

***Final Report on
Acoustic Similarity
Between the
NY and VT HVDC Corridors***

**Prepared for
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By

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Project Summary

The New England Clean Power Link (NECPL) project is designed provide clean Canadian generated energy to the United States. One component of this program is to lay High Voltage Direct Current (HVDC) cables on the bottom of Lake Champlain starting near the U.S. / Canadian border and ending near Benson Landing, VT (Figure 1). In order to satisfy environmental concerns relating to the disturbance of the near-surface (upper 1-2 m) sediments of the lake, HDR is developing a water quality model to look at the disposition of these disturbed sediments after the laying of the cable (e.g., their potential redistribution within the lake due to circulation dynamics). While there are many boundary conditions required by the model, two of the most important ones relate to the varying physical and chemical characteristics of the sediment along the path of the HVDC. During the New York 2010 and 2012 corridor surveys, cores as well as acoustic sub-bottom profiles were obtained in order to gain this required information. When a Vermont corridor was proposed on the eastern side of the lake in 2013, information was lacking as to whether or not the same sediment characteristics found along the NY corridors on the western side of the lake were representative of those along the VT corridor since this was, as previously noted, important information for the water quality model.

The scope of this study was to concentrate primarily on the programmatic needs of the water quality model which require a basic comparison between sediment types observed along the NY2010/2012 corridors and that of the newly proposed VT corridor located on the eastern side of Lake Champlain. This comparison is to be based solely on acoustic sub-bottom profiles that can distinguish between the three major types of sediment types observed within the lake and through which the NY corridors passed through. As a natural byproduct of this work, regions where sediment types were laterally similar (or dissimilar) could then be aerially defined and then investigated for possible repositioning of the corridor to meet “similarity” criteria.

In order to provide this comparison information, 955 CHIRP (sub-bottom) sonar records were utilized from Middlebury College’s Lake studies inventory using the knowledge that 1) acoustic sub-bottom profiling can define the rudimentary sediment types [recent Lake Champlain (LC), Champlain Sea (CS) and Lake Vermont (LV)] that vary along the NY corridor, 2) the physical and chemical characteristics of these sediments have been accurately defined by previous NY corridor studies, and 3) there are a sufficient number of sub-bottom profiling records that can provide a “close-approach” between the NY and VT corridors. Close-approach lines reflect those sub-bottom profiles that are as close to perpendicular as possible between the two corridors. This, in turn, facilitates the creation of a minimum distance between the two corridors wherein comparisons between sediment types can be made. Typically, it would be expected that an inverse correlation would occur between two observations as distance increases between them. Using this basic premise, it was decided to use only those lines that minimize the distance between corridors along any single seismic line (hereafter referred to as close-approach lines) as this would minimize the distance and increase the probability of better comparisons. Since the NY and VT corridors are primarily north-south oriented, close-approach lines would have a preferred east-west alignment (i.e., perpendicular to the planned corridors).

Of the 955 sub-bottom records, 224 lines were found to satisfy ‘close-approach’ criteria. Of these “close-approach’ lines, 24 were rejected as these lines were too far outside the NY Corridor to make an adequate extrapolation of sediment type. The acoustic characteristics from these 200 useable lines showed that roughly 88% of the VT and NY corridors were similar in nature. The remaining 12% showed

a split of 11% and 1% for “Dissimilar and Unknown” categories. The ‘Unknown’ category defined those lines that did not have a good enough seismic interpretation to determine a specific sediment type.

