the *Taino Aqua Ferme* offers the only functioning pier in Lake Azuei, a facility needed to load and unload our bulky geophysical equipment. It is also a gated and guarded facility, and thus offered safety for the geophysical equipment left overnight on the boat. Reginald Sainfleur, crew member, slept on the boat for additional security.

The boat was capable of a speed of ~30 knots, which allowed for quickly moving from one side of the lake to the other whenever the geophysical equipment was pulled out of the water. The boat was equipped with a *Garmin 441S* combination GPS / Fish-finder system, which the pilot used to monitor water depth and survey speed. Plastic tarps and fabric sheets draped over ropes and bungee cords attached to the center console provided some needed protection from the sun.

5.2 Power Supply

Testing on January 16 revealed that the UPS (uninterruptible power supply) battery backup system, which we brought from the U.S. to provide a stable power supply to all acquisition laptops and geophysical equipment, tripped off when connected with a local (Haitian) generator. The problem vanished when we switched a local UPS system the next day, one adapted to the Haitian 110 V / 50 Hz voltage rather than to the American 120 V / 60 Hz. Our final system configuration (Fig. 4) utilized 4 marine batteries connected in series at 24 V and connected to a locally purchased Sine-Wave UPS/battery charger system, rather than to a generator. The four batteries were recharged overnight using an extension cord connecting the UPS system in charging mode to a *Taino Aqua Ferme* outlet. This set up proved more than adequate to power up all of the geophysical equipment as well as the acquisition and navigation laptops on a daily basis, and in the process we avoided the noise and smell that would come with the use of a generator. We kept a generator on hand as a backup power source.

An in-line breaker on a power-splitting extension cord was tripping repeatedly due to the high amperage required by the BubbleGun. José Roy bypassed the breaker, enabling the BubbleGun seismic source to function normally on the improvised power system. All of the geophysical equipment was grounded to a single point to eliminate as best as possible any 50 Hz noise from the seismic data. Grounding was achieved with a steel chain towed over the starboard side (Fig. 4), which was wired to a central grounding terminal on the BubbleGun seismic source control box. Improved noise reduction was achieved by increasing the length of unshielded wire in direct contact with the steel chain and ensuring that the full length of chain (6 ft plus) was submerged.

Figure 3. The boat used for the project. _Top left_: Lauching at *Taino Aqua Ferme*. _Bottom left_: Docking at the dirt-and-gravel pier of *Taino Aqua Ferme*. _Right:_ Surveying.

***Drowned tree trunks and tree stumps result from the dramatic rise of the lake level: ~ 4 meters in the past ~ 10 years*

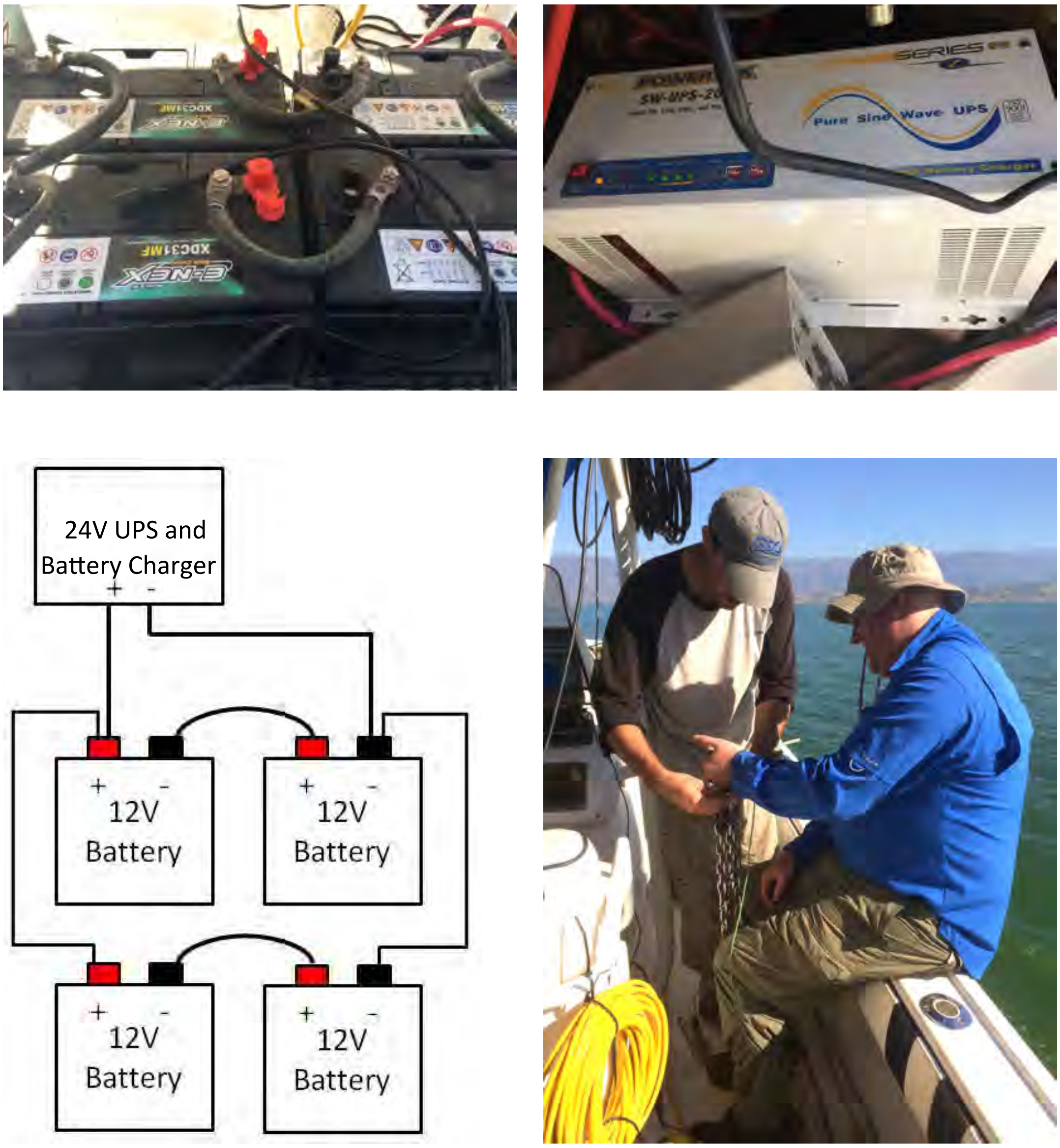


Figure 4. The geophysical equipment was powered by 4 marine batteries connected in a 24 V configuration (top left). These batteries were connected to a UPS and battery charger dual system (top right, and left). A large chain (bottom right) dropped over the side of the boat provided grounding for all the equipment.

5.3 Positioning

5.3.1 *Hemisphere* GPS Receivers

Hemisphere dual GPS antennas (Crescent VS100) were installed above the center console (Fig. 5). The two GPS antennas were mounted on a rigid steel bar with a separation of 1 m, which was strapped to the roof of center console along the boat centerline. Output from the stern antenna was logged in the headers of all seismic reflection data (CHIRP, MCS, and SCS) and also fed to the *Hypack* navigation software. All GPS positions are referenced to the customary WGS-84 datum and referred to GMT time.

5.3.2 Positions of Seismic Equipment Relative to GPS Antenna

The table below and Figure 6 describe the towing configuration relative to the GPS antenna.

Seismic equipment	Distance starboard from GPS antenna	Distance aft of GPS antenna	Towing Depth
BubbleGun seismic source	About 1 m	15.625 m	~1.0 m
MicroEel seismic streamer	About -1 m	channel 1: 28.125 m channel 24: 101 m	~0.9 m
Edgetech 424 subbottom profiler (CHIRP)	-2.4 m	0	~1.0 m

5.3.3 Navigation

A laptop displaying the *Hypack* navigation window was installed on the boat's center console, allowing the pilot to precisely follow the pre-programmed survey tracks. A bathymetric chart of Lake Azuei was compiled prior to the survey using the raw 2013 depth soundings provided by Michael Piasecki (City College of New York - CUNY) and the 2010 shorelines digitized from GoogleEarth (Fig. 7). Although the digital chart was most useful for planning the survey tracks, it turned out to be distracting as a backdrop for navigating the boat along pre-programmed profiles and thus was removed from Hypack.

6. SEISMIC REFLECTION SYSTEMS

Three different seismic reflection systems were used for this project, as described below. The manufacturers' specification sheets for the system components are provided in the appendix. Topside electronics and laptops were installed behind the boat's center console. The worktable consisted of a sheet of plywood screwed to a large plastic crate, and two large coolers provided seats.

Figure 5. Installing the GPS antennas on the center console canopy

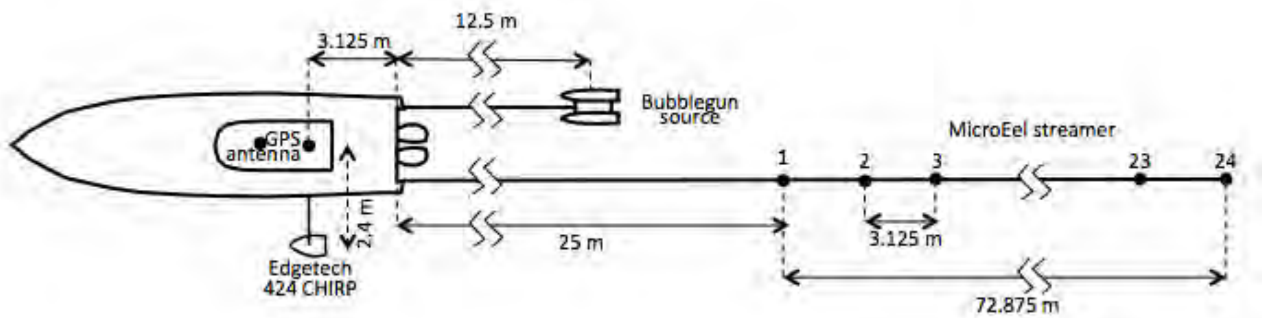


Figure 6. Configuration of the equipment relative to the boat and GPS antenna.

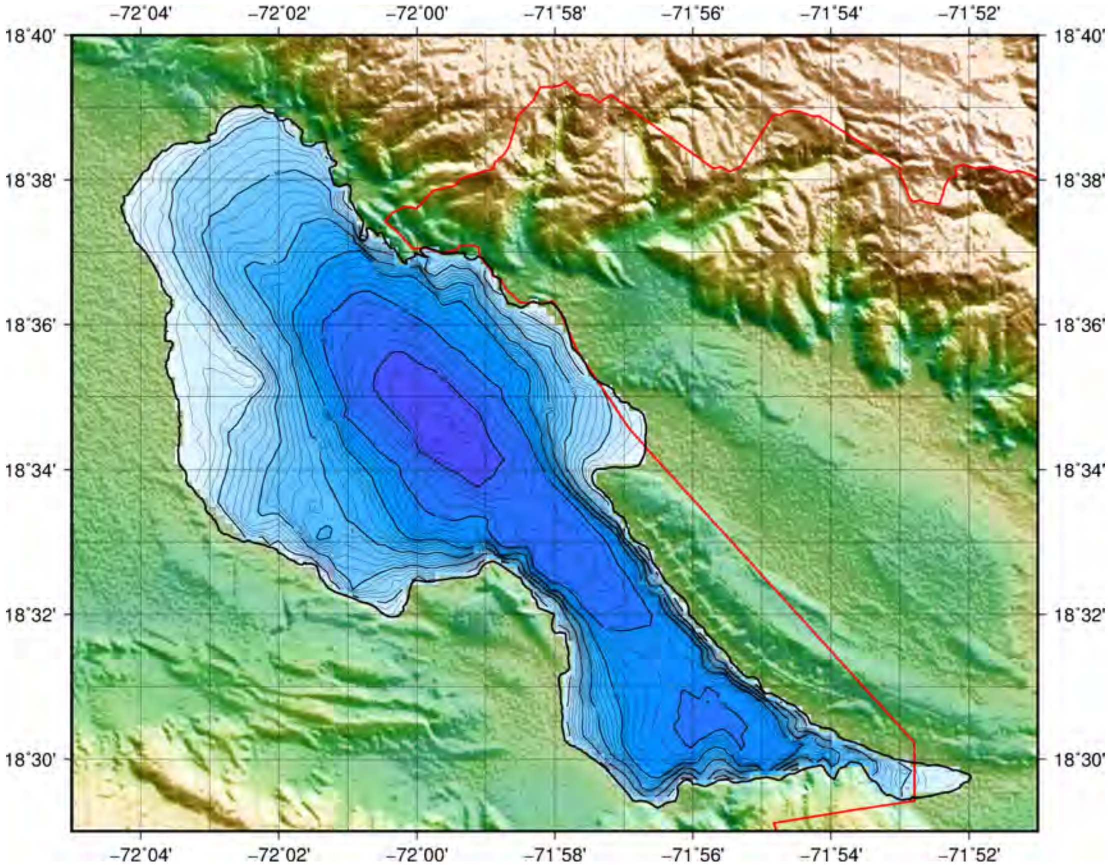


Figure 7. Bathymetric chart compiled from raw 2013 depth soundings provided by Michael Piasecki (City College of New York - CUNY) and the 2010 shorelines digitized from GoogleEarth. Contour interval is 1 m. Red line indicates the Haitian-Dominican border.

6.1. Subbottom Profiler (CHIRP)

An *Edgetech* subbottom profiler SB-424 (Fig. 8) was leased from *Electronic Sales of New England* for the survey. The relatively small size (77 cm-long) and low weight (45 kg in air) of that CHIRP sonar made it well suited for manual deployment and recovery from our small boat. It also operates in the higher frequency range (4-24 kHz) for CHIRP sonars, thus providing excellent vertical resolution (4-8 cm, nominally), but lower penetration (2 - 40 m, depending on substrate). It performed flawlessly during the survey and provided a highly detailed imagery of the lake subsurface where sediments were not gas-charged (e.g., Figs. 20, 22, and 23).

6.2 Single Channel Seismic System

URI's 5 m-long single channel streamer was deployed on January 17 for the initial testing of the BubbleGun seismic source. About 12 km of single channel seismic reflection profiles were acquired that day while we adjusted the parameters of the seismic source. That short streamer was kept aboard as a backup system during MCS acquisition, although it was not used again.

6.3 Multichannel Seismic System

6.3.1 Seismic Source: HMS-620 BubbleGun

The HMS-620 BubbleGun (Fig. 8) is a seismic source designed by *Falmouth Scientific Inc.* It is well adapted for high-resolution surveys in shallow water with small (<40') boats. It produces a pulse with a broad frequency band (70-1700 Hz), a relatively flat spectrum within that frequency range, and yet it is powerful enough to penetrate a few 100 meters below a shallow seafloor or lake bed. Because it is an electromagnetic source with a contained air volume, it does not require the use of an air compressor, and it works equally well in salt or fresh water (unlike sparker sources). It has a low power requirement and can be operated with a few marine batteries for a full day. Lastly, it is fairly portable (~ 44 kg and about 1.5 m in length) and can be deployed by hand.

6.3.2 Seismic Streamer: Geometrics MicroEel 24-Channel Streamer

The *Geometrics* MicroEel solid analog ministreamer (Fig. 8) is designed for high-resolution marine seismic imaging. It is rugged, featuring solid floatation material (rather than oil) and polymer hydrophones, which unlike ceramic hydrophones are non-shattering. The URI MicroEel streamer comprises 24 channels, with hydrophone groups spaced 3.125 m apart, so that the active section is ~75 m-long. Each hydrophone group consists of three hydrophones spaced 0.11 m apart (a 0.22 m aperture) with the group signal summed electrically and connected to a preamplifier. A battery pack connected to the deck cable and comprising two 12V sealed lead-acid batteries powers the preamplifiers. The hydrophones' broad frequency response (10 Hz to 10 kHz) is a good match for the high frequency BubbleGun source. The tow section, active section, and tail cables are all one integrated piece, with no interconnections in between. We deployed 25 m of the tow section over the side and the tail buoy attached near the far channel was floating nearly 100 m behind the boat (Fig. 6).

Thanks to the streamer overall simple design, light weight, small diameter (32 mm) and tight bend radius (46 cm nominal), we could manually deploy and recover it in under 10 minutes. To

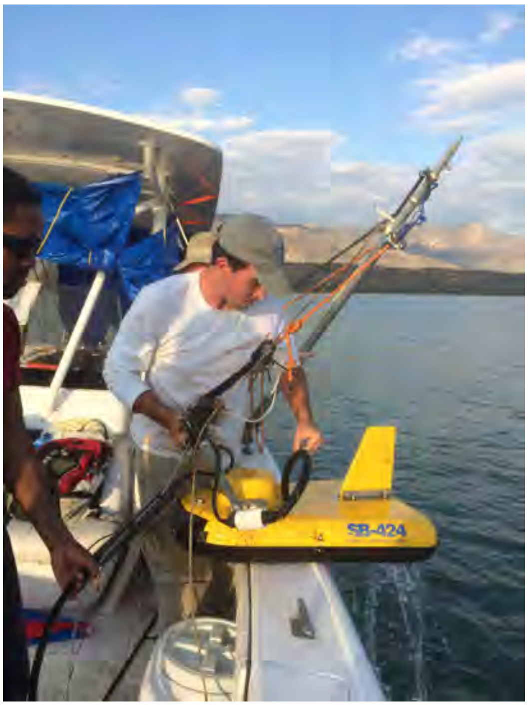


Figure 8. Seismic reflection systems
Top left: Edgetech 424 subbottom profiler (CHIRP)
Top right: FSI BubbleGun seismic source
Left: Geometrics MicroEel 24-channel ministreamer coiled in prow of survey boat.
Above: Geometrics Geode seismograph

control the depth of the streamer during acquisition, we ballasted it with lead flashing and attached a drogue at its tail end, as described below in section 8.3.

6.3.3 Seismograph: Geometrics "Geode" and SCS software

The small, lightweight *Geometrics* Geode (Fig. 8) received the output of all 24 channels and digitally transmitted them to the acquisition laptop. The associated operating software, Seismodule Controller Software (SCS), allowed monitoring of each of the 24 channels in real time from the laptop. Shot gathers were recorded on the laptop's hard drive during the survey, and backed up every evening on an external hard drive.

7. CORING SYSTEM: *LacCore's* BOLIVIA CORER AND CATARAFT PLATFORM

The coring system used for this project was provided through the NSF National Facility "LacCore" at University of Minnesota - Minneapolis (LacCore.org). A detailed description of the *LacCore* Bolivia corer is included in the appendix.

The Bolivia corer is a drive rod piston corer that can be used in waters up to 30 m deep (Fig. 9). Operations consist in manually pushing 1.5 m-long section of tubing in the sediments, recover them, and repeat. Three people can operate the Bolivia corer: One person lowers the corer, one adds 1.5 m-long drive rods as needed, and one keeps tension on the piston cable to create the needed suction for the sediments to fill the core barrel as it being pushed into the lake bed. Each section consists of a polycarbonate barrel with a diameter of 7 cm (2.75"). The transparent polycarbonate barrel (rather than the steel barrel used with the more standard Livingstone coring system) allows each core section to be saved and stored without having to extrude it. On the other hand, the weakness of polycarbonate requires that sediments not be too hard or the barrel will bend. Under ideal conditions, up to ~17 m of sediments can be recovered with successive 1.5 m drives of a Bolivia corer. For coring deep below the lake bed in water depth greater than ~5 m, a makeshift casing can be assembled from several 1.5 m-long sections of PVC drain pipes each fitted with threaded connectors. We prepared 14 PVC sections as we anticipated the possibility of coring in 20 m water depth.

Deployment of the Bolivia corer also requires a platform with a "moon pool", an opening in the platform through which the coring system can be lowered and recovered. The LacCore "cataraft" is such a platform (Fig. 10). It is easily assembled and disassembled and can be shipped anywhere around the world. It is comprised of two 4.5 m inflatable pontoons, a rigid metal frame, and two sheets of plywood. It must be fixed to the lake bed using at least 3 anchors prior to coring.

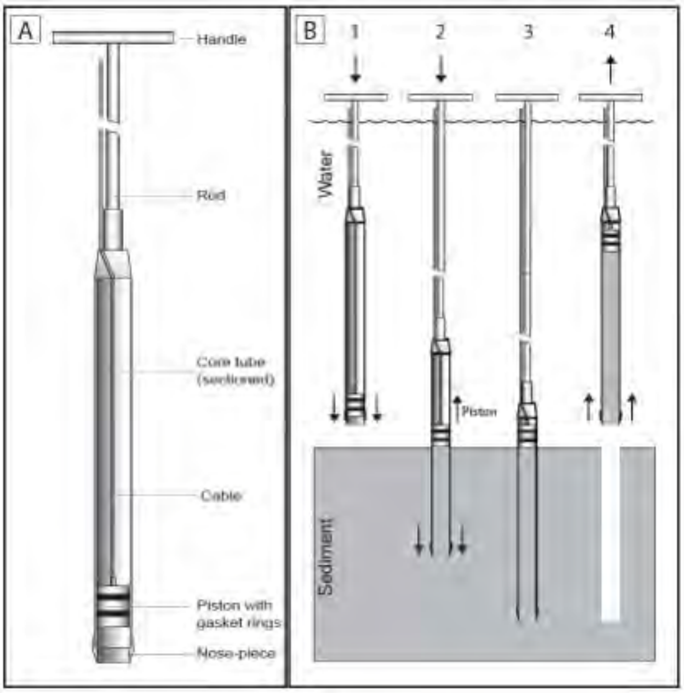


Figure 9. *After Woodward & Sloss, 2013.*
A) The main features of the Livingstone corer, a system that is similar to the Bolivia corer used for this project.
B) Diagram depicting the sampling sequence:
1. Piston is lowered on extension rods to lake bed.
2 & 3. Tension is kept on piston cable to keep piston stationary as the core tube is pushed in the sediments.
4. Core tube is brought back to surface by pulling and disconnecting the extension rods.