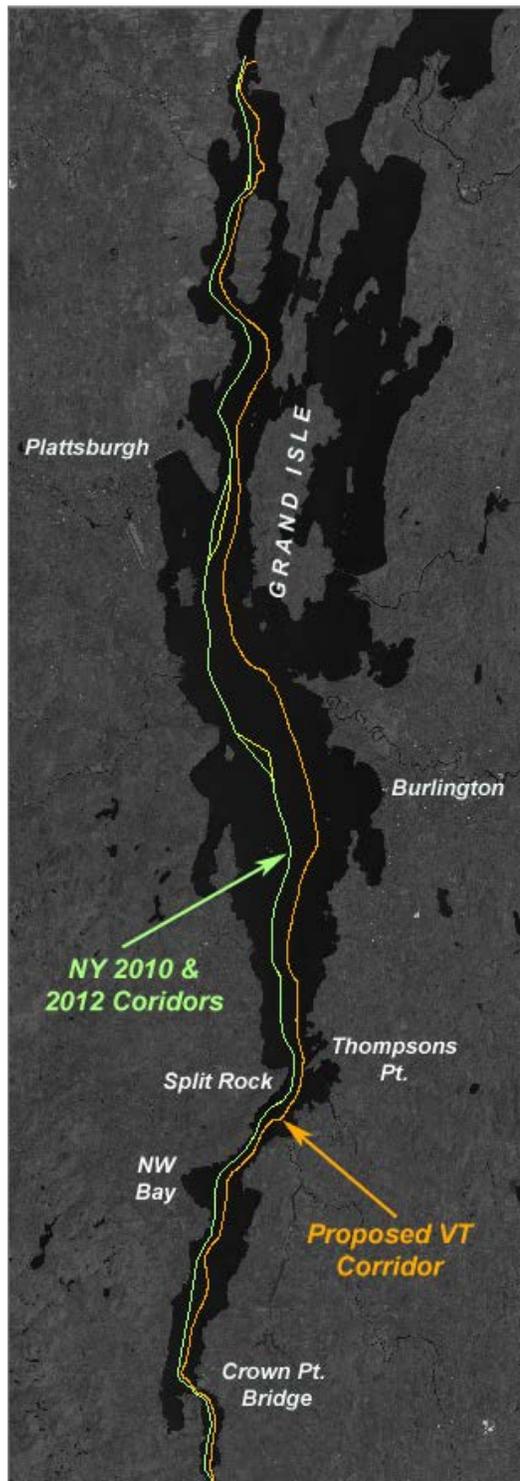


Figure 1. Proposed NY2010, NY2012 and VT corridors for laying the HVDC transmission lines in Lake Champlain.

Sediments within Lake Champlain

Physical, Chemical, Biological and Acoustic Characteristics

Sediment layering found within Lake Champlain is comprised of three depositional regimes over the past 14,000 years (e.g., Myer and Gruendling, 1979; Chase and Hunt, 1972; Freeman-Lynde et al., 1980; Cronin et al., 2008). Each is distinctive from the other in its physical, chemical, and biological characteristics (Table 1) (e.g. Chase and Hunt, 1972, Cronin et al., 2008; Dawson, 2008; Ghosh, 2012). The same can be said for the acoustic definition of these layers as seen in Figure 2. The upper layer which, in this image, tends to be acoustically “lighter” than the deeper layers were those created during the time period when present-day Lake Champlain existed as a freshwater body over the past 9000 years and is usually designated as Lake Champlain (LC) or (recent sediments). Lake Champlain sediments are diatomaceous, very dark grayish to olive brown gray clay containing freshwater ostracods, diatoms, insect remains, pine pollen, snails, and plant material (e.g. Chase and Hunt, 1972; Cronin et al., 2008; Dawson, 2008; Ghosh, 2012). In some locations there is black mottling. Grain size is variable from clays to gravelly muds depending upon the proximity to shore (Chase and Hunt, 1972). The Lake Champlain unit is the most diverse in terms of grain size and composition of the three sedimentary units in the lake. The general sedimentation rate of the LC sediments was calculated by Chase and Hunt (1972) as 0.24 cm per year. Recent studies show sedimentation rates range between 0.05 to 0.15 cm/yr for the Main Lake (e.g. Cronin et al., 2009; Ghosh, 2012).

Below the LC sediments are those sediments deposited during the epoch of the Champlain Sea between 9000-13000 years ago when this region was a brackish estuary of the Atlantic Ocean. This sediment package is typically comprised of a continuous sequence of laminated layers and referred to as Champlain Sea (CS) sediments. Champlain Sea sediments consist of dark gray clay containing marine ostracods, pelecypods, abundant foraminifera, pine pollen, and a few diatoms. Champlain Sea sediments, which were deposited at a rate of approximately 1 cm per year, overlie Lake Vermont sediments (Cronin et al., 2008). The transition between Lake Champlain and CS sediments is usually well defined in seismic profiles due to the change in density from freshwater LC sediments to saltwater CS sediments. Champlain Sea sediments are usually well stratified with prominent reflectors (Figure 2). In the South Lake, Freeman-Lynde et al. (1980) found the CS sediments to be acoustically well laminated and uniformly distributed across the lake bottom in water 30+ m deep. This unit can be between 20 – 40 m thick (Chase and Hunt, 1972; Freeman-Lynde et al., 1980; Cronin et al., 2008).

Prior to the Champlain Sea, sediments were derived from a large, pro-glacial lake known as Lake Vermont that followed the retreating glacial front as it moved northwards from 18,000-13,000 years ago). There are various temporal regimes during Lake Vermont such as the Fort Ann or Coveville stages that define the changing extents of this pro-glacial lake however, it is not necessary to discuss or reference these stages since they bear little to the scope of this project. Stratigraphically, the lowest sedimentary unit in contact with glacial till / bedrock is Lake Vermont sediments (LV). Chase and Hunt (1972) found this unit to be the most widespread of all three units observed in the Main Lake region. Lake Vermont sediments are described as non-fossiliferous clays with alternating dark brown and dark

gray layers (Chase and Hunt, 1972). On seismic profiles, these sediments are acoustically nondescript (Figure 2) and have the highest sedimentation rate of all three units Lake Vermont sediments depositing at a rate of approximately 4 to 8 cm per year between 14 and 13 ka BP (Cronin et al., 2008). In the South Lake, Freeman-Lynde et al. (1980) found that Lake Vermont sediments were acoustically laminated in deep water but acoustically transparent in shallow water. Lake Vermont sediments are often absent on bedrock highs and near shore but upwards of 126 m thick in areas near the Folger Trough and Northwest Bay. The Lake Vermont sediments have a remarkably sticky consistency that Chase and Hunt (1972) likened to taffy or cold lard. These sediments can be as thick as 45 m (Myer and Gruending, 1979), but vary greatly in thickness depending on location (Chase and Hunt, 1972). The NY and VT corridors are not located in or near LV sediments.

Below Lake Vermont is bedrock. The deepest reflector revealed in seismic profiles of the Lake Champlain basin is acoustic basement (Figure 2). This has been inferred to represent lower Paleozoic bedrock in most areas. Locally, this reflector may represent glacial till overlying bedrock. Typically, bedrock directly underlies the Lake Vermont unit at mid-lake highs and at localities close to shore (Chase and Hunt, 1972).

While it is a common occurrence that most, if not all these layers are usually shown in sub-bottom acoustic profiles, there are cases where one or more of these distinct sediment packages may be missing depending on the depositional and/or erosional history of that specific region or due to the depth resolution of the CHIRP system. The units are differentiated based on acoustic character, lithology, and microfossil content.

Table 1. Observed ranges for saturated bulk density and porosity from a variety of researchers within the lake basin from cores. See text for further details.		
Sediment type	Saturated Bulk Density	Porosity
Lake Champlain sediments (LC)	1.2 – 1.4 g/cm ³	87 – 92 %
Champlain Sea sediments (CS)	1.49 – 1.69 g/cm ³	60 – 70 %
Lake Vermont sediments (LV)	1.7 – 2.2 g/cm ³	40 – 60 %
Lake Champlain slump sediments	1.3 – 1.4 g/cm ³	82 %
Lake Champlain drift sediments	1.28 – 1.38 g/cm ³	75 – 85 %