Figure 10. The assembled coring platform, the "cataraft". The gap between the two sheets of plywood is just enough for lowering and recovering the Bolivia corer.

8. DATA ACQUISITION

8.1 Summary

Altogether, we acquired 222 km of multichannel seismic profiles, 197 km of CHIRP profiles, and 12 km of single channel seismic profiles (Figs. 11, 12, and 13). Survey lines are laid out in a grid pattern, striking parallel (NW-SE) and perpendicular (SW-SE) to the long axis of the lake. Profiles are spaced 1.2 km apart in both directions. Additional N-S, E-W, NNE-SSW, and NNW-SSE-striking profiles were acquired at the southern end of the lake (Fig. 14), where the active fault zone may extend under the lake. A few tightly-spaced CHIRP profiles were also acquired over a fold structure along the eastern shore on Day 9 (Fig. 15), in anticipation for coring. We strived to maintain a survey speed of 3.0 knot, with actual speed ranging from 2.7 to 3.3 knots. Successive days of routine seismic acquisition are labeled Day 1 (January 19) through Day 9 (January 27) and, accordingly, seismic lines are numbered 100, 101, ... for day 1; 200, 201, … for day 2; and so on. MCS and CHIRP data were acquired concurrently between January 21 and 26 (Day 3 to Day 8).

The shallow draft of the boat allowed for surveying right to the shoreline where desired. However, because the lake level was a dramatic ~10 m lower only ten years ago, we avoided surveying in water shallower than 5 m for fear of entangling the towed equipment with recently submerged trees or man-made structures.

The last two days of the survey were dedicated to collecting short sediment cores. Strong winds during these last two days prevented us from coring in exposed locations. Three cores were collected, with the first two being duplicates of each other.

8.2 Single Channel Seismic Reflection (January 17)

Once the multichannel streamer was satisfactorily ballasted by morning's end on January 17, we proceeded to test the BubbleGun seismic source with the deployment of the 5 m-long single-channel streamer (Fig. 13). The acquisition log for these 12 km of single channel seismic data is provided in the appendix.

8.3 Multichannel Seismic Reflection (January 18 to 26)

On January 16 and 17, prior to routine MCS acquisition, we experimented with taping lead flashing to the streamer to ensure that it would tow at a water depth of ~90 cm at survey speed ranging between 2.9 and 3.1 knots. It was determined that this was the optimal depth to push the first notch from the surface ghost out to 800 Hz, near the high end of the power spectrum for the BubbleGun source: At half that frequency (400 Hz), a fourth of the seismic wavelength through the water equals 0.94 m [= 1500 m/s : 400 Hz : 4]. Since the BubbleGun source was towed at ~1 m below the lake surface, the first notch from the surface ghost for both the source and the receiver should occur near ~800 Hz.

The spacing of lead flashing along the streamer was determined by trial-and-error, as follows. We strapped three *Star-Oddi* pressure sensors ("milli data storage tags") next to hydrophones #1, midway between #12 and #13, and next to #24 and ran a series of wet tests (Fig. 16). The streamer had to be pulled back on board to recover the three depth sensors and read the depth measurements after each test. By iterative process, we added/shifted lead flashing at interval along the streamer until we were satisfied that it averaged 90 cm depth (+/-10 cm) at a towing

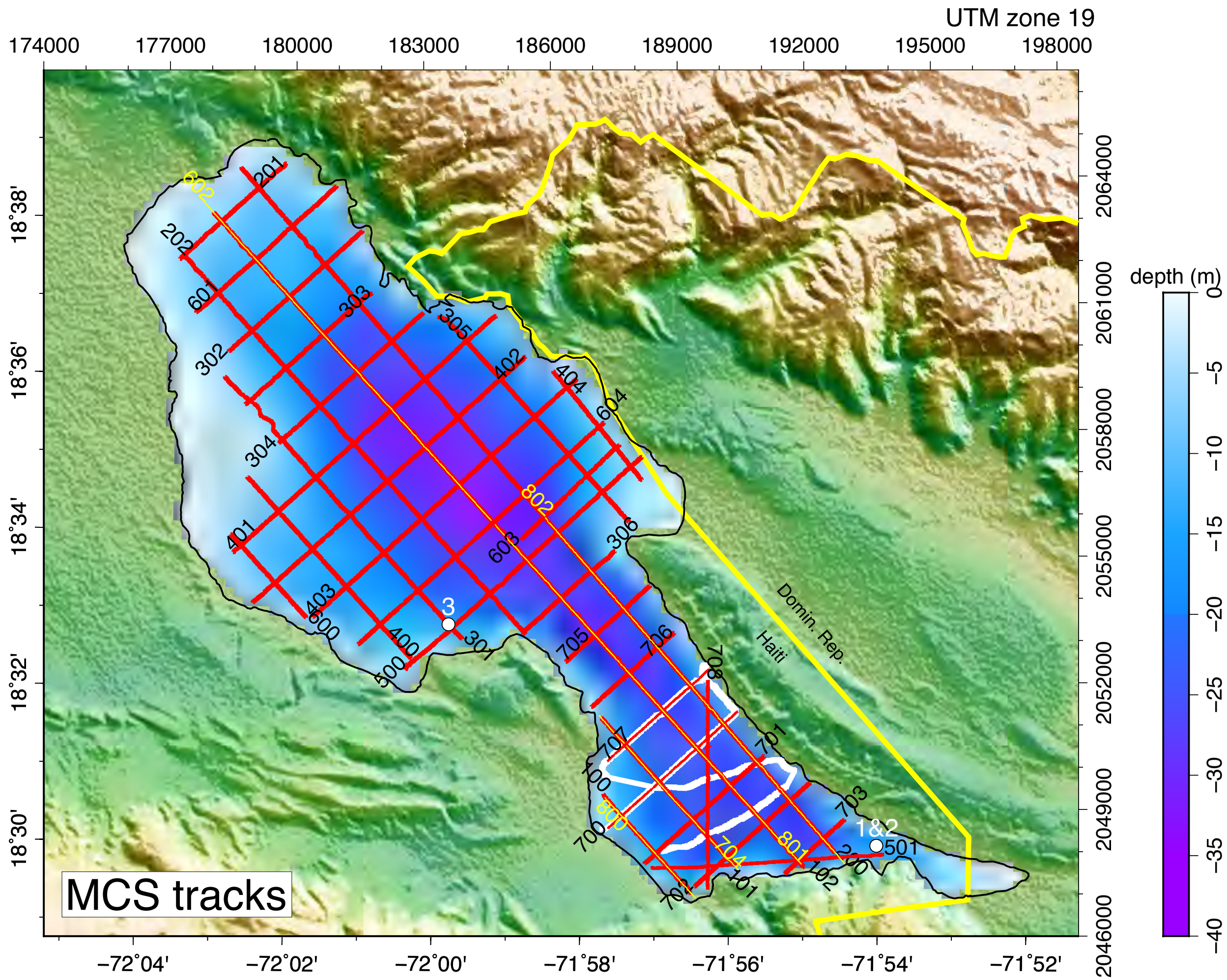


Figure 11. Multi channel seismic reflection lines acquired on January 18 (test lines, in white) and January 19 through 26 (red and yellow lines). Some lines were acquired twice to ensure both CHIRP and MCS data were collected along the same profiles. Line numbers are labeled at the beginning of each lines. White dots indicate the locations od the cores collected.

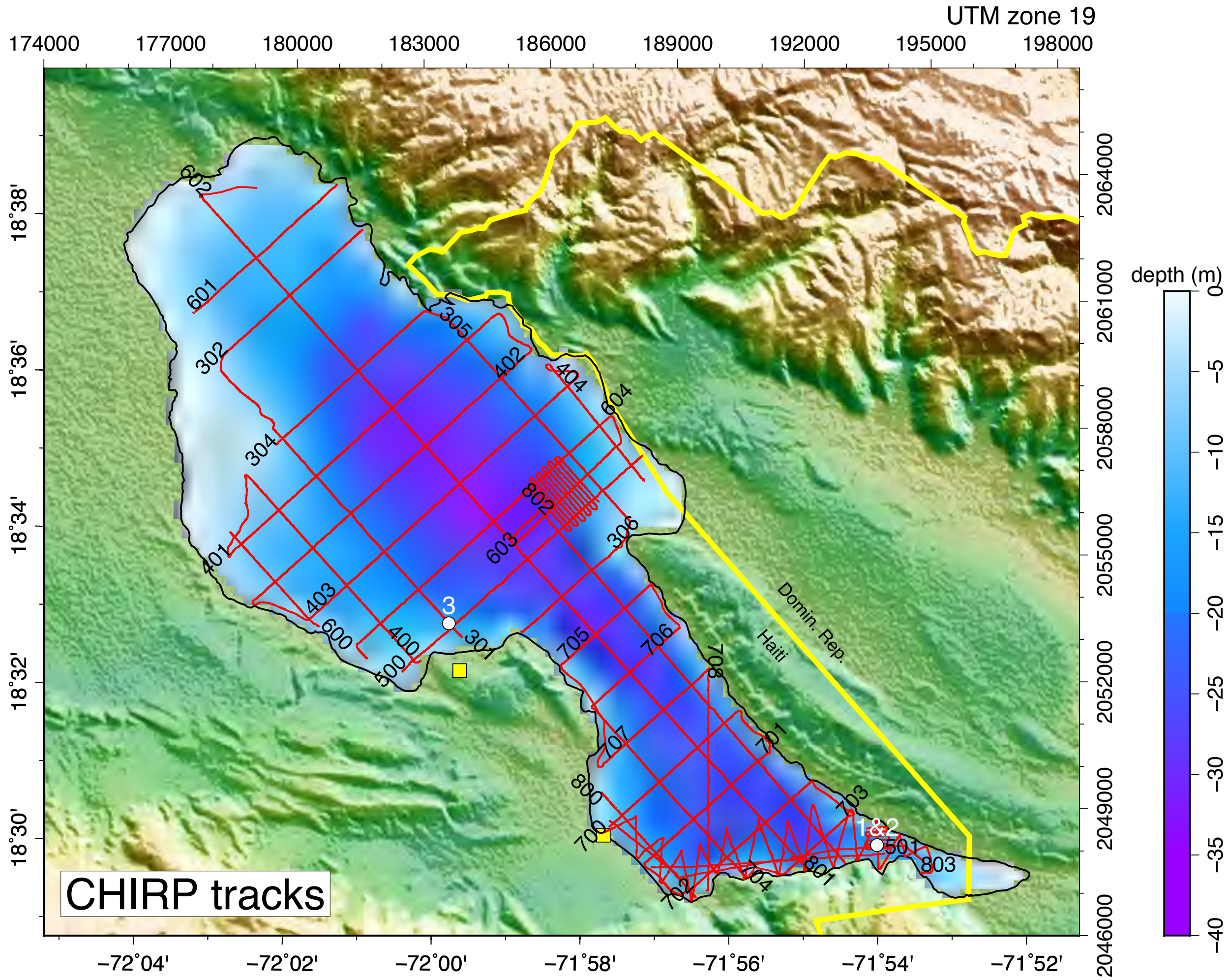


Figure 12. CHIRP lines (red lines). Line numbers are labeled at the beginning of each line. White dots indicate the locations of the collected cores. Small yellow squares indicate the locations of Parc naturel Quisqueya and the Taino Aqua ferme.

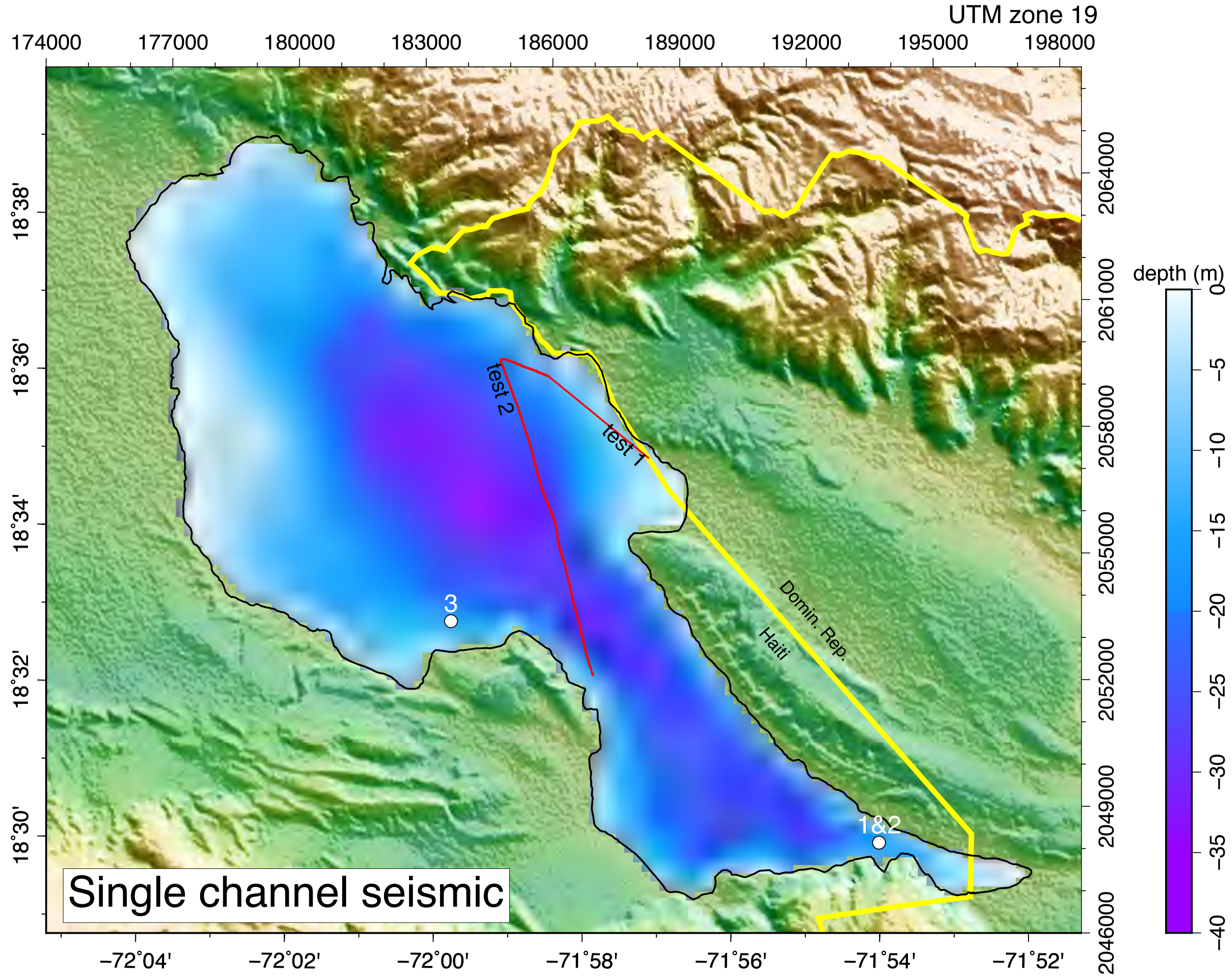


Figure 13. Single channel seismic reflection test lines (in red) acquired on January 17. White dots indicate the locations od the cores collected. The border between Haiti and the Dominican Republic is indicated in yellow.

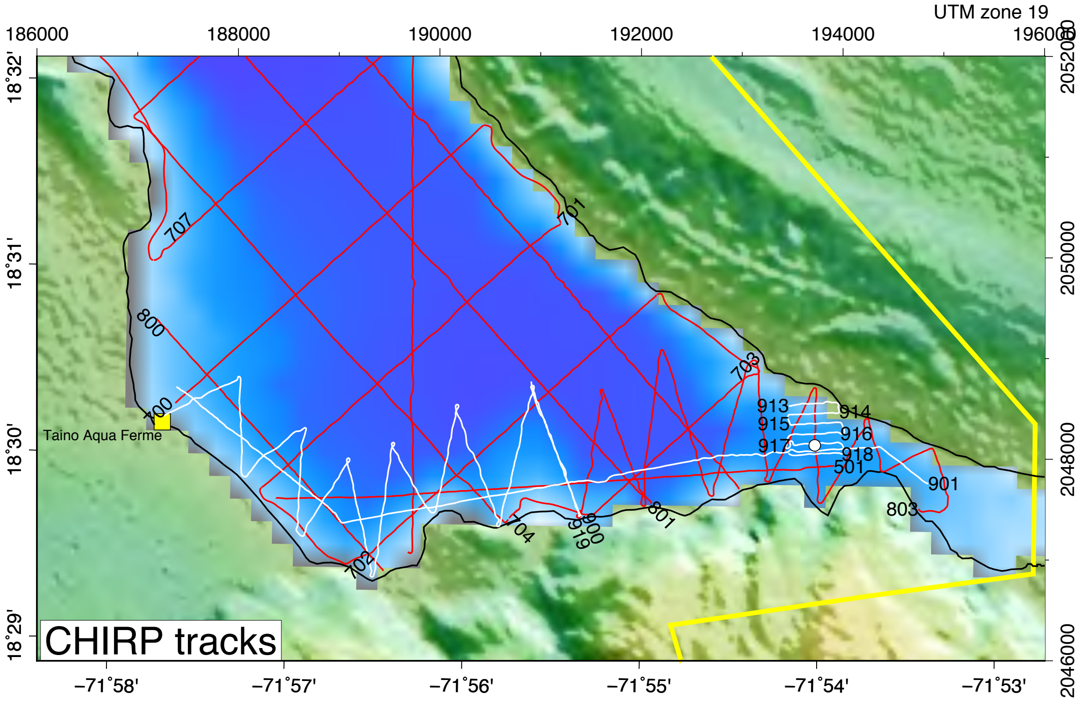


Figure 14. CHIRP lines acquired in the southern half of the lake. Profiles acquired on Day 9 are plotted in white. Line numbers are labeled at the beginning of each line. White dots indicate the locations of the collected cores. Line numbers are labeled at the beginning of each line.

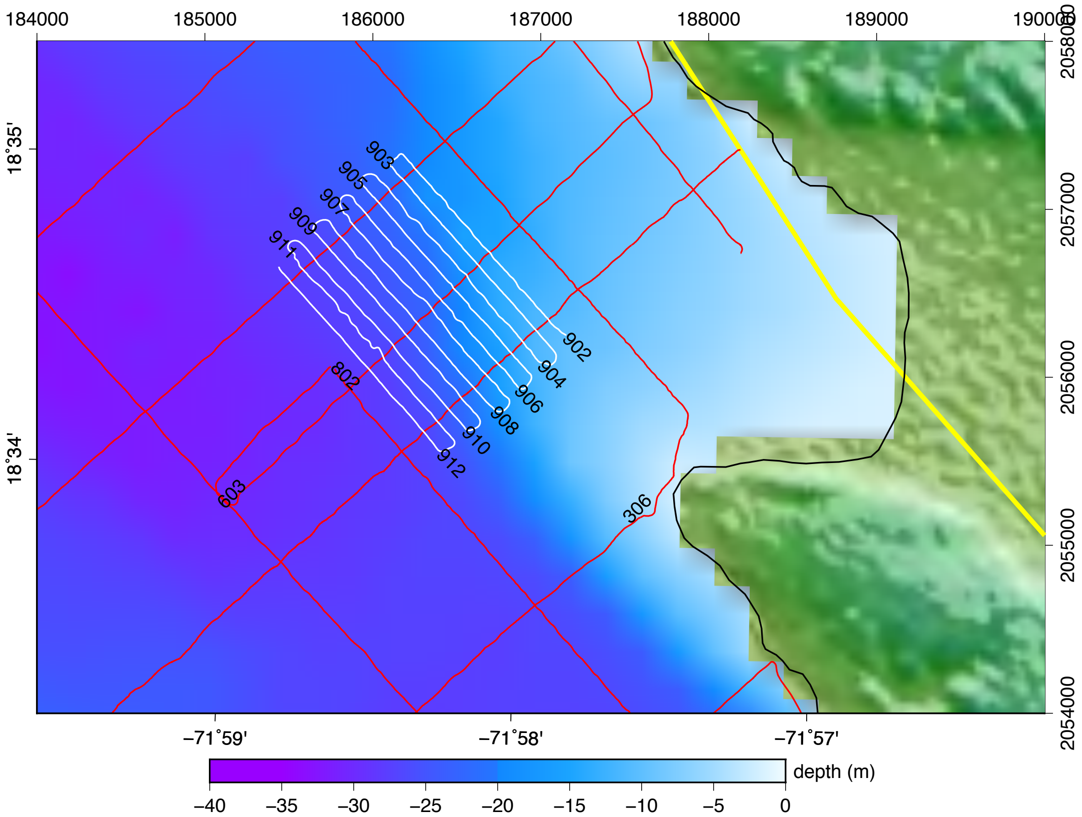


Figure 15. CHIRP profiles collected along the east shore of the lake. Line numbers are labeled at the beginning of each line; site survey carried out on Day 9 is in white. Line numbers are labeled at the beginning of each line.

Figure 16. A *Star-Oddi* pressure sensor within its protective housing, strapped to the seismic streamer. Three such depth sensors strapped near channels 1, 12-13, and 24 internally recorded the depth of the streamer with centimeter accuracy.