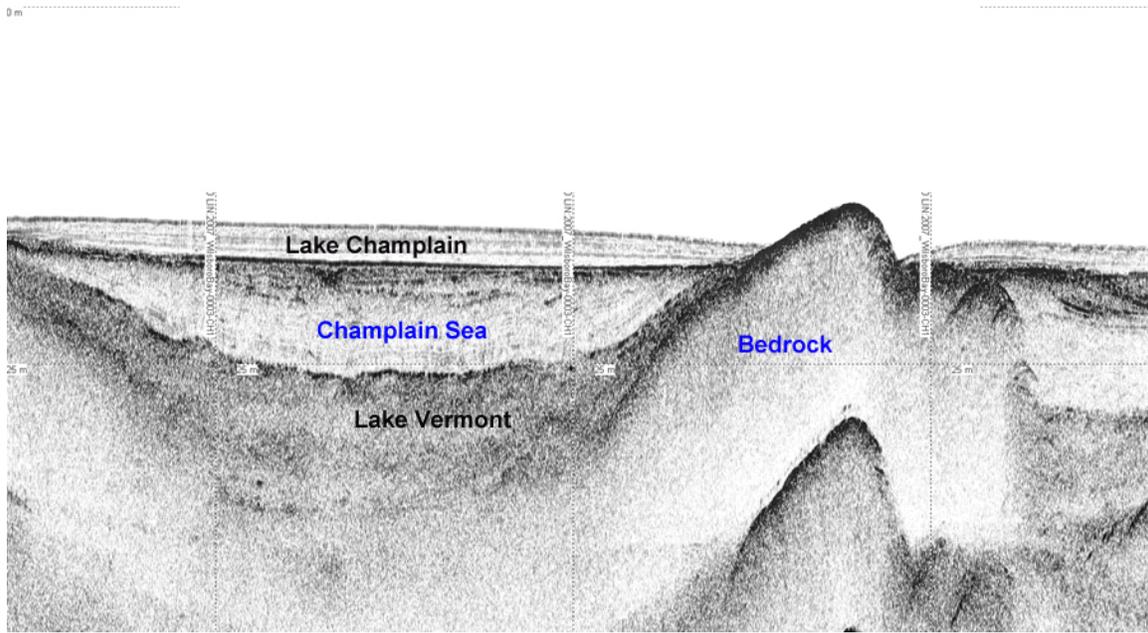


Figure 2. Acoustic imagery created from the Edgetech SB216 Chirp sub-bottom profiler and collected in Lake Champlain. All acoustic data were primarily collected using the SB216 system or Edgetech's combined Chirp/Side-scan sonar system or 3200SB 216 Chirp system. Shown are the three primary sedimentological packages found in Lake Champlain lying directly above bedrock.

Data Sets Used for Analysis

While the typically distributed NOAA charts (numbers 14781-14785) are used most frequently as representing the bottom bathymetry of the lake (Figure 3), a newer data base opened up to the public in 2005 (Manley et al., 2005) will be used in this analysis. This 2005 data base was created from 7 years of mapping the lake floor for historical artifacts and geologic structure from 1996-2002. In comparison, the NOAA map was based on roughly 9800 lead-line observations taken in the mid to late 1800s while the 2005 map was based on 735,000 single-beam observations from ship tracks that were ~175 m apart.

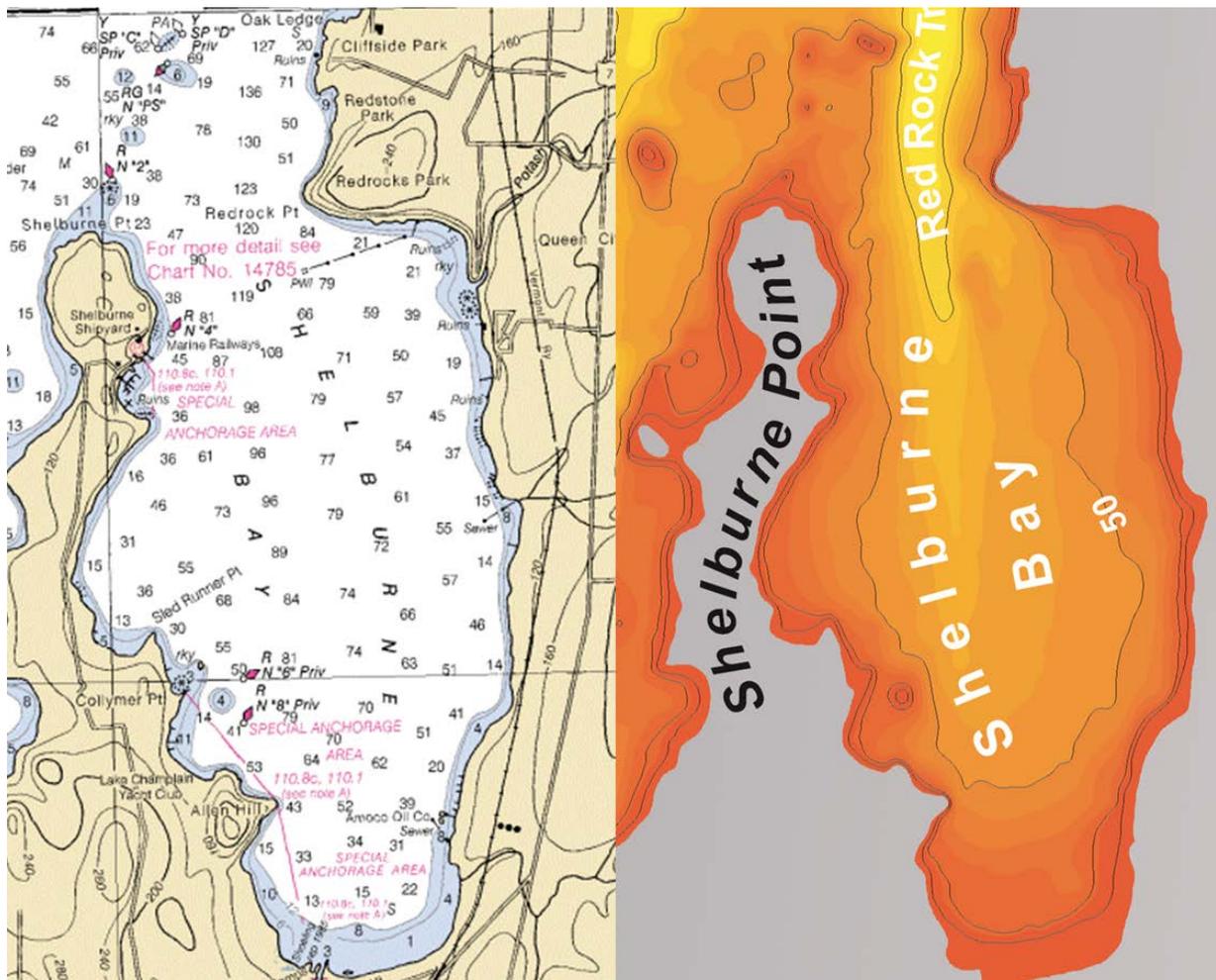


Figure 3. (Left) Standard NOAA navigational maps that are still widely used on Lake Champlain. In Shelburne Bay, approximately 100 discrete points made from lead-line observations in the mid to late 1800s make up the data set. (Right) 2005 Bathymetric map of Shelburne Bay comprised of over 10,000 observations. Contours are in feet with color transitions being every 10 feet.

The lake's bathymetric structure is highly variable and ranges from very flat regions found in both shallow bays and deeper regions to that of very rugged topography with numerous islands, shoals and near-vertical cliff faces (Figure 4).