Figure 17. A makeshift drogue was inserted between the tail of the streamer (about 4 m behind it) and the tail buoy in order to minimize the undulation of the streamer while under tow. The tail buoy is at left, and the drogue, a plastic tube containing 2 lb of lead weight, is at right.

speed of 3 knots. To minimize the undulation of the streamer in its middle section, we also improvised a drogue, a hollow tube filled with lead weights and attached between the tail of the streamer and the tail buoy (Fig. 17). We ran a few tests to find the appropriate parameters for the drogue, which turned out to be a 3-4 m-long rope and 2 lb of diving weight.

On January 18, we experienced various issues with the MCS acquisition system which we resolved by mid-afternoon, at which point we acquired a few test profiles with the 24-channel streamer.

On January 19 (Day 1), routine acquisition of MCS data (Fig. 18) started and continued until mid-day on January 26 (Day 8). We adopted a shooting interval of 1 sec, to ensure a fold that was a close as possible to 24. The system configuration is sketched in Fig. 6, and the acquisition logs are provided in the appendix.

8.4 Subbottom Seismic Profiling (CHIRP) (January 21 to 27, Day 3 through Day 9)

By the end of Day 2 of the MCS acquisition, all was running smoothly and it was decided to simultaneously acquire higher resolution CHIRP data starting on Day 3. The ping rate was set at 6Hz for the first two profiles, but a ping rate of 5 Hz was then adopted for the remainder of the survey. The CHIRP was towed from a fishing outrigger pole on the port side of the boat. The rigging was adjusted so that the CHIRP remained about 1 m below the surface of water with the boat running at 3 knots. The pole was held in place with ropes tied to the front of the boat and to the center console (Fig. 19). This set-up proved suitable for the entire survey. See log sheets in the appendix for a summary list of CHIRP profiles and Figs. 12, 14, and 15 for their locations.

Preliminary inspection of the data reveal numerous instances of what appears to be young turbidite sequences being actively folded (Fig. 20).

Figure 18. _Left_: *BubbleGun* seismic source is lowered in the water. _Right_: *BubbleGun* under tow; the seismic source itself dangles ~1 m below the two blue floats; the streamer is not visible, towing ~90 cm below lake surface.

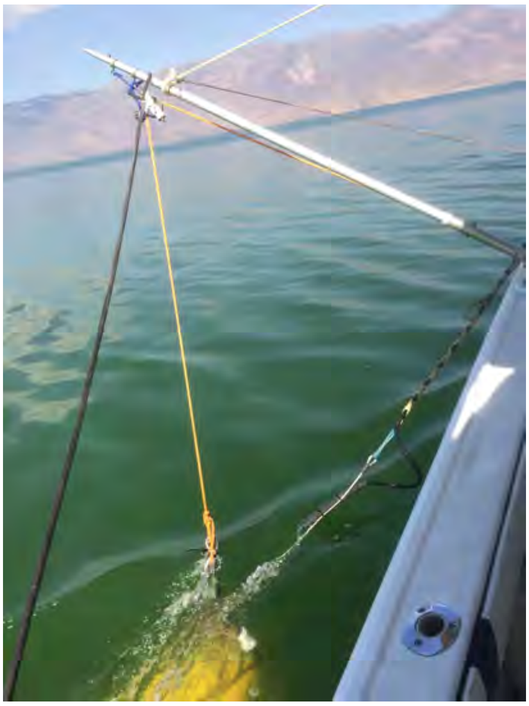


Figure 19. The *Edgetech 424* CHIRP under tow using a fishing outrigger pole on the port side of the boat.

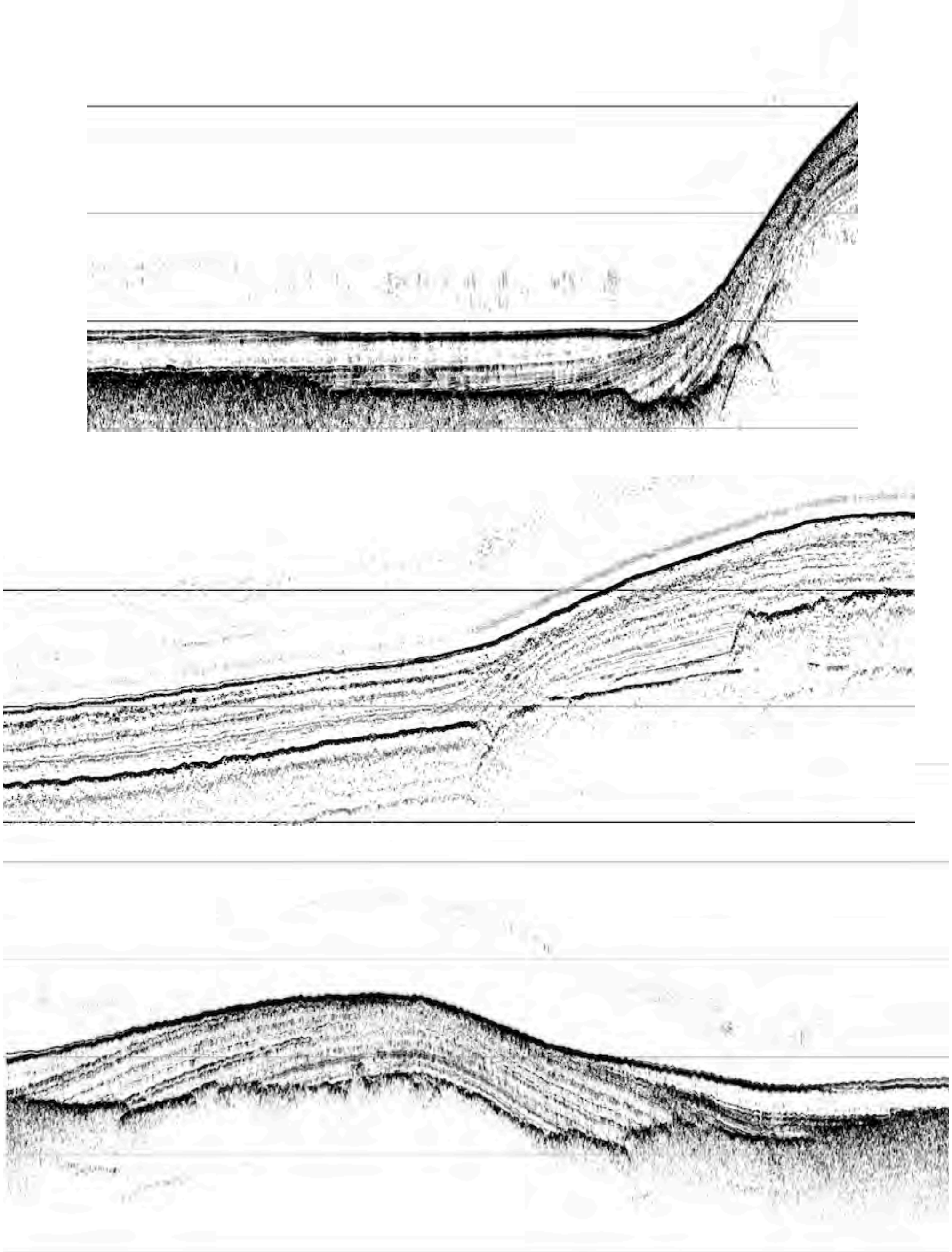


Figure 20. Three samples CHIRP profiles acquired in the southern half of the lake that provide evidence for active folding. Time lines are spaced every 0.005 sec (= 3.75 m in water). Gas fronts often obscure the stratigraphy several meters below lake bottom.

8.5 Coring (January 28 and 29)

Our intention was to choose core locations that strategically targeted strata that pinch-out against the limbs of anticlines, as would be expected to occur along active folds. Several such locations were identified in CHIRP profiles acquired during the previous survey days. Such strategy should allow us to obtain a longer range of chronostratigraphy than would be possible with the same length of core near the lake's depocenters. However, particularly strong winds on the second day of coring forced us to abandon our chosen targets and to seek instead an area sheltered from the east wind, an area that displayed uneventful flat strata near the surface (core locations indicated on Figs. 11 through 14).

In the end, three short cores were collected using LacCore's Bolivia Corer deployed from the cataraft platform (Fig. 21). The cataraft was towed by the boat to the coring targets and anchored there; the boat stayed adjacent to the cataraft, both for easing the exchange of coring elements and for safety reasons.

Note that the core positions indicated below are the intended coring positions, as a hand-held GPS was not used on the cataraft. Due to strong winds on both coring days, we experienced difficulties anchoring the cataraft; in the end, we had to use the boat as one of the anchors. The pilot, José Roy, positioned the boat as best as he could so that the cataraft would be as close as possible to the intended target. We estimate that the probable deviations from these intended positions are up to 10-15 m. Because of strong afternoon winds, we also had to cancel coring operations earlier than anticipated each day, and had to cancel coring operations altogether on January 30.

Each of the three cores collected bottomed onto a resistant layer less than 1 m below the lakebed (Figs. 22 and 23). Visual inspections through the transparent polycarbonate tubing revealed a reddish layer near that depth; its nature is unknown at time of writing of this report.

Core #	**Position (intended)**	**Date & time**	**Water depth (from boat echosounder)**	**Corer Penetration**	**Core Recovery**
LA17BC-01-1	18°30.0931'N 71°54.0302'W *UTM*: *193,720 m* *2,048,138 m*	January 28 19:15 GMT	19.7 m	82 cm	bottom 26 cm missing
LA17BC-02-1 (duplicate)	18°30.0931'N 71°54.0302'W *UTM*: *193,720 m* *2,048,138 m*	January 28 19:30 GMT	19.8 m	87 cm	87 cm
LA17BC-03-1	18°32.8442'N 71°59.8324'W *UTM*: *183,585 m* *2,053,384 m*	January 29 15:30 GMT	16.0 m	74 cm	74 cm

Figure 21. *Top*: Anchors are dropped to stabilize the cataraft prior to coring. A TV crew from *Télé Métropole* and the Recteur of the State University of Haiti (UEH) are aboard the boat in the background.
Bottom Left: Adding drive rods to the Bolivia corer.
Bottom right: Removing the piston from the recovered core.

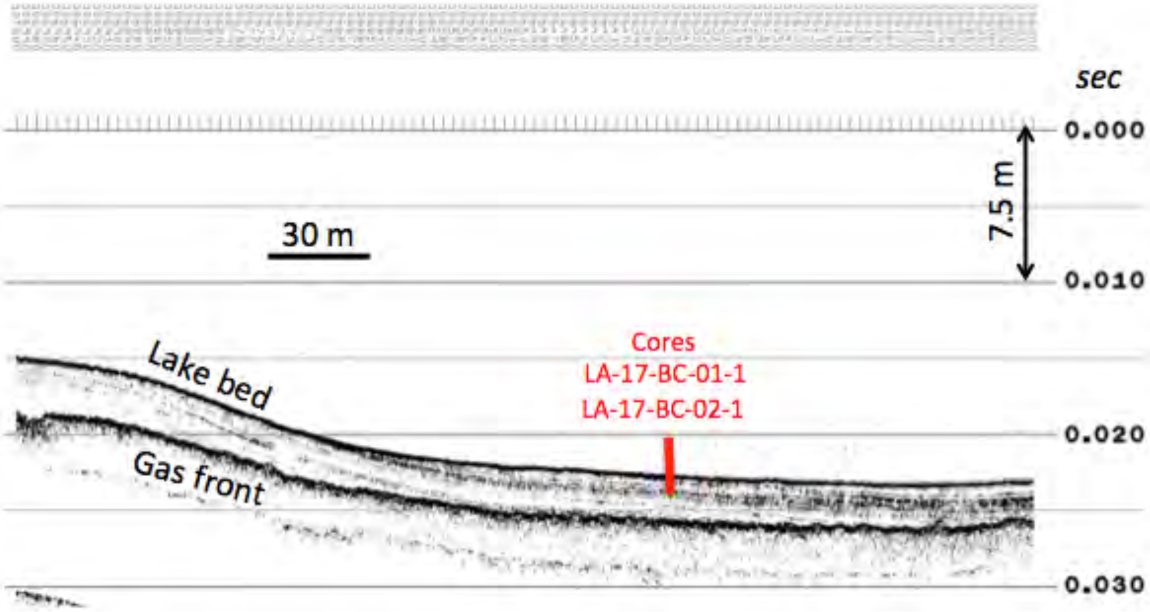


Figure 22. Intended position of cores LA-17-BC-01-1 and LA-17-BC-02-1 overlaid on CHIRP profile.

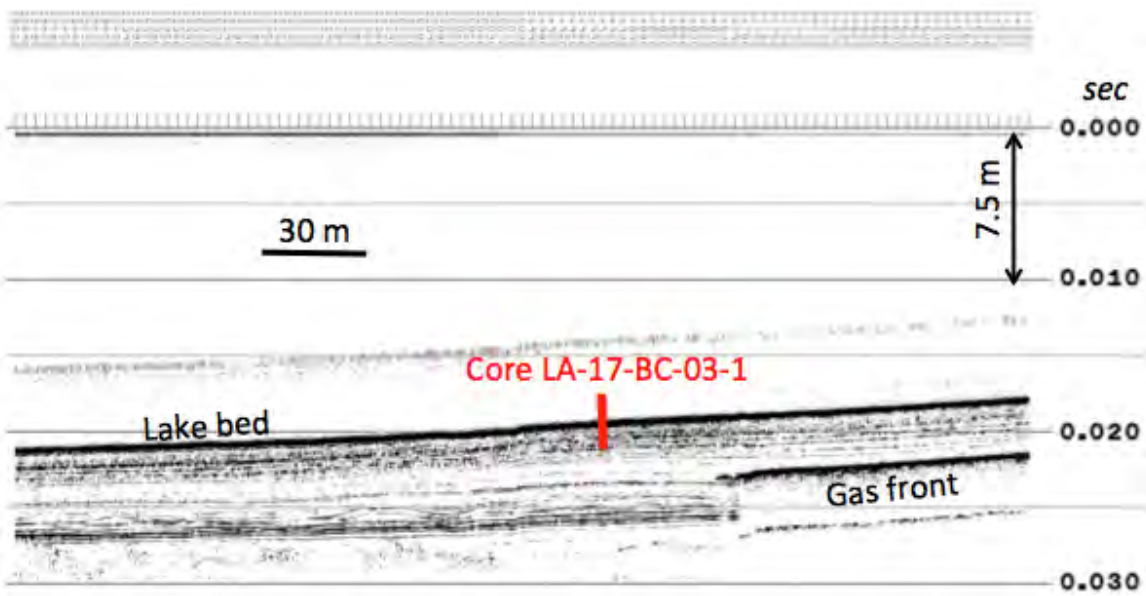


Figure 23. Intended position of cores LA-17-BC-03-1 overlaid on CHIRP profile.

9. ON-SITE DATA PROCESSING

Seismic data acquired during the day were backed up on external hard drives back at base camp in the evening. Because our main focus throughout the survey was to insure that data of the highest quality were acquired, on-site data processing was a secondary objective. Rustic conditions, the lack of Internet connectivity, and the lack of electricity during daylight hours limited the amount of data treatment we were able to accomplish. Nonetheless, we met our objective of training our students in the principles and practices of MSC and CHIRP data acquisition and its initial treatment.

10. EDUCATION, OUTREACH, AND COLLABORATIONS

Outreach and education figured prominently during the data acquisition phase and will continue to do so throughout the entire term of the project. Pamphlets explaining the project and its potential benefits to the residents of the region were written in French and Creole (pamphlets are included in the Appendix). These were distributed amongst local residents, government officials, and police as well as to administrator, faculty and students of UEH and other local project participants. Prior to the start of data acquisition, a formal visit was made to the Mairie (Town Hall) de Ganthier, the township where the survey took place. We were well received by the Directeur de la Mairie who expressed great interest in the project and appreciation for its potential benefits to his community. We left a stack of pamphlets with him for distribution to members of the public visiting the Mairie.

Survey operations were filmed and members of the scientific party were interviewed by reporters from two Haitian TV channels, *Télé Quisqueya* (January 24) and *Télé Métropole* (January 28). On both occasions, the TV crew boarded a small boat that followed our survey boat on the lake and captured on camera our geophysical and coring operations (e.g., Fig. 21). The reports produced were aired on national evening news programs.

On January 28th, the survey team also received a visit at the Tainos Aqua Ferme dock from 42 UEH civil engineering students, accompanied by our Haitian Colleagues, Professors Dominique Boisson and Roberte Momplaisir, as well as the UEH Recteur, Prof. Fritz Deshommes. Each of the students received our outreach pamphlet. Milene Cormier presented a summary of the project objectives to the students followed by a lively question and answer exchange.

Graduate student Casey Hearn was already highly proficient with most marine geophysical methods, and this project extended his expertise with the multichannel seismic reflection method. In fact, his participation with field acquisition has turned out to be critical to our overall success. In turn, this project will provide research material for part of his PhD dissertation.

A total of 8 Haitian scientists from UEH (Kelly Guerrier, Roberte Momplaisir, Steeve Symithe, Sophia Ulysse, Ebdel Alexis and Jimmy-Heal Charlot) and from the Laboratoire National des Bâtiments et Travaux Publics (Berthoumieux Junior Jean and Silvert Paul) participated in the field project. These visitors arrived in ones and twos throughout the survey, joining the project team for meals and a night at base camp followed by participation in a day of data acquisition on board the boat. Two French scientists, Sylvie Leroy from the Université Pierre et Marie Curie in Paris, and Nadine Ellouz-Zimmermann from the Institut Français du Pétrole et Energies Nouvelles, also visited our field operations for a few days each; together, we discussed how to best integrate results from our respective research projects in Haiti.

While at UEH and during the survey, Lehman undergraduate senior students, Britta Brown and Paul Knotts, interacted extensively with UEH students, conducting interviews for a video documentary they planned on their own initiative, and engaging UEH students in discussions about life in Haiti and Haitian students' educational experiences. This contact was so robust that we came to think of Britta and Paul as student-ambassadors for the project. In addition to these outreach activities, both Lehman students participated in data acquisition, enthusiastically engaging in every aspect of the field experience. Because they both are en route to becoming New York City high school teachers with ~150 students of their own a piece each year, it is anticipated that their experience will propagate outwards to their students and into the community, potentially reaching thousands of people over the next few years. Britta Brown has been accepted into the Masters of Teaching - Earth Science at the American Museum of Natural History. Paul Knotts has been accepted into the Lehman College Masters of Science in Science Education - Earth Science. Both these funded programs are completed within the 18 months and require graduates to teach in high needs New York City schools for 4 years.

11. ACKNOWLEDGEMENTS

Many people contributed to the success of this survey. We gratefully acknowledge our colleagues at the Université d'Etat d'Haïti, Professors Dominique Boisson, Roberte Momplaisir, and Kelly Guerrier for their invaluable scientific contribution to the project and their energetic logistical support. In addition, thanks to their help, our education and outreach efforts in Haiti were much more far-reaching than we had anticipated. We gratefully acknowledge the active support of the Recteur of the Université d'Etat d'Haïti, Prof. Fritz Deshommes, which included, along with others, helping clear all of the equipment through Customs. Professor Nigel Wattrus has lent his expertise with MCS acquisition at no cost to our project: We are indebted for this generous and essential contribution. We are also most appreciative of his daily participation with acquisition on the boat, and the fact that he managed to keep a friendly and humorous attitude despite a myriad of challenges. We deeply appreciate the effort, engagement, and professionalism of our students, Casey Hearn, Britta Brown, and Paul Knotts, who maintained their good humor throughout the project despite sometime challenging conditions. We thank the Laboratoire National des Bâtiments et Travaux Publics for providing a vehicle and a driver, as well as the Bureau des Mines et de l'Energie for logistical support. We thank the direction of the Taino Aqua Ferme, who graciously offered the use of their secured pier for the duration of the project as well as overnight access to an electric outlet for recharging our set of batteries: These services actually proved critical to the success of our project. Jose Roy, from Pegasus Diving, provided much more than a boat, skillful navigation, and friendly professionalism: Thanks to his resourcefulness, we were able to work out a solution for every technical issue that challenged the success of our survey. We thank Prof. Michael Piasecki at City College of New York-CUNY for generously providing his raw 2013 bathymetric sounding of Lake Azuei that greatly facilitated survey planning. Mark Warren at Electronic Sales of New England was most helpful with the lease of his subbottom (CHIRP) profiler. The professionalism of the staff at the LacCore NSF National Facility made it a smooth and pleasant experience to lease their coring system. We thank Marsha Warren at URI for her attention to administrative details and for her friendly support before, during, and after this field survey. The U.S. National Science Foundation financed this project under grants EAR-1624583 and EAR-1624556.

12. REFERENCES

Benford, B., C. DeMets, and E. Calais, GPS estimates of microplate motions, northern Caribbean: evidence for a Hispaniola microplate and implications for earthquake hazard, *Geophysical Journal International, 191, 481*-490, 2012.

Calais, E., A. Freed, G. Mattioli, F. Amelung, S. Jonsson, P. Jansma, S.-H. Hong, T. Dixon, C. Prepetit, and R. Momplaisir, Transpressional rupture of an unmapped fault during the 2010 Haiti earthquake, *Nature Geoscience, 3*, 794-799, 2010.

Douilly, R., J.S. Haase, W.L. Ellsworth, M.P. Bouin, E. Calais, S.J. Symithe, J.G. Armbruster, B. Mercier de Lépinay, A. Deschamps, S.L. Mildor, M.E. Mermonte, and S.E. Hough, Crustal Structure and Fault Geometry of the 2010 Haiti Earthquake from Temporary Seismometer Deployments, *Bulletin of the Seismological Society of America, 103*, 2305-2325, 2013.