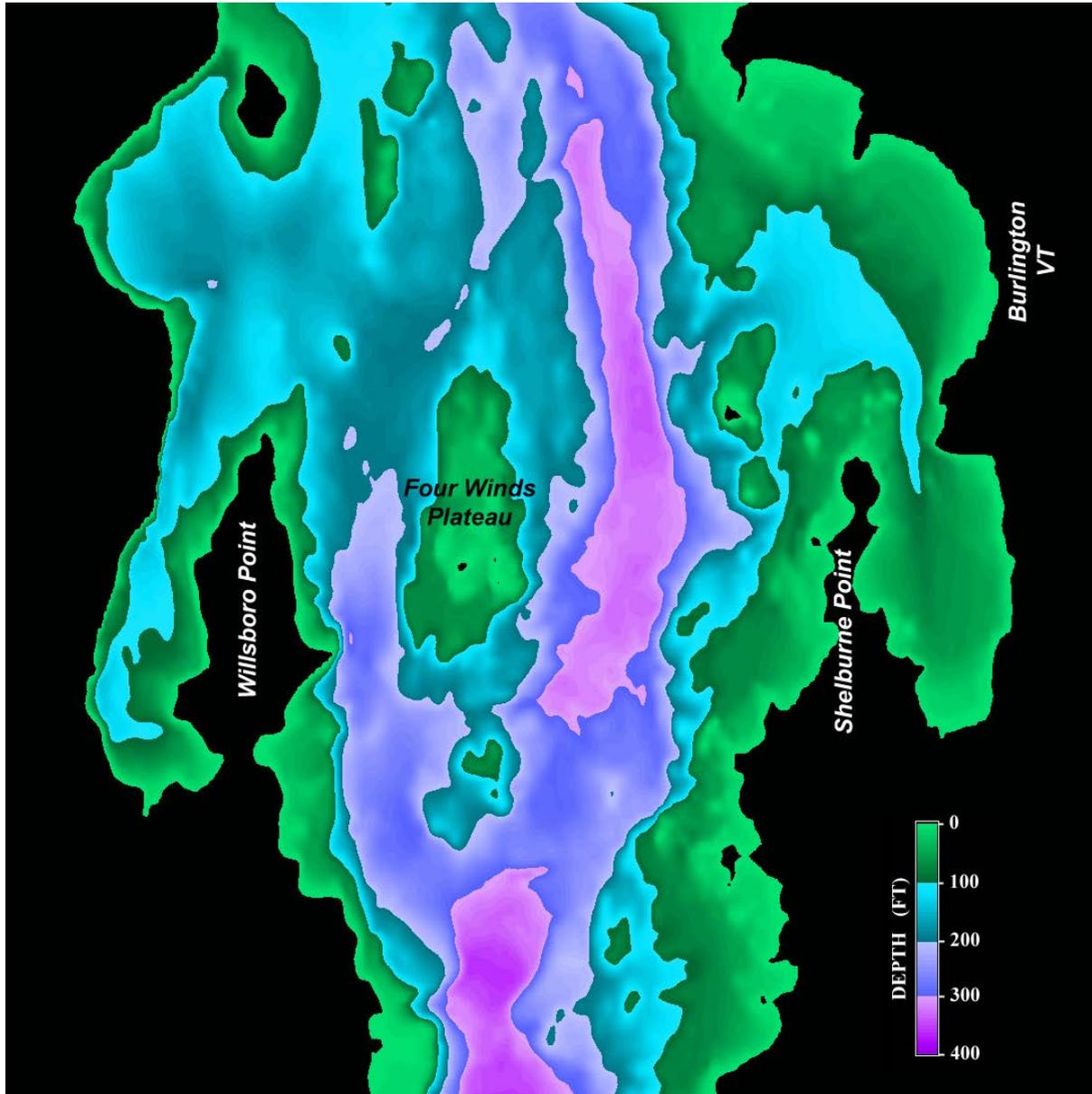


Figure 4. Example of the highly variable bathymetry of Lake Champlain which ranges from nearly flat lying to that of very steep cliffs which are associated with old faults, islands and shoals. Section displayed is the broadest part of the lake near the city of Burlington, VT (located in the upper right of the image).

In addition to the bathymetric data, roughly 645 Chirp lines were taken from the Middlebury College research vessel *R/V Baldwin* (2003-2008) using the Edgetech SB216 sub-bottom profiler. Surveys occurring between 2008-2013, were added to the inventory thereby bringing the total data set up to 849 lines. The additional lines were obtained using the aforementioned SB216 on the *R/V Baldwin* from 2008-2011 as well as from the college's newest research vessel, the *R/V Folger*, using the either SB216 or Edgetech Chirp/SideScan "Combi" system. An additional 106 lines were obtained in July 2014 using an Edgetech 3200SB 216 Chirp system on the *R/V Melosira*. The total inventory of Chirp lines is 955 with a subset of 200 selected as representing the "closest approach" lines as previously discussed. These were then used to address the issue of acoustic similarities / dissimilarities between the NY and VT corridors (Figure 5).