Mercier de Lépinay, B., A. Deschamps, F. Klingelhoefer, Y. Mazabraud, B. Delouis, V. Clouard, Y. Hello, J. Crozon, B. Marcaillou, D. Graindorge, M. Vallée, J. Perrot, M.-P. Bouin, J.-M. Saurel, P. Charvis, and M. St-Louis, The 2010 Haiti earthquake: A complex fault pattern constrained by seismologic and tectonic observations, *Geophysical Research Letters, 38*, doi:10.1029/2011GL049799, 2011.

Symithe, S., and E. Calais, Present-day shortening in Southern Haiti from GPS measurements and implications for seismic hazard, Tectonophysics, 679, 117-124, 2016.

Woodward, C.A., and C.R. Sloss, Coring and augering, in *Treatise on Geomorphology*. Academic Press, San Diego, CA, vol. 14, *Methods in Geomorphology*, J. Shroder, A.D. Switzer, A.D., and D.M. Kennedy, (Eds.), pp. 119–137, 2013.

13. APPENDICES

The following documents are appended after this page:

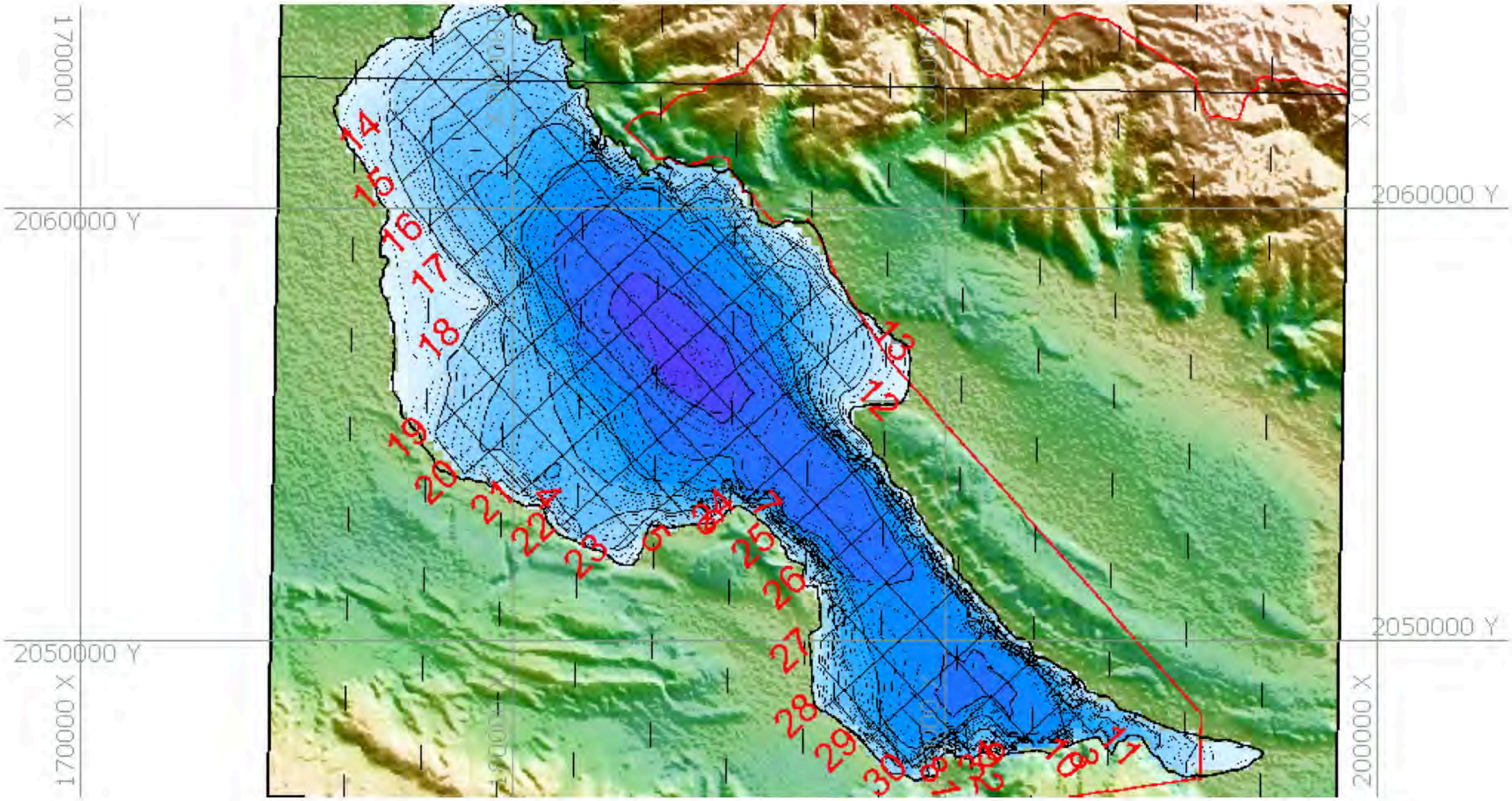
- Summary table of seismic profiles and a map with the Hypack line numbers annotated
- Acquisition log sheets, single channel seismic reflection
- Acquisition log sheets, multichannel seismic reflection
- Acquisition log sheets, CHIRP subbottom profiling
- Manufacturers' specs sheets for the equipment used.
- Pamphlets for distribution to the general public, including the French, Creole, and English versions (each pamphlet is printed double-sided and folded in three like a letter).

DATA ACQUISITION LOGS

LINE NUMBER CORRELATION

Hypack	MCS	CHIRP		Hypack	MCS	CHIRP		Hypack	MCS	CHIRP		Hypack	MCS	CHIRP		Hypack	MCS	CHIRP
4	600	600		**15**	601	601		**26**	706	706		**40**				**51**		910
5	400	400		**16**	302	302		**27**	Test2 707	707		**41**				**52**		911
6	301	301		**17**	303			**28**	Test1 700	700		**42**		901		**53**		912
7	202			**18**	304	304		**29**	701	701		**43**				**54**		913
8	100 800	800		**19**	401	401		**30**	702	702		**44**		902		**55**		914
9	101 704	704		**20**	402	402		**31**	703	703		**45**		903		**56**		915
10	102 602 801	602 801		**21**	403	403		**32**	501	501		**46**		904		**57**		916
11	200 802	802		**22**	604	604		**35**	603	603		**47**		905		**58**		917
12	305	305		**23**	500	500		**37**	708	708		**48**		907		**59**		918
13	404	404		**24**	306	306		**38**		803 900 919		**49**		908		**?**		906
14	201			**25**	705	705		**39**				**50**		909				

HYPACK LINE NUMBERS (LINES 35 THROUGH 59 WERE ADDED ON THE FLY AND ARE NOT PLOTTED)



LAKE AZUEI PROJECT - SINGLE-CHANNEL SEISMIC LOG

DATE: 1/17/2017

Shooting interval: 0.5 sec **Sample interval: 0.25 ms** **Record length: 300ms to 500ms**

Line # (Hypack)	Course (N°E)	Speed (knots)	Start time (GMT)	End time (GMT)	Start/End positions	Comments
TEST LINE # 1	SE-NW	2.74-2.8	20:14:53.593		18°34.9744'N 71°57.2069'W	Along eastern shoreline, heading NW 2.7-2.8 knots. (No corresponding Hypack line)
				20:28:58.924	18°36.2169'N 71°59.1970'W	
TURN			20:28:59.304		18°36.2168'N 71°59.1970'W	
				20:30:08.374	18°36.1821'N 71°59.2205'W	
TEST LINE # 2	NNW-SSE	2.8-2.9	20:30:08.804		18°36.1821'N 71°59.2205'W	Across central part of lake, heading SSE 2.8-2.9 knots. (No corresponding Hypack line)
				22:00:20.546	18°32.1781'N 71°57.9089'W	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG – TEST LINES DATE: 1/18/2017

Shooting interval 1 sec **Sample interval 0.25 ms** **Record length 300ms**

Line # (Hypack)	Course (N°E)	Speed (knots)	Start time (GMT)	End time (GMT)	Start Latitude	Comments
MCS TEST 1 One file per shot First shot #104	N052°E =>NE	~3.0	18:37:52.20	19:19	18°30.4326'N 71°57.4479'W	Hypack line 28, N052°E
						~18:50 turn on the streamer preamp oops!
						Shooting every 1 sec ~18:56 all is grounded.
						End of line 28 @ shot # 2400
						Stopped logging @ 2927 to address grounding issue
						Shot 3475 tried bypassing UPS entirely and going straight to inverter
MCS TEST 2 Shot # 3509	N238°E =>SW	3.0	19:38:47		18°32.1757'N 71°56.4706'W	Start Hypack line 27
						5554: First shot after testing BG tow point
						7350: Change heading after lon E-W test line
						7560: Turning to head West, on Hypack line; loss of laptop connection, logging stopped
						4300: End of day.

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Thursday 1/19/2017** **HAITI DAY 1**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
100(8)	109	154	2.93	14:11			18 30.54 -71 57.57	Hypack line #8; 100-105 are off line; battery 12.55
	1020	158	3.2	14:26			18 30.12 -71 57.15	Very calm surface conditions. Channel 22 still misbehaving.
	1970	154	3.2/3.3	14:41			18 29.52 -71 56.56	
					2038			Total # of records 2374
101(9)	2050	314	3.0	15:14			18 29.84 -71 55.96	Hypack line # 9
	2940	316	3.2	15:29			18 30.39 -71 56.51	Surface conditions flat calm.
				15:42				Lots of missed shots.
	3880	316	3.1/3.2	15:45			18 31.07 -71 57.14	
	4805	319	2.9/3.0	16:01			18 31.63 -71 57.72	Wind increasing.
					4884			2834 records
102(10)	4992	319	2.9/3.0	17.09			18 29.89 -71 55.09	First few shots will be off as the boat settles into the line 4992 is on line.
				17:16				Variable speed 2.4-4kts
	5898	320	2.8/2.9	17:24			18 30.45 -71 55.63	Sea state increased, up to 2 ft waves. Drop off in data quality for far channels.
	7035	310	3.1	17:43			18 31.10 -71 56.27	
	8070	316	2.9/3.0	18:00			18 31.73 -71 56.88	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Thursday 01/19/2017** **HAITI DAY 1**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
102 continued	8919	319	2.9/3.0	18:15			18 32.24 -71 57.38	
				18:19				Quick adjustment in course and speed,
	9879	305	3.2	18:30			18 32.83 -71 57.96	
	10710	320	3.0-3.2	18:45			18 33.36 -71 58.48	
	11696	320	3.2	19:00			18 34.01 -71 59.10	
				19:13				Quick speed adjustments
	12555	311	2.9/3.0	19:15			18 34.54 -71 59.63	
				19:21				Wind increasing, seas 1 ft+ , signal degradation for far hydrophones
	13416	302	3.0	19:30			18 35.06 -72 00.13	
	14279	307	2.8-3.0	19:45			18 35.58 -72 00.64	Wind increasing, seas 1-2 ft, white caps and streaks. Data quality suffering for many hydrophones.
	15204	305	3.0/3.1	20:00			18 36.12 -72 01.17	Wind steady from the WNW , waves building slightly
	16072	307	3.0/3.1	20:15			18 36.64 -72 01.69	
	16924	300	3.1/3.2	20:30			18 37.20 -72 02.25	
	17902	308	3.0/3.1	20:45			18 37.78 -72 02.81	Data quality still reduced by sea state.
					18359	20:53		End of line.

***As appears on log sheet**

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Friday 01/20/2017** **HAITI DAY 2**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
200(11)	100	317	3.1	13:53			18 30.03 -71 54.62	Start of Hypack line 11 on long line axis of lake. Line start location adjusted west to avoid shoreline. Line 11 no longer parallel to the others NW/SE oriented. Conditions calm
	485	309	3.2	14:00			18 30.25 -71 54.82	
	1430	315	3.2	14:15			18 30.87 -71 55.40	Winds light from the east
	2296	316	3.3	14:30			18 31.45 -71 55.95	
	3197	317	3.0/3.1	14:45			18 32.04 -71 56.50	Light winds from the SE, increasing
	4099	323	2.9/3.0	15:00			18 32.68 -71 57.03	
	5025	318	2.9	15:15			18 33.16 -71 57.56	
	5924	319	3.0	15:30			18 33.72 -71 58.09	Winds decreasing, very calm.
	6757	317	3.1/3.2	15:45			18 34.26 -71 58.60	Channel 24 is very noisy and ha been for some time.
	7670	310	2.8/2.9	16:00			18 34.82 -71 59;12	
	8593	312	2.9/3.0	16:15			18 35.39 -71 59.65	
	9588	312	3.1	16:30			18 36.02 -71 00.25	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Friday 01/20/2017** **HAITI DAY 2**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
200(11) continued	10397	315	3.1/3.2	16:45			18 36.55 -72 00.74	
	11262	322	2.9/3.0	17:00			18 37.11 -72 01.27	Channel 24 seems to have settled.
	12185	329	3.1/3/2	17:15			18 37.68 -72 01.82	
	13087	314	3.2/3.3	17:30			18 38.30 -72 02.39	
					13626	17:39		End of line 200/ Hypack line 11
201(14)	13650	199	3.1	18:00			18 38.69 -72 02.14	Start of line 201/Hypack line 14 Wind light from the SW
	14539	227	3.0/3.1	18:15			18 38.21 -72 02.69	
	15460	229	3.3	18:30			18 38.15 -72 03.32	
					15771	18:35		End of line 201/Hypack line 14
202(7)	15790	132	3.2	18:44			18 37.47 -72 03.41	Start of line 202/ Hypack line 7
				18:47				Quick speed adjustments 2.6-3.1 kts. Wind increasing from the west
	16730	143	3.2/3.3	19:00			18 36.88 -71 02.84	
	17630	144	3.4	19:15			18 36.26 -72 02.23	
	18521	143	2.9/3.0	19:30			18 35.65 -72 01.63	Speed corrections. Wind and wave building slightly from W.
	19425	139	3.1/3.2	19:45			18 35.06 -72 01.06	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Friday 01/20/2017** **HAITI DAY 2**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
202(7) continued	20314	139	3.2	20:00			18 34.49 -72 00.50	
	21214	142	3.2-3.4	20:15			18 33.91 -71 59.94	Waves 1 ft plus, winds steady from the west.
	22117	148	3.1	20:30			18 33.39 -71 59.41	
				20:36				Waves increasing 1-2 ft. Signal degraded on far geophones
	23010	146	3.1	20:45			18 32.85 -71 58.90	
					23234	15:49	18 32.73 -71 58.79	End of line 202/ Hypack line 7

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Saturday 01/21/2017** **HAITI DAY 3**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
301(6)	100	320	2.9	15:05			18 32.80 -71 59.80	Start of Hypack line 6.
	1029	321	3.2	15:20			18 32.27 -72 00.26	(it seems that first file was 301, not 300)
	1890	320	3.3	15:35			18 33.84 -72 00.81	Winds light and variable, conditions flat calm.
	2886	319	3.2	15:50			18 34.46 -72 01.46	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Saturday 01/21/2017** **HAITI DAY 3**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
301 (6) continued	3398	322	3.3	16:00			18 34.88 -72 01.83	
				16:11				Very shallow spot, 1.5 m. Diverted from line.
	4236	330	3.2	16:15			18 35.44 -72 02.34	Running ~100m off line to avoid shallows
		311		16;29	4918	16:29		We are about back on track. End of line
302(16)	4940	061	3.1	16:36				Hypack line 16
	5465	047	3.2	16:45			18 36.67 -72 02.41	
	6330	045	3.1	17:00			18 37.15 -72 01.87	
	7261	050	3.3	17:15			18 37.69 -72 01.26	
					7550			
303(17)	7560	247	3.1	17:40			18 37.07 -72 00.95	Hypack line 17
	7855	233	3.2	17:45			18 36.91 -72 01.15	
	8764	233	3.1	18:00			18 36.37 -71 01.77	
	9676	229	3.1	18.15			18 35.84 -72 02.37	Still on Hypack line 17.
					10058	18:22	18 35.62 -72 02.61	End of line 303/Hypack line 17

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Saturday 01/21/2017** **HAITI DAY 3**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
304(18)	10070	045	3.2	18:41			18 35.15 -72 01.12	Start of line 304 Hypack line 18. 18:40 started recording CHIRP file 304
	11226	038	3.2/3.3	19:00			18 35.85 -72 01.33	Winds increasing from the NW. Waves 1 ft or less.
	12109	036	3.3/3.4	19:15			18 36.41 -72 00.70	
					12847	19:27		End of line 18/304.
305(12)	12860	110	3.3	19:31			18 36.77 -71 59.97	Start of line 305/ Hypack line 12
	14198	140	3.2	19:52			18 35.98 -71 59.16	
	14708	143	3.3	20:01			18 35.64 -71 58.82	
	15569	141	3.3/3.4	20:15			18 35.08 -71 58.28	
	16430	141	3.2/3.3	20:30			18 34.53 -71 57.74	
					16961	20:39		End of lien 305/Hypack line12
306(24)	16970	235	3.3	20:47			18 33.77 -71 57.65	Start of line 305/ Hypack line 24
	17765	233	3.5	21:00			18 33.32 -71 58.19	Rough wave conditions from the NW, 2 ft plus.
					18687	21:15	18 32.75 -71 58.85	End of line 306/ Hypack line24

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG DATE: Sunday 01/22/2017 HAITI DAY 4

Shot Interval: 1s Sampling rate: 0.25ms Record Length: 300ms

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
400(5)	100	315	3.0	14:01			18 32.46 -72 00.39	Start of line 400, Hypack line 5 Winds from ENE, moderate, waves 1 ft or less
	896	321	3.0	14:15			18 32.89 -71 00.82	
	1795	322	3.1	14:30			18 33.44 -71 01.35	
	2700	319	2.9/3.0	14:45			18 33.99 -71 01.89	Wind steady form ENE, waves increasing 1.5 ft
	3584	327	3.0	15:00			18 34.54 -72 02.43	
					3837	15:04	18 34.67 -72 02.60	End of line 400, Hypack line 5
401(19)	3850	043	2.8/3.0	15:30			18 33.74 -72 02.71	Start of line 401, Hypack line 19 Wind steady from ENE, waves 1.5 ft
	4765	053	2.8	15:45			18 34.21 -72 02.17	
	5635	051	2.8	16:00			18 34.69 -72 01.64	
	6525	054	3.0	16:15			18 35.18 -72 01.09	
	7477	054	3.0/3.1	16:30			18 35.71 -72 00.49	Wind steady, shifting towards SE
	8318	049	3.1	16:45			18 36.73 -71 59.93	
	9222	055	3.0	17:00			18 36.73 -71 59.35	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG DATE: Sunday 01/22/2017 HAITI DAY 4

Shot Interval: 1s Sampling rate: 0.25ms Record Length: 300ms

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
401 (19) continued					9373	17:02	18 36.81 -71 59.25	End of line 401, Hypack line 19 wind from SW waves 1-1.5 ft
402(20)	9380	202	2.9	17:19			18 36.26 -71 58.88	Start of line 402, Hypack line 20
	10084	226	3.1/3.2	17:30			18 35.87 -71 59.33	
	10926	228	3.2	17;45			18 35.38 -71 59.87	
	11818	225	3.0	18:00			18 34.88 -72 00.45	Wind speed decreasing slightly, still from SW
	12718	222	3.2	18:15			18 34.35 -72 01.03	
	13634	210	3.2	18;30			18 33.80 -72 01.65	
	14512	225	3.3	18:45			18 33.26 -72 02.26	
					14824	18:50	18 33.08 -72 02.47	End of line 402, Hypack line 20
403(21)	14830	050	3.0	19:04			18 32.96 -72 01.62	Start of line 403, Hypack line 21
	15460	053	3.0	19:15			18 33.26 -72 01.24	Winds light from NW
	16431	048	3.1	19:30			18 33.51 -72 00.63	
	17256	056	3.1	19:45			18 34.29 -72 00.09	
	18140	054	3.1	20:00			18 34.81 -71 59.50	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Sunday 01/22/2017** **HAITI DAY 4**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
403(21) continued	19061	053	3.0	20:15			18 35.35 -71 58.90	
	19937	059	3.2	20:30			18 35.86 -71 58.32	
					20210	20:34		End of line 403, Hypack line 21
404(13)	20222	144	2.9	20:46				Start of line 404, Hypack line 13 Line adjusted away from shoreline, no longer parallel
	21021	141	3.0	21:00				Winds still light from the NW
	21919	144	3.0	21:15			18 35.02 -71 57.51	
					22381	21:22	18 34.73 -71 57.26	End of line 404, Hypack line 13

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Monday 01/23/2017** **HAITI DAY 5**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
500(23)	112	047	Variable	13:09			18 32.27 -72 00.38	Start of line 300, Hypack line 23 Ignore shots 100-111 Wind stiff from the ENE, whitecaps and rollers
	459	054	2.6	13:15			18 32.45 -72 00.19	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Monday 01/23/2017** **HAITI DAY 5**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
500 (23) continued	1370	054	2.8	13:30			18 32.92 -71 59.83	Signal degraded on far channels, waves choppy 1-2 ft
	2240	052	3.2	13:45			18 33.42 -71 59.06	Waves increasing, 2 ft plus. Lots of fetch
	3140	057	2.6	14:00			18 33.87 -71 58.57	
	4040	045	2.7	14:15			18 34.40 -71 58.09	Signal degraded for far channels
	4965	062	3.0	14:30			18 34.75 -71 57.57	Wind increasing. Shorter fetch has wave heights temporarily lower
					5446	14:38	18 35.03 -71 57.26	End of line 500, Hypack line 23
501(32)	~5550	266	3.2	15:47			18 29.97 -71 57.10	Start of line 501, Hypack line 32 Improvised line in southern corner of lake; before streamer was traveling in direction of the wind. Several shots before streamer was powered on.
	6393	263	3.1	16:00			18 29.91 -71 54.77	
	7269	260	3.0	16:15			18 29.85 -71 55.52	
	8147	265	2.8	16:30			18 29.79 -71 56.26	Continuing beyond extent of planned line 32
	9045	262	2.7	16:45			18 29.76 -71 56.99	Seeing some 60 cycle noise here
					9158	16:46		End of line 501, Hypack line 32

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Tuesday 01/24/2017** **HAITI DAY 6**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
600 (4)	100	313	3.3	14:01			18 32.92 -72 01.77	Start of line 600, Hypack line 4 Wind moderate from NE, waves 1.5 ft
	900	316	3.0	14:15			18 33.38 -72 02.22	Streamer settled down towards end of line 600.
					1853	14:30	18 33.93 -72 02.77	End of line 600, Hypack line 4
601(15)	1860	041	2.8	16:03			18 36.83 -71 03.24	Start of line 601, Hypack line 15 Winds light from the east, waves 1 ft
	2180			16:09				Strongly dipping reflector in MCS
	2552	047	2.9	16:15			18 37.17 -72 02.86	
	3457	039	3.3	16:30			18 37.68 -72 02.26	
	4371	042	2.7	16:45			18 38.18 -72 01.70	
					4843	16:53	18 38:44 -72 01.43	End of line 601, Hypack line 15
602(10)	4850	131	2.9	17:20			18 38.16 -72 03.16	Start of line 602, Hypack line 10 Second time running line 10, this time starting NW corner under improved survey conditions. Winds light from SE, Waves <1 ft
	5392	131	2.9	17:30			18 37.85 -72 02.86	
	6290	140	2.7	17:45			18 37.35 -72 02.37	

LAKE AZUEI PROJECT MULTICHANNEL SEISMIC LOG **DATE: Tuesday 01/24/2017** **HAITI DAY 6**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
602(10) continued	7296	132	3.2	18:01			18 36.72 -72 01.75	
	8100	132	3.0	18:15			18 36.23 -72 01.28	Winds calm.
	9135	138	3.2	18:32			18 35.60 -72 00.65	
	9909	135	3.2	18:45			18 35.10 -72 00.18	Calm conditions continuing on line 602
	10740	134	3.2	19:00			18 34.53 -71 59.61	
	11059	131	3.3	19:15			18 33.92 -71 59.02	
					11609	19:17		End of line 602, Hypack line 10 Broke off line 10 to start crossline 35
603(35)	11620	045	3.1	19:19			18 34.01 -71 58.79	Start of line 603, Hypack line 35
	12290	039	3.2	19:30			18 34. 37 -71 58.42	Wind light form the west.
	12997	054	3.3	19:45			18 34.93 -71 57.82	
					13389	19:52		End of line 603, Hypack line 35
604(22)	13400	228	3.0	20:20			18 35.44 -71 57.81	Start of line 604, Hypack line 22 Wind increasing from west
	14190	233	3.1	20:15			18 35.00 -71 58.31	Many missing shots.

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Tuesday 01/24/2017** **HAITI DAY 6**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
604(22) continued	14811	234	3.0	20:30			18 34.46 -71 58.91	Wind increasing from west, waves 1 ft plus with chop.
	15611	233	3.3	20:45			18 33.93 -71 59.51	
	16275	249	3.0	21:00			18:33.39 -72 00.11	
	17130	223	3.1	21:16			18 32.82 -72 00.75	
					17592	21:24		End of line 604, Hypack line 22

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
700(28)	100	050	2.9	14:17			18 30.28 -71 57.61	Start of line 700, Hypack line 28 Intermittent 60-cycle noise
	937	050	3.0	14:30			18 30.73 -71 57.10	Light wing from the north, waves <1 ft. Channels 12, 22, 24 misbehaving.
	1513	045	2.9	14:45			18 31.18 -71 56.59	
	2488	046	2.9	15:00			18 31.72 -71 55.89	
					2615	15:02		End of line 700, Hypack line 28 ***Adjusting record length to 0.275 sec to try to resolve the trigger issue

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
701(29)	2620	240	3.0	15:18			18 31.16 -71 55.62	Start of line 701, Hypack line 29
	3363	228	3.15	15:30			18 30.79 -71 56.05	Still seeing occasional trigger faults although the length of the delays dropped slightly.
	4020	231	3.1	15:45			18 30.27 -71 56.63	Trigger faults returned, no change from previous record length setting. Wind calm.
					4806	15:58	18 29.81 -71 57.14	End of line 701, Hypack line 29
702(30)	4810	048	2.95	16:15			18 29.55 -71 56.43	Start of line 702, Hypack line 30
	5692	053	3.05	16:30			18 30.04 -71 55.88	
	6560	046	3.05	16:45			18 30.56 -71 55.30	
					7149	16:55	18 30.88 -71 54.93	End of line 701, Hypack line 30
703 (31)	7160	226	2.9	17:11			18 30.41 -71 54.48	
	7685	228	3.0	17:20			18 30.12 -71 54.79	
	8285	229	3.0	17:30			18 29.79 -71 55.17	
					8431	17:32		End of line 703, Hypack line 31

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
704(9)	8440	320	3.2	17:44			18 29.77 -71 55.89	Start of line 704, Hypack line 9
	9360	321	3.0	18:00			18 30.33 -71 56.45	
	10250	324	2.9	18:15			18 30.87 -71 56.98	
	11286	321	2.9	18:30			18 31.47 -71 57.57	
					11668	18;39		End of line 704, Hypack line 9
705(25)	1180	040	3.15	18:52			18 32.40 -71 58.22	Start of line 705, Hypack line 25
	12155	047	3.2	19:00			18 32.67 -71 57.92	Wind light from the NW
	13052	041	3.2	19:15			18 33.20 -71 57.32	
					13361	19:20		End of lin3 705, Hypack line 25
706(26)	13370	236	3.3	19:31			18 32.76 -71 56.82	Start of line 706, Hypack line 26
	14204	229	3.5	19:45			18 32.76 -71 57.43	
					14931	19:57		End of line 706 HYPACK LINE 26
707(27)	14940	044	3.1	20:21			18 31.13 -71 57.64	Start of line 707, Hypack line 27
	15975	043	2.95	20:12			18 31.73 -71 56.98	
	16877	033	2.9	20:45			18 32.22 -71 56.41	Wind building from MW.
					17057	20:48		End of line 707, Hypack line 27

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
708(37)	17070	181	3.2	20:59			18 32.15 -71 56.32	Start of Hypack line 37, seismic line 708
	18040	191	3.15	21:15			18 31.34 -71 56.31	
	18975	190	3.6	21.30			18 30.52 -71 56.30	
	19914	185	3.0	21:45			18 29.70 -71 56.29	
					20165	21:50		End of line 708, Hypack line 37

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Thursday 01/26/2017** **HAITI DAY 8**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
800(8)	100	135	2.8	12:44				Start of Line 800, Hypack line 8 Repeat of earlier line with CHIRP
	1047	132	2.9	13:00			18 30.05 -71 57.10	Winds light to moderate from east. Some 60-cycle noise around shot 550.
	1856	126	2.9	13:15			18 29.54 -71 56.60	
					2140	13:19		End of line 80, Hypack line 8

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Thursday 01/26/2017** **HAITI DAY 8**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
801(10)	2150	321	3.0	13:47			18 29.86 -71 55.06	Start of line 801, Hypack line 10
	2920	321	3.0	14:00			18 30.32 -71 55.50	
	3816	325	3.0	14:15			18 30.86 -71 56.04	
	4756	318	2.9	14:30			18 31.41 -71 56.57	
	5711	319	3.25	14:46			18 32.04 -71 57.19	
	6559	321	3.3	15:00			18 32.62 -71 57.76	
	7415	318	3.3	15:15			18 32.22 -71 58.33	
					8417	15:31	18 33.90 -71 59.00	End of line 801, Hypack line 10
802(11)	8430	140	3.2	15:43			18 34.21 -71 58.53	Start of line 802, Hypack line 11
	9436	140	3.1	16:00			18 33.57 -71 57.93	Continuing along line 802, Hypack line 11 to collect CHIRP. Wind building from SE, waves 1-1.5 ft
	10333	133	3.3	16:15			18 32.97’ -71 57.36’	
	11239	131	3.2	16:30			18 32.36 -71 56.80	
	12131	136	3.15	16:45			18 31.80 -71 56.26	

LAKE AZUEI PROJECT - MULTICHANNEL SEISMIC LOG **DATE: Thursday 01/26/2017** **HAITI DAY 8**

Shot Interval: 1s **Sampling rate: 0.25ms** **Record Length: 300ms**

Line # (Hypack)	Start shot #	Course (N°E)	Speed (knots)	Start time (GMT)	End shot #	End time (GMT)	Start Lat/Lon	Comments
802(11) continued	13026	137	2.9	17:00			18 31.36 -71 55.77	
	14005	130	3.0	17:16			18 30.68 -71 55.21	
	14832	127	2.9	17:30			18 30.16 -71 54.73	
					15351	17:38	18 29.85 -71 54.45	End of line 802, Hypack line 11

LAKE AZUEI PROJECT - CHIRP LOG DATE: Saturday 01/21/2017 HAITI DAY 3

Shot Interval: 5 Hz (0.2 s) Sampling rate: 43.4 kHz Pulse length: 10 ms

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start/End Lat, Lon	Comments
301(6)	R:000	315	3.0	15:05:17	13092		18°32.6654'N 71°59.6475'W	Hypack line 6; Ping rate may have been 6 Hz rather than 5 Hz for this line? Dead calm. Gorgeous CHIRP data, 6-7 m penetration
				16:00				No penetration
				16:11				Must veer off course, bottom coming up very rapidly
					42842	16:28:10	18°35.9221'N 72°02.8512'W	End of Line 301/Hypack line 6
302(16)				16:36:42	45905		18°36.3065'N 72°02.8381'W	Start of Line 302/Hypack line16 Ping rate may have been 6 Hz rather than 5 Hz for this line?
					61466	17:20:03	18°37.8701'N 72°01.0721'W	End of line 302/Hypack line 16
303								No CHIPR acquisition. The CHIRP topside system has overheated and shut down. It needs to cool off. We shade it and will resume acquisition for next profile.
304(18)				18:40:08	3467		18°35.0906'N 72°02.1953'W	Start of Line 304/Hypack line 18 Wind picking up.
					18872	19:31:29	18°36.7784'N 72°00.0169'W	End of line 304/Hypack line 18
305(12)				19:31:30	18875		18°36.7782'N 72°00.0163'W	Start of line 305/Hypack line 12
					41305	20:46:16	18°33.8450'N 71°57.5729'W	End of line 305/Hypack line 12 Waves are rocking the boat, small whitecaps, wind from WNW
306(24)				20:46:16	41306		18°33.8450'N 71°57.5731'W	Start of line 306/Hypack line 24
					50206	21:15:56	18°32.7584'N 71°59.3840'W	End of line 306/Hypack line 24

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Sunday 01/22/2017** **HAITI DAY 4**

Shot Interval: 5 Hz (0.2 s) **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
400(5)	R:000	315	3.0	14:01			18 32.470 -72 00.42	Hypack line 5; Heading NW
	R:000	321	3.0	14:17			18 32.977 -72 00.9007	Light breeze from the northeast penetration from ~8m
	R:000	322	3.0	14:30	12239		18 33.4315 -72 01.3915	
	R:000	319	3.0	14:45	16647		18 34.0212 -72 01.9178	Winds from the northeast
	R:000	327	3.0	15:00	21000		18 34.5607 -72 02.444	Just noticed that we were locking on the multiple mistake in data
	R:000	202	3.0	15:17	26427	15:30	18 34.0364 -72 02.6227	
401(19)	R:000	043	3.0	15:30	29798		18 33.7032 -72 02.7534	Hypack line 19; 401 begins. Winds from the ENE
	R:000	053	3.0	15:45	34651		18 34.2258 -72 02.1715	
	R:000	051	3.0	16:00	38990		18 34.7010 -72 01.6425	
	R:000	054	3.0	16:15	43420		18 35.1882 -72 01.0849	~6 m penetration
	R:000	054	3.0	16:30	48764		18 35.7889 -72 00.4178	~5 m penetration. Winds from ESE
	R:000	049	3.0	16:45	52613		18 36.2400 -71 59.9196	4 m penetration (seeing lots of gas)
	R:000	055	3.0	17:00	57338	17:02	18 36.7911 -71 59.2845	3 m penetration

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Sunday 01/22/2017** **HAITI DAY 4**

Shot Interval: 5 Hz (0.2 s) **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
402(20)	R:000	055	3.0	17:18	62800		18 36.3083 -71 58.8422	Hypack line 20 begins; good read on winds from ESE
	R:000	226	3.0	17:30	66460		18 35.8421 -71 59.3698	4 m penetration
	R:000	228	3.0	17:45	70805		18 35.5358 -72 00.9297	2 m penetration + gas
		218	3.0	18:00	~75400		18 34.870 -71 00.466	1.5 m penetration – gas. 28 m deep
				18:08			18 34.544 -72 00.820	Excellent penetration ?(>8 m)? 24 m water depth
		222	3.2	18:15	75960		18 34.330 -72 01.64	At least 3 m penetration, nice stratigraphy
				18:20				Increased the TVG beyond the scale and it went to 0 – lost signal?
		210	3.2	18:30	83919		18 33.8057 -72 01.651	At least 6 m penetration. Beautiful textured CHIRP.
		225	3.3	18:45	88672		18 33.930 -72 02.303	6-7 m penetration, gorgeous stratigraphy
					~90105	18:50	18 33.061 -72 02.469	End of line 402 (Hypack 20)
Turning								Acquiring on the turn, heading for Hypack line 21
403 (21)	R:000	050	3.8	19:03	~94618		18 32.94 -72 01.62	Start of line 403 (Hypack line 21). Heading NE.
		060	3.0	19:16	97983		18 33.346 -72 01.16	

LAKE AZUEI PROJECT - CHIRP LOG DATE: Sunday 01/22/2017 HAITI DAY 4

Shot Interval: 5 Hz (0.2 s) Sampling rate: 43.4 kHz Pulse length: 10 ms

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
403(21) continued		048	3.0	19:30	102552		18 33.8462 -72 00.6020	8 m of penetration. Saw an interesting drop-off feature
		056	3.0	19:45	10660		18 34.3120 -72 00.78	Gas present in record (peglegs). Less than 1 m penetration.
		054	3.0	20:00	111337		18 34.81 -71 59.50	Gas layer still present. 1.5 m penetration.
		053	3.0	20:15	115340		18 35.35 -71 58.91	1.5 m penetration (gas layer present).
	R:000	059	3.0	20:30	119862	20:34	18 35.85 -71 58.36	Gas layer close to lake bed. End of line 21
404(13)	R:000	144	3.0	20:46	124790		18 36.10 -71 58.47	Start of line 404; Hypack line 13. Line adjusted away from t shoreline/not parallel.
	R:000	141	3.0	21:00	128830		18 35.61 -71 57.403	Gas layer present.
	R:000	144	3.0	21:15	133855		18 34.98 -71 57.46	
	R:000	144	3.0		136023	21:23	18 34.71 -71 57.24	End of Hypack line 13

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Monday 01/23/2017** **HAITI DAY 5**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
500(23)	000	048	3.0	13:07	3175		18 32.3065 -72 00.3638	Hypack line 23 (W-> E) Gas close to surface
	000	048	3.12	13:15	5251		18 32.4378 -72 00.2100	Gas gone. 6m -> multiple
				13:27				6+m penetration; gas 2-3 m
	000	047	3.11	13:30	9676		18 32.9229 -71 59.6364	Gas gone. 5m of sed.
								Sea state increasing, waves -> 2 ft
	000	047	3.1	13:45	14172		18 33.4348 -71 59.0675	Marginal conditions –gas@ ~1.5 m
				13:50				Gas layer persistant – now 0.5 m below lake floor.
	000	047	3.1	14:00			18 33.8653 -71 58.5853	Waves continue to build! V. poor data – gas just below
				14:10	21692		18 34.1481 -71 58.2607	Lake floor rises, seds surey2[?] ~2-3m out of gas
								* Try swell filter to clear up wavy data *
	000	047	3.1	14:15	23220		18 34.2940 -71 58.1070	Lake floor rising; WD ~15 m
				14:17	23727			Rise slowed w/ WD ~8 m. Gas now close to surface
	000	047	3.1	14:30	27656		18 34.7329 -71 57.6045	WD ~6.5; flat bottom, hard surface/gas 0.5 m below
				~14:37	29145		18 34.9105 -71 57.4064	~6 m of penetration; more protected water.
					30265	14:38	18 35.0351 -71 57.2560	EOL; WD ~4.5

LAKE AZUEI PROJECT - CHIRP LOG DATE: Monday 01/23/2017 HAITI DAY 5

Shot Interval: 5 Hz Sampling rate: 43.4 kHz Pulse length: 10 ms

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
501(32)	000	266	3.1		2209		18 29.9859 -71 53.8915	Hypack line 32
								~2 m of sed
	000	266	3.1	16:00			18 29.9244 -71 54.7050	WD ~22 m
				16:11	10527		18 29.8691 -71 55.3784	Floor rising – sediments arched ~2-3 k penetration; gas rising up arched seds erosional lake floor
	000	266	3.0	16:15	11401		18 29.8390 -71 55.4831	Rising lake floor (sandy?) plateaus ~11 m
				16:20	13102		18 29.8314 -71 55.8105	Lake floor falling and subsurface reflections appear.
				16:23				Gas appears
				16:26	14955			Gas gone – seds (& lake floor) rising; ~4 m penetration
	000	266	2.9	16:30	15790		18 29.8000 -71 56.2328	Arched sediments now descending
	000		2.84	16:45	20266		18 29.7627 -71 56.9714	Lake floor rising ~2 m of seds below truncating @ erosional lake floor; WD ~
					20854	16:47	18 29.7651 -71 57.0759	EOL

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Tuesday 01/24/2017** **HAITI DAY 6**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
600(4)	000	285	2.8		3407		18 32.7784 -72 01.5725	Hypack line 4
		317	3.15	14:16	8936		18 33.4134 -72 02.2457	Hard bottom; WD ~9 m
						14:31	18 33.9580 -72 02.7893	EOL
601(15)	000	048	3.1	16:03	14927		18 36.7833 -72 03.3075	Hypack line 15
		047	3.0	16:16	18816		18 37.181 -72 02.251	Penetration 4-5 m; light breeze from E
		047	3.3	16:30	22922		18 37.6764 -72 92.2908	
		047	2.8	16:45	27321		18 38.1547 -72 01.7436	Bottom rising; WD ~8.5 m;~1.5 m penetration
					29777	16:53	18 38.4334 -72 01.4390	EOL
		~264	4.4-4.5	17:03				We decide to record the CHIRP during the turn. There is useful information. ~2 m penetration
602(10)	000	131	3.0	17:19	~38300		18 38.189 -72 03.193	Hypack line 10 (SOL). Begin CHIRP acquisition (no penetration)
				17:24				Abrupt change in penetration at around 6.5 m depth. Now ~6 m penetration
		131	2.8	17:39	44421		18 37.515 -72 02.526	2 m penetration
		134	3.1	17:55	48652		18 36.941 -72 01.973	20 cm penetration

LAKE AZUEI PROJECT - CHIRP LOG DATE: Tuesday 01/24/2017 HAITI DAY 6

Shot Interval: 5 Hz Sampling rate: 43.4 kHz Pulse length: 10 ms

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
602(10) continued		137	3.0	18:10	53426		18 36.385 -72 01.427	2 m penetration
		132	3.1	18:25	57704		18 33.864 -72 00.912	2 m penetration.
		138	3.2	18:40	61994		18 35.289 -72 00.347	#18:30 change window screen 1.5 m penetration
		135	3.3	18:55	66485		18 34.711 -71 59.784	1 m penetration
		140	3.3	19:10	70982		18 34.117 -71 59.205	#19:04 adjusted screen 5 m penetration
		024	3.1		73361	19:17	18 33.887 -71 58.898	EOL (Hypack line 10) Remained recording.
603(35)		048	3.2	19:17	73037		18 33.002 -71 58.805	Hypack line 35. Heading NE
		034	3.2	19:30	77314		18 34.401 -71 58.381	2 m penetration
		047	3.2	19:45	81491		18 34.933 -71 57.824	
		010	3.2		83690	19:53	18 35.235 -71 57.563	EOL Hypack 35
604(22)		231	3.0	20:00	86374		18 35.454 -71 57.804	Start of Hypack line 22 Heading SW
		235	3.1	20:15	90589		18 35.000 -71 58.318	#20:03 Adjusted screen.
				20:17				We accidentally change the sampling rate, maybe (MC)
		242	3.1	20:30	95008		18 34.448 -71 58.937	20 cm penetration

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Tuesday 01/24/2017** **HAITI DAY 6**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
604(22) continued		233	3.2	20:43	00340		18 33.925 -71 59.521	2 m penetration
		236	3.0	21:00	103691		18 33.365 -72 00.148	2 m penetration
				21:09				Adjusted screen
		237	3.1	21:15	108544		18 32.864 -72 00.214	5 m penetration
		222	3.0	21:25	111339		18 32.517 -72 01.055	EOL 604, Hypack line 22

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
700(28)	R002	047	2.93	~14:15	878		18 30.2643 -71 57.6371	Hypack line 28
		047		~14:30	4725		18 30.6967 -71 57.1515	Lake floor descending – rough (erosional) surface ~2 m of penetration
	R002	048	2.9	14:45	9240		18 31.1979 -71 56.5875	@ base of slope – patchy with gas
				15:01				
								Rises at end of line. Beds pinching.
	R003			15:03			18 31.7819 -71 55.9256	Running to start of next line
*** these 2 files [above] were saved in HAITI_DAY_6_CHIRP - line 604 ***								

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
701(29)	R001			~15:17	~18800			Hypack line 29. Plunging lake floor
		228		~15:20	19745		18 31.1673 -71 55.6154	WD: 23 rate of descent, decreased gas ~0.5 m below lake floor
				15:30	22726		18 30.8275 -71 56.0106	~1 m penetration, gas below?, flat bottom. WD ~24m
					~24400			Fluid (gas) escape features?
				15:46	27542		18 30.2582 -71 56.6485	Bottom rising slowly, smooth surface. ~1-2 m penetration
						15:58		EOL
				15:58				Transit to Hypack line 30
702(30)	R000	046	2.95	16:14	35776		18 29.51 -71 56.47	Start of line 702. Hypack line 30
								Small fold? with onlapping layer lakeward 35566 = ping
		529	3.05	16:30	40155		18 29.97 -71 55.96	
		048		16:48	46178		18 30.6494 -71 55.2060	Lake floor rising slowly (WD 23 m) ~0.5 m penetration -> gas
						16:55	18 30.8746 -71 54.9480	EOL
	R001							Transit -> Hypack
								Bottom tracker set up – help TVG

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
703(31)	R001			17:09	52344		18 30.4892 -71 54.3501	Hypack line 31
		227	2.9	17:16	54588		18 30.2717 -71 54.6347	Lake floor descends rapidly -> WD:23 m ~2 m of penetration -> gas
***				17:30	58741		18 29.8037 -71 55.1604	Rising lake floor. ~2.5 m of penetration
				17:32	59559		18 29.7081 -71 55.2647	EOL
								Transit -> Hypack line 9
704(9)	R001	317		17:41	62256		18 29.6627 -71 55.7754	Hypack line 9
***	001	317	3.16		62789		18 29.7015 -71 55.8316	Drilling target WD 11m ***
		370	3.02	17:55	66098		18 30.11 -71 56.24	Lunch
		320	2.87	18:10	70726		18 30.66 -71 56.78	
		320	2.93	18:25	752776		18 31.22 -71 57.31	
		330	2.62	18:40	79375		18 31.72 -71 57.79	End of line 704 (Hypack line 9)
705(25)		053	3.26	18:51	82910		18 32.35 -71 58.29	Start of line 705/Hypack line 25
		055	3.18	19:06	87287		18 32.84 -71 57.73	Flat, flat, flat
***		055	3.0	19:20	91995		18 33.38 -71 57.12	Sed onlapping fold. **** End of line 705/Hypack line 25

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
706(26)	000	229	3.23	~19:30	94570		18 32.8507 -71 56.7257	Transit
		229			97400		18 32.5092 -71 57.1083	Pockmark. WD ~25.7 Gas ~0.5 m below – feeding? m
		229	3.5	19:45	99238		18 32.2625 -71 57.3788	Flat. WD 25.5 m, ~1 m penetration
					100400			Rising lake floor, ~2.5 m penetration
***					101213			Faults! 6 m penetration ****
						19:47	18 31.8126 -71 57.8900	EOL
707(27)	001	057	3.06	20:10			18 31.0371 -71 57.7851	Start line 707/ Hypack line 27 WD: 5 m
				20:17			18 31.2178 -71 57.5012	Descending, WD: 18 m, 2.5 m penetration
		047	2.8	20:39	112758		18 31.7198 -71 57.0000	Flat, WD: ~24 m, ~2 m penetration
					116112			Bottom rising, 1 m -> gas
						20:48	18 32.3235 -71 56.3096	Rising! -. 7 M & slowly continues EOL
708(37)				20:58			18 32.2453 -71 56.3335	Freelance line Hypack line 37
		175	3.18	21:13	125640		18 31.48 -71 56.32	Flat but jagged horizons -> waves Wind has picked up. Some gentle folds??
				21:23				Course jog.
				21:24				Speed adjustment
		186	3.56	21:30	130670		18 30.61 -71 56.30	

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Wednesday 01/25/2017** **HAITI DAY 7**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
708(37) continued		185	3.0	21:45	134999		18 29.83 -71 56.28	
		185	3.0		137049	21:50	18 29.48 -71 56.22	EOL Line 708. N-S line.

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Thursday 01/26/2017** **HAITI DAY 8**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
800(8)		13		~12:45	360			Hypack line 8
				12:50	2390		18 30.4758 -71 57.5148	Erosional surface, debris flow? ~1.5 m penetration
		137	2.94	13:00	5364		18 30.0938 -71 57.1421	~2 m penetration
		137	2.91	13:15	9904		18 29.5546 -71 56.6160	Rising lake floor, WD: 13 m 6+ m penetration
					11324	13:20	18 29.3832 -71 56.4518	EOL
801(10)		317	2.99	~13:45	18866		18 29.7601 -71 54 9574	Southern end of Hypack line 10
		317	3.05	14:00	23422		18 30.3099 -71 55.4904	Quick descent off fault? Flattens out at ~WD 24 m. <0.5 -> gas
		317	2.97	14:15	27870		18 30.8519 -71 56.0213	Flat – occasional pockmark, eg., ping 27659, 29185
					29474			Pockmark with flare?

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Thursday 01/26/2017** **HAITI DAY 8**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
801(10) continued		317	2.85	14:30	32375		18 31.3763 -71 56.5311	Flat with weak undulation ~1.5 m penetration
		317	3.3	14:47	37553		18 32.0460 -71 57.1884	Slowly descending ~1 m penetration
				15:15	45881		18 33.1988 -71 58.3122	Flat – less than 0.5 m sed.
							18 33.8971 -71 59.0022	EOL
				15:32	51420			Transit to Hypack line 11(5)
802(11(5))		139	3.2	15:41	53769		18 34.3138 -71 58.6222	Hypack line 11(5) Sailing into 1 ft waves. Flat – limited penetration (<0.5 m)
				16:00	59399		18 33.5845 -71 57.9505	Flat with small undulations. WD: 24.5 m <0.5 m penetration before gas
		139	3.3	16:15	63900		18 32.9870 -71 57.3872	Flatness continues! Still XXX? Gas Some xxx? Reflections visible. WD: 24.5 m
		139	3.1	16:30	63831		18 32.3847 -71 56.8257	Flat – rising very slowly. Gas has descended. Now have ~1.5 m penetration
		139	3.0	16:45	72869		18 31.8206 -71 56.2990	Ditto
		139	2.95	17:00	77369		18 31.2773 -71 55.7861	Ditto
		139	3.05	17:17	82475		18 30.6663 -71 55.2086	Ditto
					84600		18 30.3144 7154.8700	Lake floor rise, gas descends. Arched structure. ~4 m penetration
		139	3.06	17:30	86337		18 30.1828 -71 54.7608	Rise begins! EOL
					28448 89080	-EOL	18 29.8516 7154.4488	

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Thursday 01/26/2017** **HAITI DAY 8**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
803(38) Segment 1	96928	084	3.5	18:06				Zig-zag lines along S. shore. Hypack line 38
	99515	244	4.1	18:13			18 30.08 -71 53.37	Turn, end of segment 1, start of segment 2. Penetration good below 10 m water depth.
	100790			18:18			18 29.95 -71 53.64	Turn, end of segment 2, start of segment 3
	102172	204	3.8	18:22			18 30.23 -71 53.72	Turn, end of segment 3, start of segment 4. ~2m of penetration in low slope areas
	104744	010	3.7	18:31			18 29.78 -71 57.99	Turn, end of segment 4, start of segment 5. Potential gas in water column just before turn
	107803	194	3.75	18:41			18 30.39 -71 54.02	Turn, end of segment 5, start of segment 6
	110670	354	3.6	18:50			18 29.89 -71 54.29	Turn, end of segment 6, start of segment 7
	113983	192	3.6	19:01			18 30.55 -71 54.38	Turn, end of segment 7, start of segment 8
	117906	349	3.75	19:15			18 28.81 -71 54.59	Turn, end of segment 8, start of segment 9
	122026	173	3.5	19:28			18 30.59 -71 54.90	Turn, end of segment 9, start of segment 10. Large fold @ 19:31
	126288	331	3.45	19:43			18 29.76 -71 54.97	Turn, end of segment 10, start of segment 11
	129606	195	3.65	19:54			18 30.36 -71 55.22	Turn, end of segment 11, start of segment 12
	133200			20:06			18 29.69 -71 55.34	End of segment 12

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Friday 01/27/2017** **HAITI DAY 9**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
900(38)		351	3.5	13:12	1			Start of line 900/continuation of Hypack line 38, segment 13. Wind stiff from the east, waves 1-2 ft with whitecaps.
					5475	13:22	18 30.42 -71 55.64	End of seg 12
901(42)			4.0	13:46	5490		18 29.90 -71 53.39	Start of line 901/Hypak line 42
				13:49				First turn of line 901. Heading west 2 m of penetration
		283	3.85	14:00	10517		18 30.03 -71 54.40	~1 m penetration. Slowly dipping westward
		265	3.75	14:15	14800		18 29.88 -71 55.33	Climbing a fold. No penetration along upper slope of fold.
		262	3.9	14:30	19250		18 29.70 -71 56.31	Crossed a steep rise, no folded sediment visible
				14:35				Second turn of line 901, wave direction less favorable.
		320	4.35	14:45	23686		18 30.00 -71 57.14	Waves building 2-3 ft.
					26198	14:53	18 30.35 -71 57.64	End of line 901/Hypack line 42
902(44)		328	4.5	15:19	26615		18 34.44 -71 57.85	Start of line 902/Hypack line 44
					30100	15:30		End of line 902/Hypack line 44
903(45)		137	3.3	15:32	30450			SOL 903/Hypack line 45
				15:46	34770			EOL 903/Hypack line 45

LAKE AZUEI PROJECT - CHIRP LOG **DATE: Friday 01/27/2017** **HAITI DAY 9**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
904(46)		331	4.0	15:48	35313		18 34.34 -71 57.92	SOL 904/Hypack line 46
					38730	15:59		EOL 904/Hypack line46
905(47)		137	3.1	16:01	3922		18 34.89 -71 58.51	SOL 905/Hypack line 47
					43660	16:16	18 34.30 -71 57.96	EOL 905/Hypack line 47
906(?)		323	4.1	16:17	44123		18 34.26 -71 58.00	SOL 906/Hypack line ?
					47557	16:30		EOL 906/Hypack line ?
907(48)		135	3.45	16:31	48051		18 34.81 -71 58.59	SOL 907/Hypack line 48
					52251	16:44		EOL 907/Hypack line 48
908(49)		319	4.1	16:46	52620		18 34.18 -71 58.07	SOL 908/Hypack line 49
					56221	16:58		EOL 908/Hypack line 49
909(50)		140	3.4	17:00	56583		18 34.75 -71 58.69	SOL 909/Hypack line 50
					60799	17:14		EOL 909/Hypack line 50
910(51)		316	4.15	17:15	61037		18 34.12 -71 58.15	SOL 910/Hypack line 51
					64600	17:25		EOL 910/Hypack line 51
911(52)		138	3.4	17:27	65128		18 34.66 -71 58.76	SOL 911/Hypack line 52
					69402	17:41		EOL 911/Hypack line52
912(53)					69550		18 34.06 -71 58.22	SOL 912/Hypack line 53
					73307	17:54		EOL 912/Hypack line 53

LAKE AZUEI PROJECT CHIRP LOG DATE: Friday 01/27/2017 HAITI DAY 9

Shot Interval: 5 Hz Sampling rate: 43.4 kHz Pulse length: 10 ms

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
913(54)		095	3.6	18:40	73766		18 30.30 -71 54.18	SOL 913/Hypack line 54
					75072	18:44		EOL 913/Hypack line 54
914(55)		280	3.45	18:45	75207		18 30.31 -71 53.90	SOL 914/Hypack line 55
					76645	18:49		EOL 914/Hypack line 55
915(56)		092	3.4	18:51	76942		18 30.21 -71 54.17	SOL 915/Hypack line 56
					78467	18:55		EOL 915/Hypack line 56
916(57)		251	3.85	18:57	78600		18 30.19 -71 54.87	SOL 916/Hypack line 57
					80116	19:01		EOL 916/Hypack line 57
917(58)		085	3.3	19:04	80931		18 30.11 -71 54.16	SOL 917/Hypack line 58
					82425	1909		EOL 917/Hypack line 58
918(59)		259	3.75	19:10	82883		18 30.05 -71 53.88	SOL 918/Hypack line 59
					84324	19:15		EOL 918/Hypack line 59
919(38)		350	4.3	19:30	85379		18 29.69 -71 55.35	Sol 919/Hypack line 38. Rerunning segment13 and continuing along track
		198	3.4	19:41	88611		18 30.37 -71 55.63	Winds light from west Turn, end of seg13, start of seg 14
		343	3.7	19:54	92427		18 29.63 -71 55.80	Turn, end of seg 14/start of seg 15
		190	3.7	20:05	95768		18 30.28 -71 56.05	Turn, end of seg 15/start of seg 16
		330	3.7	20:15	98758		18 29.70 -71 56.16	Turn, end of seg 16/start of seg 17

LAKE AZUEI PROJECT CHIRP LOG **DATE: Friday 01/27/2017** **HAITI DAY 9**

Shot Interval: 5 Hz **Sampling rate: 43.4 kHz** **Pulse length: 10 ms**

Line # (Hypack)	File #	Course (N°E)	Speed (knots)	Start time (GMT)	Ping #	End time (GMT)	Start Lat/Lon	Comments
		185	3.65	20:22	100961		18 30.07 -71 56.41	Turn, end of seg 17/start of seg 18
		345	3.6	20:34	104651		18 29.35 -71 56.50	Turn, end of seg 18/start of seg 19
		209	3.7	20:46	107929		18 29.98 -71 56.66	Turn, end of seg 19/start of seg 20
		005	3.8	20:54	110461		18 29.56 -71 56.91	Turn, end of seg 20/start of seg 21
		228	4.0	21:03	113210		18 30.13 -71 56.90	Turn, end of seg 21/start of seg 22
		007	4.0	21:10	115193		18 29.88 -71 57.23	Turn, end of seg 22/start of seg 23
		247	4.0	21:18	117627		18 30.41 -71 57.27	Turn, end of seg 23/start of seg 24
						21:25		End of seg 24

HEGG MARINE SOLUTIONS
A Division of Falmouth Scientific, Inc.

HMS-620 Bubble Gun™

Ultra-Portable Low-Frequency Acoustic Seismic Systems

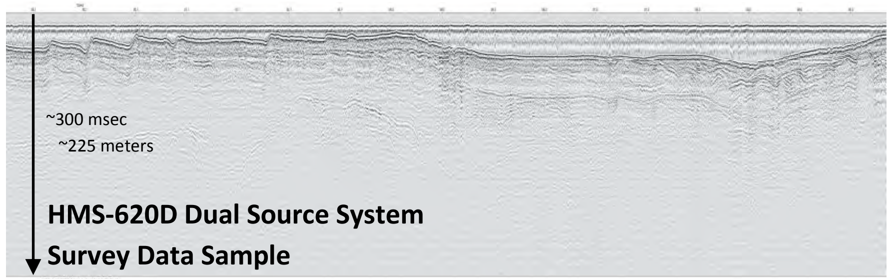
The HMS-620 Bubble Gun™ uses low-frequency acoustic signals to provide superior signal penetration vertically through coarse sand, gravel tills, and other difficult-to-penetrate sediments.

Small system component size and portability make this a valuable tool for any survey platform.

Complete Single-Source Bubble Gun™ System
shown with source vehicle suspended on display frame
and shipping case for transceiver and cables

APPLICATIONS

- Offshore Wind Turbine and Dam Site Surveys
- Cross River Surveys for Bridge Construction
- Bedrock Investigation
- Pipeline Construction Surveys
- Geotechnical Site Investigation
- Coastal Engineering



Collected in Vineyard Sound, MA (courtesy USGS)

FEATURES/BENEFITS

- **Wide-band 70-1700Hz pulse** provides bottom penetration through many sediment types
- **Very stable and repeatable source pulse without the need for external timing controllers**
- Rugged, lightweight transducer platform provides stable operation in adverse sea-state conditions
  - Electromagnetic Sound Source; **Contained Air Volume (no air compressor needed)**
  - Single and Dual Source Vehicles Available
  - No need for heavy handling or deployment equipment
- Flexible portable transceiver unit optimizes system for a wide range of sediments
  - Low-noise pre-amp with high/low pass filters and gain control
  - User-selectable trigger or external trigger
  - **Multiple Sources can be synchronized to a common trigger without need for external timing control**
  - **Repeatable Shot-to-Shot Phase and Amplitude Wavelet Correlation > 0.96**
- **Minimal Electric Power Requirements**
  - Selectable 110 or 220 VAC source of less than 1 KWatt for single source, 2 KWatt for Dual Source
  - Optional 24 VDC powered system available (two 12V batteries; no generator needed)
- Oil-filled single channel hydrophone streamer cable
  - 7-meter multi-element active section
  - 35-meter deactivation switches on each hydrophone element enable exportation outside of USA
- Compatible with industry-standard data acquisition software & multi-channel streamers

HMS-620D with Geometrics Geode and MicroEel
multi-channel data acquisition system
(courtesy Geometrics)

SPECIFICATIONS

HMS-620 Bubble Gun™ System Components

Seismic source

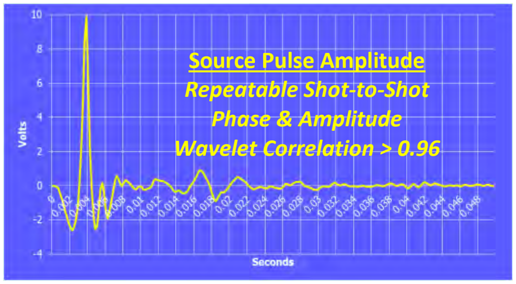
Source Vehicle and Electromechanical Tow Cable

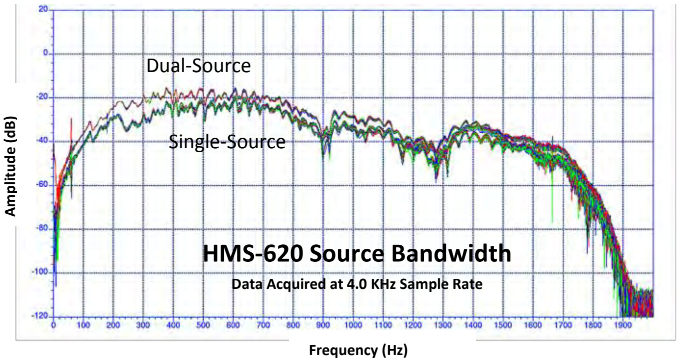
Source vehicle is compact and easy to deploy

Source Type:	Electromagnetic / Contained Air Volume (no compressor needed)
Frequency:	Wide band, 70-1700Hz pulse
Acoustic Source Level:	Single: Approximately +200 dB ref 1µPa @ 1 meter Dual: Approximately +204 dB
Normalized Shot-to-Shot Cross Correlation:	Repeatable Shot-to-Shot Phase and Amplitude Wavelet Correlation > 0.96
Tow Vehicle:	Stainless steel and plastic frame, buoyant surface-towed vehicle
Tow Cable:	50-meter abrasion resistant electro-mechanical cable
Dimensions (approximate):	Single: 109.22 x 93.97 x 48.26 cm (43 x 37 x 26 in) Dual: 190.5 x 93.97 x 48.26 cm (75 x 37 x 26 in)
Weight in Air (approximate):	Single Vehicle/Source – 43.5 kg (96 lbs) Dual Vehicle/Source – 80 kg (175 lbs) Tow Cable - 12.25 kg (27 lbs)

Seismic Transceiver

Signal Input:	Designed to operate with HMS-620 System Hydrophone Streamer Cable; 7-pin Amphenol connector
Gain:	Adjustable in 3 dB steps 0 to 45 dB
Filters:	Adjustable high- and low-pass active
Analog Interface:	± 10 V Output





Power Supply

Trigger Input:	External key or manual time-based selection
Repetition Rate:	1/8 second maximum
Transducer Connector:	7-pin Amphenol to mate with HMS-620 Source Vehicle Tow cable
Packaging:	Portable splash-resistant case
Dimensions & Weight:	55.88 cm x 53.34 cm x 25.4 cm (22 in x 21 in x 10 in); 17.24 kg (38 lbs)

Hydrophone Streamer Cable

Length:	Active section - 7 meters; Single- channel, 24 elements; Leader – 50 meters
Preamplifier:	Integral preamp - 20 dB gain; Designed to operate with HMS-620 Transceiver
Power Input:	Supplied by transceiver
Weight in Air:	13.6 kg (30 lbs)

Specifications Subject to Change without Notice

05 May 2015

Falmouth Scientific, Inc.
1400 Route 28A, PO Box 315, Cataumet, MA 02534-0315
Email: fsi@falmouth.com • Tel: 508-564-7640 • Fax: 508-564-7643 • **www.falmouth.com**

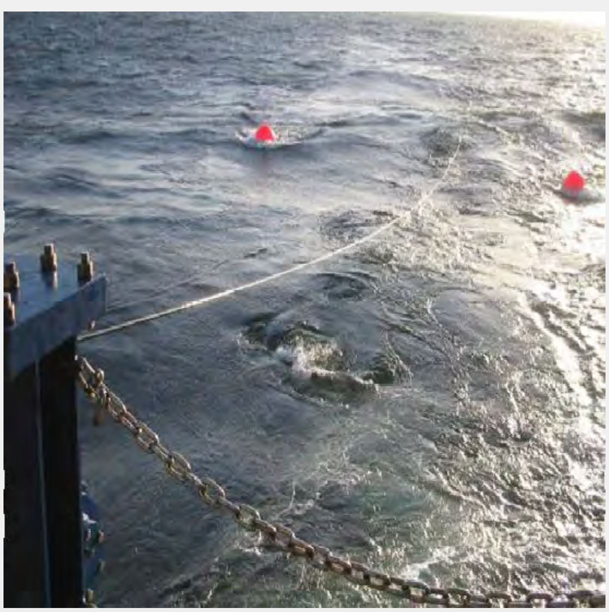
MicroEel

GEOMETRICS
Innovation • Experience • Results

SOLID ANALOG SEISMIC STREAMER

Features & Benefits

- State-of-the-art, high-sensitivity polymer hydrophones provide a stable, accurate response over wide temperature and pressure ranges
- Unique streamer design isolates vibration and suppresses ship and towing noise
- Solid flotation withstands the rigors of commercial surveys in harsh conditions; non-hazardous and easily transported on commercial airlines
- Standard configurations of 12 and 24 channels; custom configurations also available
- Extremely lightweight, deploys easily by hand or from small winch



Overview

The MicroEel is configured with an active section of 12 or 24 channels and a hydrophone group interval of 3.125 or 6.25 m. Each group includes three depth-limited proprietary polymer hydrophones with a frequency response of 10 Hz to 10 kHz. The group signal is summed electrically and connected to one preamplifier per channel. Custom configurations are also available.

Integrated with the active section is the tow cable, which connects topside to the MicroEel Streamer Battery Pack and seismograph via a deck cable.

The active section is built using Geometrics continuous-flotation molding method. This solid construction is specifically designed to withstand the rigors of commercial surveys in harsh conditions.

The MicroEel solid streamer has the performance and reliability that allows you to stay at sea longer, with less down time, and collect high-resolution data where other streamers cannot go.

The MicroEel is backed and supported by Geometrics, now in its 42nd year, and our worldwide service center network. Contact us today to find out how the MicroEel can work for you.

2190 Fortune Drive, San Jose, CA 95131 USA • 408-954-0522 (tel) • sales@geometrics.com • www.geometrics.com

MicroEel SOLID ANALOG SEISMIC STREAMER

Hydrophone		
	Sensor Type	Proprietary Polymer
	Frequency Response	10 Hz to 10,000 Hz ±1.0 dB
	Capacitance	7.2 nF per element at 22° C
	Sensitivity (Nominal)	-196 dB re 1 Volt per 1 μPa
	Sensitivity to Acceleration	< -70 dB re 1 Volt per g
	Operating Depth (Maximum)	30 ±5 m
Preamplifier		
	Type	Ultra-low noise differential
	Gain	6 dB
	Low Corner Frequency	-3 dB at 10Hz
	Current	11mA per channel
	Power	±12 V DC MicroEel Battery Pack (topside)
Active Section		
	Channels	12 or 24; other counts available*
	Hydrophones per Group	1 or 3; other counts available*
	Group Aperture	0 or 0.22 m; up to 1 m maximum*
	Group Interval	3.125 m or 6.25 m; other intervals available to 1 m minimum*
	Flotation Material	Polyurethane-based
	Outside Diameter	32 mm
	Weight (in air)	0.79 kg/m
	Bend Radius	0.46 m
	Strength Member	Kevlar center stress core
	Working Load	182 kg
	Breaking Strength	909 kg
Deck and Tow Cables		
	Type	Multi-conductor with polyurethane jacket
	Length (Maximum Total)	400 m (including active section)
	Termination	Deck: Y-type with one 61-socket connector (or 27-socket connector), one 4 pin connector (topside); one 55-socket waterproof connector Tow: one 55-pin waterproof connector
	Outside Diameter	13.5 mm
	Weight	0.15 kg/m
	Bend Radius	0.46 m
	Strength Member	Kevlar center stress core
	Working Load	182 kg
	Breaking Strength	909 kg
Temperature		
	Operating Range	-10°C to +60°C
	Storage Range	-40°C to +60°C

*Please contact the factory to discuss your requirements.
Specifications subject to change without notice for product improvement/development.
Depending on the end user's location, the MicroEel may require a US Department of Commerce export license. ~MicroEel_r2.doc 082514 cl

GEOMETRICS
Innovation • Experience • Results

Geode Ultra-Light Exploration Seismograph

- Multi-purpose seismic recorder: refraction, reflection, earthquake monitoring, VSP, blast and vibration measurements, marine surveys, sub-bottom profiling and continuous recording
- Light-weight (8 lb/3.6 kg), in-field modules connect to the Ethernet port on your laptop for easy, instant interfacing
- Available with 3 to 24 channels per box; connect more boxes to build low cost distributed systems up to 1000 channels
- Data transmitted from Geode to host computer digitally, reducing long, expensive analog cables
- 24-bit dynamic range, low distortion and built-in geophone[2] and line testing[2], noise monitor
- 20 kHz bandwidth provides ultra-high resolution or low frequencies for earthquake monitoring
- Standby low-power means light batteries, long life
- Powerful built-in no-charge applications software gives quick answers:
  - Model problems before going to the field
  - Pick breaks on site and view travel-time curves on site for optimum shot positioning
  - Display an in-field preliminary cross section to see what you might have missed
  - Undertake a comprehensive analysis back at the office and easily compare results with several interpretation methods

3-YEAR WARRANTY

The new 24-bit Geode seismic recorder is the most versatile and flexible seismograph available today. Small and lightweight enough to throw in your suitcase for an evaluation survey. Expands instantly for full-scale 2-D and 3-D surveys at a cost your accountant will love. And when you are not using the Geode for reflection, refraction downhole or tomography surveys, use it for monitoring earthquakes, quarry blasts or vibration from heavy equipment. The Geode will even do sub-bottom profiling or record data continuously.

For light-duty applications, you can use your laptop to view, record and process your data. In harsh conditions, control your Geodes with Geometrics' StrataVisor™ NZ/C series computers and seismographs. You can connect Geodes together to build systems over 1000 channels on multiple lines. Geodes are shock-proof, dust-proof, submersible and withstand extreme temperatures.

Geode modules deploy right in the field close to your geophones to improve signal quality and reduce cable costs. Data are transmitted digitally using industry-standard Ethernet eliminating expensive, hard to configure interface cards. Geodes can even be installed on your office network.

The Geode comes with a 3-year warranty backed by Geometrics, now in our 36th year of prompt, knowledgeable customer support. Geodes are available for rent to quickly expand your system.

Geodes operate from either your laptop or from Geometrics StrataVisor NZ field computer

The StrataVisor NZ with daylight visible color screen and built-in plotter is weather and shock resistant

Geode Specifications:

Configurations: 3, 6, 8, 12, 16 or 24 channels in weatherproof field deployable Geode module. Geode is operated from either Windows 98/NT4/ME/W2K/XP based laptop[1] or by Geometrics' ruggedized StrataVisor NZ field computer/seismograph. Basic operating software controls one Geode and can be optionally expanded to control multiple Geodes, do marine surveying, continuous recording, repeaters, sub-bottom profiling, VSP, GPS synchronization, blast and vibration monitoring and surveillance.

A/D Conversion: 24 bit result using Crystal Semiconductor sigma-delta converters and Geometrics proprietary over sampling.

Dynamic Range: 144 dB (system), 110 dB (instantaneous, measured) at 2 ms, 24 dB.

Distortion: 0.0005% @ 2 ms, 1.75 to 208 Hz.

Bandwidth: 1.75 Hz to 20 kHz. 0.6 and DC low frequency option available.

Common Mode Rejection: > 100dB at <= 100 Hz, 36 dB.

Crosstalk: -125 dB at 23.5 Hz, 24 dB, 2 ms.

Noise Floor: 0.20 uV, RFI at 2 ms, 36 dB, 1.75 to 208 Hz.

Stacking Trigger Accuracy: 1/32 of sample interval.

Maximum Input Signal: 2.8V PP, 0 dB.

Input Impedance: 20 kOhm, 0.02 uf.

Preamplifier Gains: Standard factory configuration is 24 and 36 db, selectable in software. Optionally, can be jumpered for software selectable 12 and 24 dB or can be jumpered in four channel blocks as a single fixed gain of 0 dB for high-voltage devices.

Anti-alias Filters: -3 dB at 83% of Nyquist frequency, down 90 dB.

Acquisition and Display Filters:
Low Cut: OUT, 10, 15, 25, 35, 50, 70, 100, 140, 200, 280, 400 Hz, 24 or 48 dB/octave, Butterworth.
Notch: 50, 60, 150, 180 Hz and OUT, with the 50 dB rejection bandwidth 2% of center frequency.
High Cut: OUT, 32, 64, 125, 250, 500 or 1000 Hz, 24 or 48 dB/octave.

Sample Interval: 0.02, 0.03125, 0.0625, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0 ms.

Correlation: Optional high-speed hardware correlator available in each Geode for fast cycle time with vibrators and pseudo-random (MiniSosie) sources[2]. Correlates 16K record, unlimited channels in under 1 sec.

Record Length: 16,384 samples standard, 65,536 samples optional[2].

Pre-trigger Data: Up to full record length.

Delay: 0 to 100 sec in steps of 1 sample interval.

Data Transmission: Uses Ethernet transmission standard over CAT 5 copper or multimode fiber-optic cable. Distance between boxes: CAT 5 cable up to 0.25 km; fiber-optic cable up to 1.5 km.

Intelligent Self-Trigger: Earthquake, blasting and vibration monitoring[2]

Optional Built-In Test Functions

Digital:
- CPU diagnostics
- Internal network test
- Digital functions
- Battery Warning

Instrument:
- Noise
- DC Offset
- Gain Accuracy
- Gain and Phase Similarity
- Distortion
- Crossfeed
- Bandwidth
- Timing Accuracy

Line:
- Noise
- Geophone similarity
- Disconnected phones

Continuous Recording: Available for vibration monitoring.[2]

Auxiliary Channels: All Geode channels can be programmed as either AUX or DATA. Fixed data and aux channels available in StrataVisor NZ.

Roll Along: Built-in, no external roll box required[2]

Line Testing: Real time noise monitor displays real-time output from geophones. Optional geophone pulse test helps identify bad geophones and shorted or broken cables[2].

Instrument Tests: Optional built-in daily, weekly and monthly testing available[2]. External laboratory quality test system available to measure noise, crosstalk, dynamic range, gain similarity and trigger accuracy to factory specification.

Data Formats: SEG-2 standard. SEG-D and SEG-Y available[2].

System Software:
Basic operating software includes full compliment of acquisition, display, plotting, filtering and storage features.
Other functions available as options to control multiple Geodes, add additional preamp gains, high-speed correlation, expanded record length, tape writing, geophone pulse test, expanded test and diagnostics, roll along capability, marine surveying, sub-bottom profiling, blast and vibration monitoring, continuous recording and surveillance.

Bundled Applications Software:
- SIPQC delay time refraction software from Rimrock Geophysics
- SeisImager/2D Lite refraction analysis software from OYO
- WinSeis Lite reflection processing software from Kansas GS.

Upgrades of SeisImager/2D are available; please contact the factory with your requirements.

Data Storage: Stores data locally in SEG2 on laptop/PC media. Drivers available for tape/disk storage in SEG2/D/Y[2].

Plotters: Drives a variety of Windows™ compatible printers including Printrex 4, 8 and 12 inch plotters. Consult factory.

Triggering: Positive, negative or contact closure, software adjustable threshold. Will self-trigger on continuous data using threshold detecting STA/LTA-like algorithm.

Power: Requires 12V external battery. Uses 0.65 W/channel during acquisition, sleep mode reduces power consumption by 70% while in standby.

Environmental: -30 to 70 degrees C. Waterproof and submersible. Withstands a 1 m drop onto concrete on 6 sides and 8 corners. Passes MIL810E/F vibration.

Physical: 10"L x 12"W x 7"D (25.4cm L x 30.5cmW x 17.75cmD). Weighs 8 lb. (3.6 kg). Uses waterproof Bendix 61 pin connector for geophone input.

Operating System: Windows 98/ME/NT4/W2K/XP.

Warranty: Three year standard, extended warranty available.

1- **Most laptop computers are NOT field devices.** They are easily damaged by harsh treatment or exposure to extreme environments Geometrics StrataVisor NZ/Cs designed to operate in harsh conditions for extended periods and should be used with the Geode for surveys where reliability is important.

2 - Available as an option. Geode_v10_ds.doc 102705

GEOMETRICS INC. 2190 Fortune Drive, San Jose, California 95131, USA
Tel: 408-954-0522 – Fax: 408-954-0902 – Email: sales@geometrics.com

GEOMETRICS EUROPE 20 Eden Way, Pages Industrial Park, Leighton Buzzard LU7 4TZ, UK
Tel: 44-1525-383438 – Fax: 44-1525-382200 – Email: chris@georentals.co.uk

GEOMETRICS CHINA Laurel Technologies, Ste 1807-1810, Kun Tai Int'l Mansion, #12B, Chaowai St., Beijing 100020, China
Tel: 86-10-5879-0099 – Fax: 86-10-5879-0989 – Email: laurel@laureltech.com.cn

3100

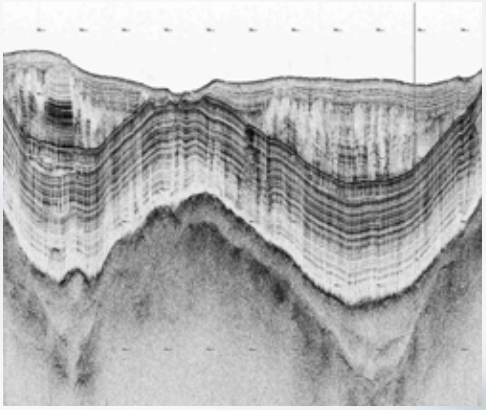
PORTABLE SUB-BOTTOM PROFILING SYSTEM

FEATURES

- Portable
- Low power requirement (runs on AC or DC)
- Choice of towfish depending on the application
- Pole mount option for shallow water surveys
- Easy to setup and operate

APPLICATIONS

- Geological Surveys
- Geohazard Surveys
- Buried Object Location
- Mining/Dredging Surveys
- Bridge/Shoreline Scour Surveys
- Pipeline and Cable Location



The 3100 is EdgeTech's portable version of their highly successful sub-bottom profiler product line. The system utilizes EdgeTech's Full Spectrum CHIRP technology which provides higher resolution imagery of the sub-bottom structure and greater penetration.

The 3100 is ideally suited for use in rivers, lakes, ponds and shallow water ocean applications up to 300m max depth. The system was designed for customers that require a portable system that can be used from smaller boats while not wanting to sacrifice image quality.

A 3100 system comes with a choice of two towfish; either the SB-424 or SB-216S. These towfish operate at different frequency ranges and selection between the two depends on the type of application. The 424 operates at 4-24 kHz and will provide slightly higher resolution but less penetration. The 216S operates at 2-16 kHz and provides slightly less resolution but greater penetration. Along with a towfish, the 3100 system comes with a portable splash-proof topside processor with laptop computer running EdgeTech's DISCOVER software for display of the sonar data. The system comes standard with a 35m tow cable with customer-specified lengths also available.

EdgeTech

3100

PORTABLE SUB-BOTTOM PROFILING SYSTEM

KEY SPECIFICATIONS

TOWFISH	SB- 216S	SB- 424
Frequency Range	2-16 kHz	4-24 kHz
Vertical Resolution (depends on pulse selected)	6-10 cm	4-8 cm
Penetration		
In coarse calcareous sand	6m	2m
In clay	80m	40m
Length	105 cm (41”)	77 cm (30”)
Width	67 cm (26”)	50 cm (20”)
Height	40 cm (16”)	34 cm (13”)
Weight in Air	76 kg (167 lbs.)	45 kg (100 lbs.)
Weight in Water	32 kg (70 lbs.)	18 kg (40 lbs.)
Max Depth Rating of Towfish	300 meters	
TOPSIDE PROCESSOR		
Hardware	Rugged, portable splashproof enclosure	
Operating System	Windows 7	
Display	Splashproof semi-rugged laptop	
Archive	DVD-R/W	
File Format	JSF, SEG-Y & XTF	
I/O	Ethernet	

SB-216S TOWFISH

SB-424 TOWFISH

Corer

Close

CSDCO

Continental Scientific Drilling Coordination Office

Bolivia corer after drive

Bolivia

Corer

A modification to the Livingstone, called the Bolivia corer, replaces the Livingstone's 2-inch (5 cm) steel barrel with standard polycarbonate tube, eliminating the need to extrude cores and providing superior retention of upper watery sediments. When a depth is reached at which sediments are too tough for the polycarbonate tube (usually at least several meters below lake floor, depending on sediment characteristics), it only takes a few minutes to switch to the steel barrel and continue coring in the same hole. The Bolivia can also be deployed with a square rod long enough to take 1.5-meter drives, increasing efficiency in both coring time and polycarbonate tubing utilization. Maximum depths attainable.

Instructions (http://csdco.umn.edu/sites/csdco.umn.edu/files/livingstone-bolivia1.pdf) for the operation of the Bolivia corer.

Type:
Direct Push, Piston, Repeat-drive
Minimum Water Depth (m):
0
Maximum Water Depth (m):
30-50
Maximum Sediment Depth (m):
17
Dimensions and Weight:
6 kg, 7x7x150cm, plus drive rods
Minimum Open-Water Deployment Requirement:
vessel with moonpool
Core Diameter/Profile (cm):
7
Lithologies:
Fine-grained, Soft Sediment

Accessories

Corer

Casing (Soft Sediment Coring) (/resources/equipment/casing-soft-sediment-coring)

Core Liners (/resources/equipment/core-liners)

Cutting Cylinder (/resources/equipment/cutting-cylinder)

Drive Rods (/resources/equipment/drive-rods)

Figure 8 (/equipment/accessories/figure-8)

Pipe Cutter (/resources/equipment/pipe-cutter)

more Bolivia images

- - 

    (http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/bolivia_no_tube.jpg?itok=IL52LUyf)

Corer

- 

  [(http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/bolivia_cool.jpg?itok=F5uSm7Ih)](http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/bolivia_cool.jpg?itok=F5uSm7Ih)

- 

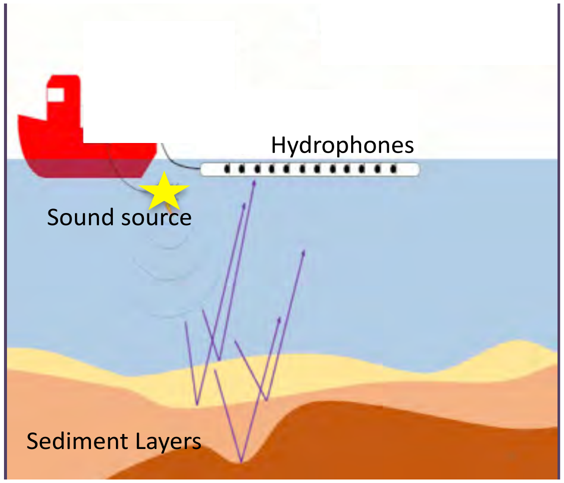
  [(http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/bolivia_piston1.jpg?itok=UsfsXR7O)](http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/bolivia_piston1.jpg?itok=UsfsXR7O)

- 

  [(http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/livingstone-bolivia7.jpg?itok=D_4RiyGd)](http://csdco.umn.edu/sites/csdco.umn.edu/files/styles/embed_medium/public/livingstone-bolivia7.jpg?itok=D_4RiyGd)

LAC CORE
LacCore.org
National Lacustrine Core Facility

(http://laccore.org)



Methods

Seismic Reflection

Sound waves are emitted from the boat. They echo back from the lake floor and the sediment layers beneath it to be captured by sensors pulled behind the boat. The time for the sound to travel from the boat to the lake floor and back is used to determine the thickness and shape of the sediment layers.

Coring

Tubes are forced several meters into the lake floor to obtain samples that are analyzed and dated.

An International Collaboration

An international team of universities and governmental agencies:

Unité de Recherche en Géoscience
Université d'Etat d'Haïti

Unité Technique de Sismologie
Bureau des Mines et de l'Énergie, Haïti

Laboratoire National du Bâtiment et des Travaux Publiques, Haïti

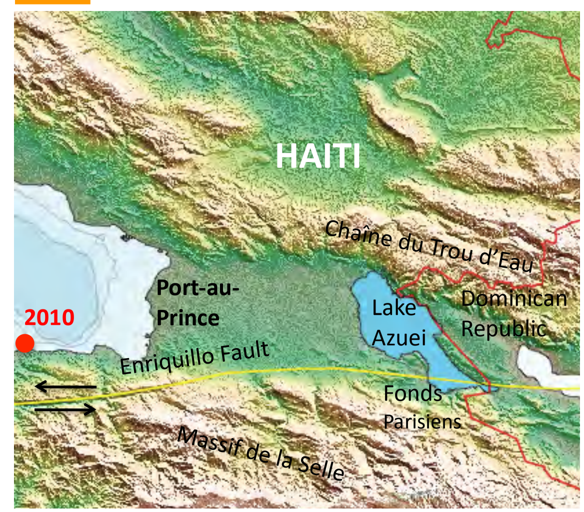
Graduate School of Oceanography
University of Rhode Island, USA

Lehman College
City University of New York, USA

Large Lake Observatory Research Laboratory
University of Minnesota-Duluth, USA

Lac|Core
National Lacustrine Core Facility
University of Minnesota-Minneapolis, USA

Project Lake Azuei

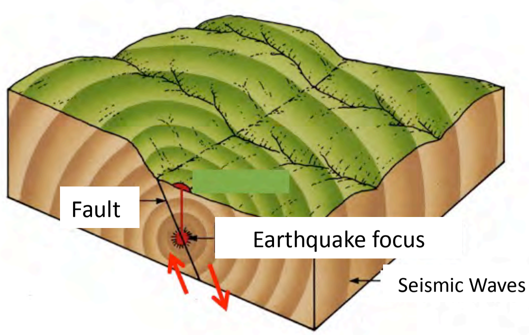


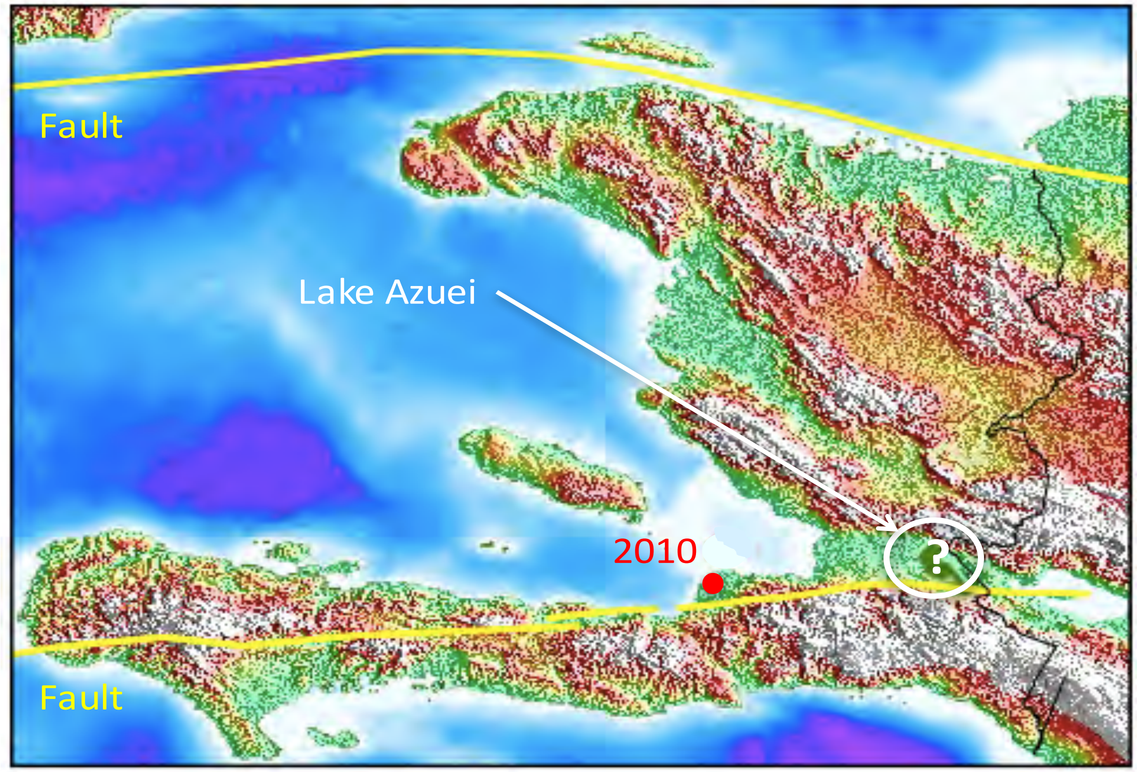
Project Lake Azuei Objective:

To develop a better understanding of the large earthquakes that occur in the region by studying the lake bottom.

What causes earthquakes?

A fault is a fracture that extends deep into the rock. An earthquake is caused by a sudden movement of several meters on the fault.





"Seismic Hazard"

In an instant, the massive devastation caused by earthquakes can kill, injure, and maim many people; cause uncontrollable fires; destroy building, bridges, roads and ports; cut telecommunication and electric lines and more.

How can this project reduce seismic hazard?

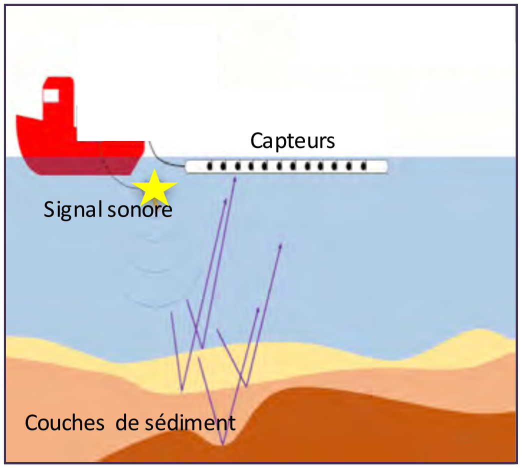
No one can predict precisely when an earthquake will occur, but the scientific community can identify regions with the greatest hazard. This information is communicated to local and national governments so that they can educate the public and prepare the emergency services to respond to an earthquake disaster.

Why is the seismic hazard so great for Haiti?

Two large active faults run directly through Haiti. Very large earthquakes have occurred on these faults in the past and will occur again in the future.

How can studying Lake Azuei help us better understand earthquakes?

Earthquakes disrupt the sediment layers of the lake floor, thereby recording seismic events. This project will image the deformation within the lake floor sediments that was caused by past earthquakes.



Kijan n'ap fè sa

Sismik Refleksion

Yon bato ki sou lak la fè yon son ki rebondi sou fon lak la. Yon seri de lòt ti aparèy ke nou plase sou dlo a, mezire konbyen tan son sa a pran pou li fè eko nan fon lak la epi remonte sou dlo a. Sa pèmèt nou konnen ki pwofondè lak la ak epesè kouch sòl ki anba lak la.

Kawotaj

Nou foure yon tib nan sab ki anba lak la, sa ki pèmèt nou remonte ak kantite sab (pa anpil). Apre sa, nou pral analize sab sa yo nan laboratwa pou nou konn ki kalite sab yo, ki kote yo soti e depi konbyen tan yo rive la.

Kolaborasyon entènasyonal

Yon ekip ki gen ladan plizyè moun ki soti nan invèsite ak ajans gouvènman nan plizyè peyi :

Unité de Recherche en Géosciences
Université d'Etat d'Haïti

Unité Technique de Sismologie
Bureau des Mines et de l'Énergie, Haïti

Laboratoire National du Bâtiment et des Travaux Publics, Haïti

Graduate School of Oceanography
University of Rhode Island, USA

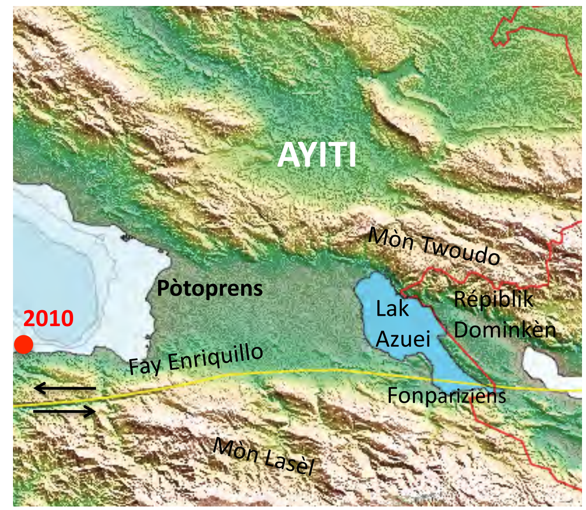
Lehman College
City University of New York, USA

Large Lake Observatory Research Lab University of Minnesota-Duluth, USA

Lac|Core
National Lacustrine Core Facility
University of Minnesota-Minneapolis, USA

Pwojè sa a, se National Science Foundation (USA) ki bay kòb pou li fèt ak sipò plizyè enstitisyon peyi

Pwojè Lak Azuei

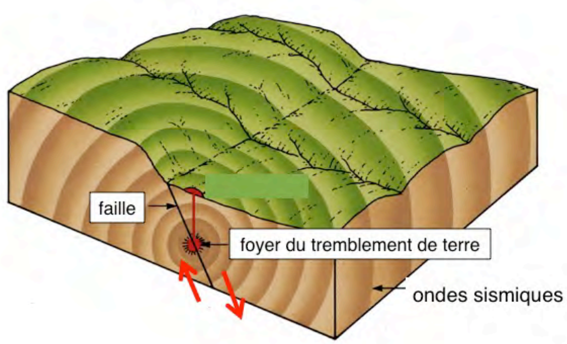


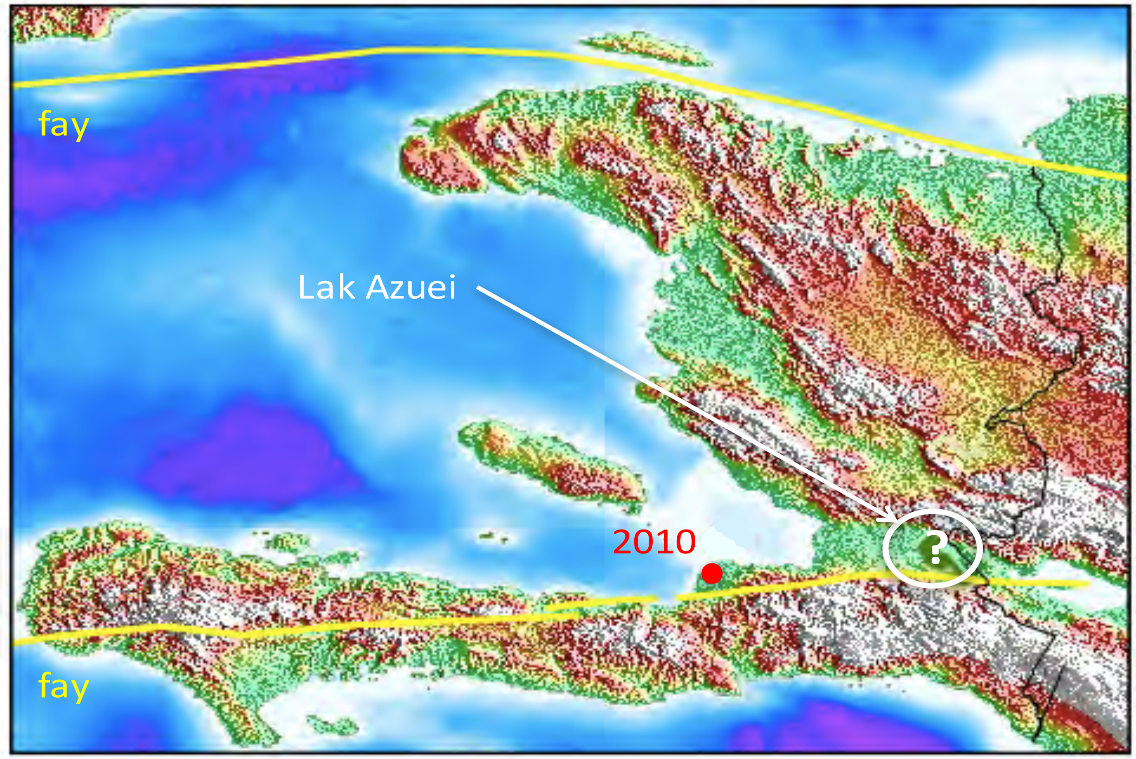
Pou kisa Pwojè Lak Azuei a ?

Chache konnen ki kalite sòl ki anba lak la pou nou ka konprann pi byen gwo tranbleman tè (goudougoudou) ki te pase nan zòn nan.

Kisa ki fè tè a tranble?

Tè a gen kote ladan li ki fele. Na jewoloji, yo rele sa "fay" Sa konn rive ke nan kèk nan kote sa yo gen yon mouvman bridsoukou ki fèt. Se sa nou rele tranbleman tè (goudougoudou).





"Menas tranbleman tè (goudougoudou)"

Se yon gwo dezas ki, nan yon ti moman, ka touye anpil moun, blese anpil lòt, rann kèk moun tou kokobe pou rès lavi yo; mete dife; kraze kay, wout, waf, ayopò, koupe kominikasyon pa telefòn, liy eletrik ak anpil lòt dega.

Kijan pwojè sa a ka diminye menas tranbleman tè (goudougoudou)

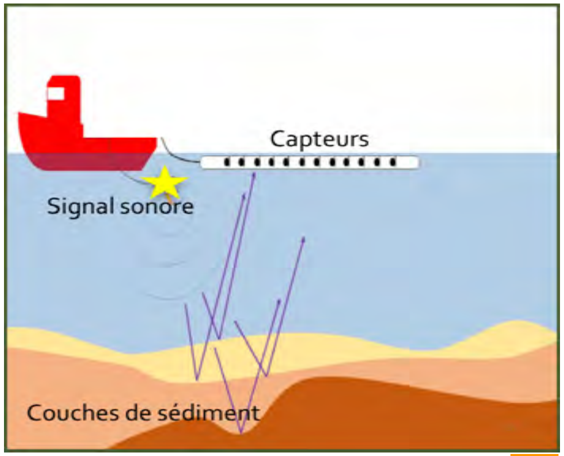
Pa gen anken moun ki ka di kilè goudougoudou a ap pase, men moun ka fè lasyans ka chache konnen ki zòn ki pi an danje. Apre, syantifik yo kay bay Leta enfòmasyon sa yo ki ka sèvi pou enfòme popilasyon an epi ede peyi a fès fas a dezas sa a.

Pou kisa pou Ayiti pran menas goudougoudou a ak anpil serye ?

Gen 2 gwo fay ki travèse peyi a Dayiti. Fay sa yo bay gwo tranbleman tè déjà e yo gen pou yo bay gwo tranbleman tè ankò (nou pa ka konn ki lè).

Kijan etid ki fèt sou lak Azuei la ka pèmèt nou konprann tranbleman tè (goudougoudou)?

Goudougoudou brase bil sab ki anba lak la sa kif è ke nou ka rejwenn tras li. Pwojè sa ap chache jwenn tras ansyen goudougoudou nan sab ki anba lak la.



Méthodes

La sismique réflexion

Le signal sonore produit à partir du bateau, qui rebondit sur le fond de lac, et sur les couches de sédiments en dessous, est enregistré par des capteurs. Le temps aller-retour du son fournit une information sur la profondeur, l'épaisseur et la forme des couches de sédiments.

Le Carottage

On enfonce un tube dans les sédiments pour prélever des échantillons sur quelques mètres. Ces échantillons seront ensuite analysés et datés.

La collaboration internationale

Une équipe internationale qui inclut des universités et agences gouvernementales :

Unité de Recherche en Géosciences
Université d'Etat d'Haïti

Unité Technique de Sismologie
Bureau des Mines et de l'Énergie, Haïti

Laboratoire National du Bâtiment et des Travaux Publics, Haïti

Graduate School of Oceanography
University of Rhode Island, USA

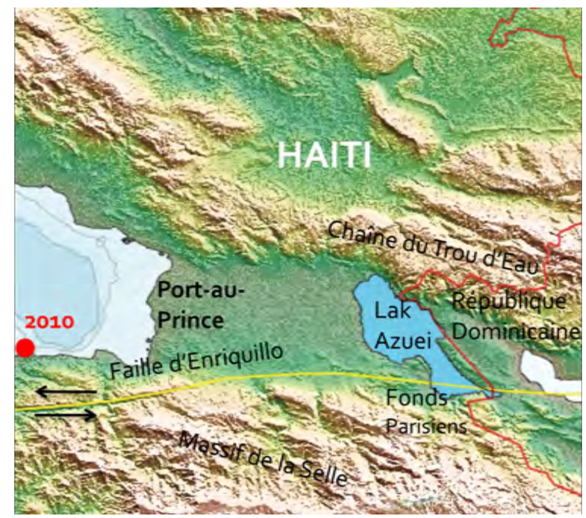
Lehman College
City University of New York, USA

Large Lake Observatory Research Lab University of Minnesota-Duluth, USA

Lac|Core
National Lacustrine Core Facility
University of Minnesota-Minneapolis, USA

Ce projet est financé par la National Science Foundation avec le support d'institutions haïtiennes

Projet Lac Azuei

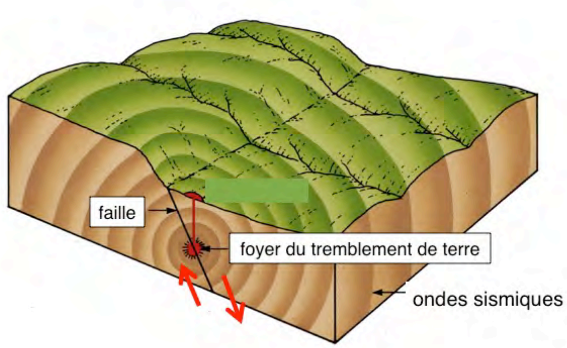


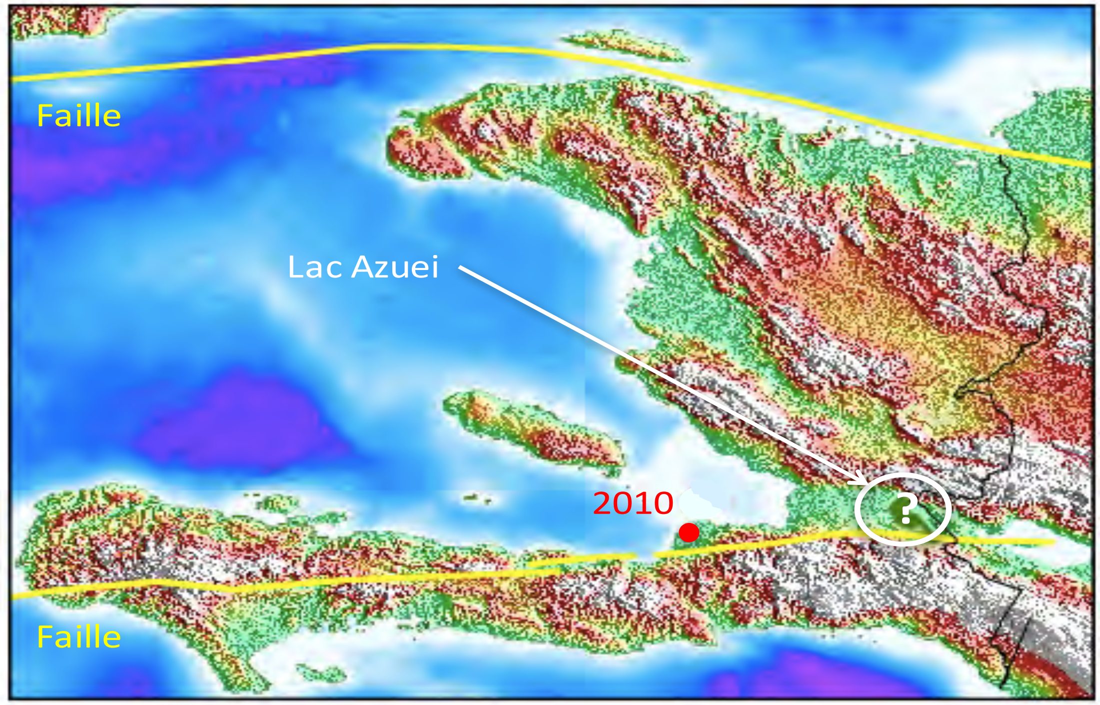
Objectif du Projet Lac Azuei

Etudier le fond du Lac Azuei pour mieux comprendre les grands tremblements de terre qui ont eu lieu dans la région.

Qu’est-ce qui produit un tremblement de terre?

Une faille est une cassure qui pénètre profondément dans la roche. Un tremblement de terre est le résultat d’un mouvement brutal, de quelques mètres, sur cette cassure.





“Le risque sismique”

Une dévastation massive qui, en un instant, peut produire beaucoup de morts, de blessés, d’handicapés à vie; des incendies; ainsi que la destruction des bâtiments, routes, ports, aéroports et la coupure des liaisons téléphoniques, de lignes électriques et autre.

Comment ce projet peut diminuer le risque sismique ?

Personne ne peut prédire la date précise d’un tremblement de terre, mais la communauté scientifique peut identifier les zones les plus à risques. Cette information, transmise aux gouvernements locaux et nationaux, peut-être utilisée pour informer la population et surtout préparer les services publics à répondre à un tel désastre.

Pourquoi le risque sismique est-t-il important à Haïti?

Haïti est traversé par deux grandes failles actives qui ont produit, et qui produiront encore, des grands tremblements de terre.

Comment l’étude du Lac Azuei peut aider à comprendre les tremblements de terre?

Les tremblements de terre bouleversent les couches de sédiments qui se sont déposées au fond du lac. Ces sédiments enregistrent l’évènement (sismite) dans les roches. Le projet cherche donc à identifier les traces de ces sismites dans la succession des couches de sédiments enfouies sous le lac.