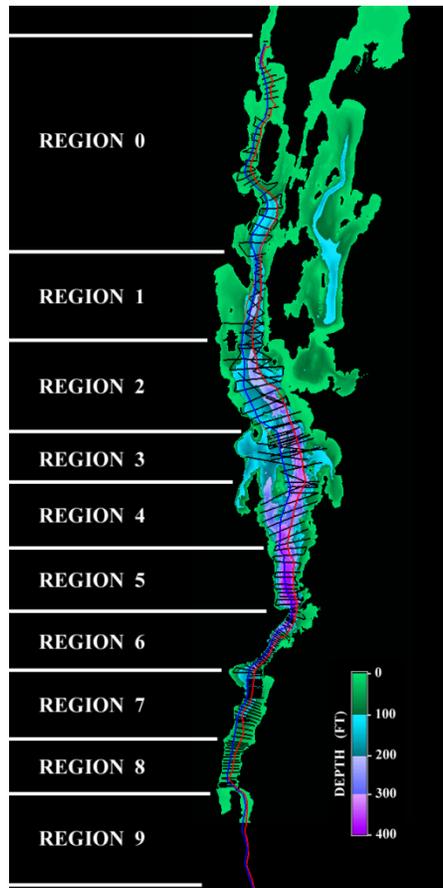


Figure 5. Bathymetric map of the lake showing the 200 close-approach sub-bottom profiles lines used in this analysis. The 10 subdivisions (regions) are delineated for more detailed visualization and analysis throughout this report.

Two external data sets consisting of the NY2010 and NY2012 Chirp lines and core physical/chemical properties were provided by HDR for additional background information. Finalized core properties were used to verify acoustic sub-bottom profile classifications against direct sediment observations. On the other hand, the NY2010 and NY2012 sonar data required post-processing in order to be utilized in this project. Due to time constraints, only the NY2010 seismic data were processed. These data were included into the master data base for 1) verification that seismic data sets were observing the same acoustic characteristics at all intersections defined between the north-south oriented NY2010 corridor

and the primarily east-west “closest approach” Lake Studies survey lines and 2) provide acoustic information between intersection points along the NY2010 corridor that, in turn, would verify the continuous or discontinuous nature of sediment type spanning that distance. In effect, this allowed us to look at the NY2010 along-corridor variability of sediment type along with its associated structural setting.

Analysis

Data Coverage

As can be seen in Figure 5, a majority of Lake Champlain is covered by close-approach lines. The entire data set was then divided into 10 separate regions that were primarily defined by the coverage zones. These 10 regions extend from the Canadian border (Region 0) to Benson Landing (Region 9) and will be used in the results section of the similarity analysis. Naming of the acoustic lines was simplified from the original survey line naming convention to that of region and sequential line number in the following format RX-YY where RX is the region number from R0-R9 and YY is the line number within that region. Line numbers start with 01 at the northern border and typically increase sequentially to the south (e.g., R1-12 or R9-02) provided no new lines were added after the original setup of the data base.

Detailed Regional Analysis

The following is a synopsis of each region based on seismic lines that represent ‘best quality’ records while at the same time, satisfying a ‘shortest-distance’ requirement between the NY and VT corridors within that specific line (i.e., the close-approach lines that were discussed earlier). Cores from the NY2010 and NY2012 surveys were also used to confirm the sediment type determined from the acoustic profiles. Within each region, every close-approach line was utilized in the analysis phase of this project.

An example of an acoustic profile that will be characteristic of all profiles used in this report can be seen in Figure 6. The profile is aligned so that the viewer is looking northward and west is to the left of the image. The locations of any corridor lines within the near-boundaries of the image are also provided as colored dots. The NY2010, NY2012 and VT color coding is blue, orange and magenta, respectively. If a corridor line is slightly outside of the image (but within ~200 m), an appropriately colored arrow (associated to the corridor as noted above) is positioned to that side and directed as to where it would be expected to appear in the image if it were extended. Vertical distance between the light grey horizontal lines is typically 20 m based on a sound velocity of 1500 m/s. The horizontal scale for every raw image has been scaled to 200m/in.

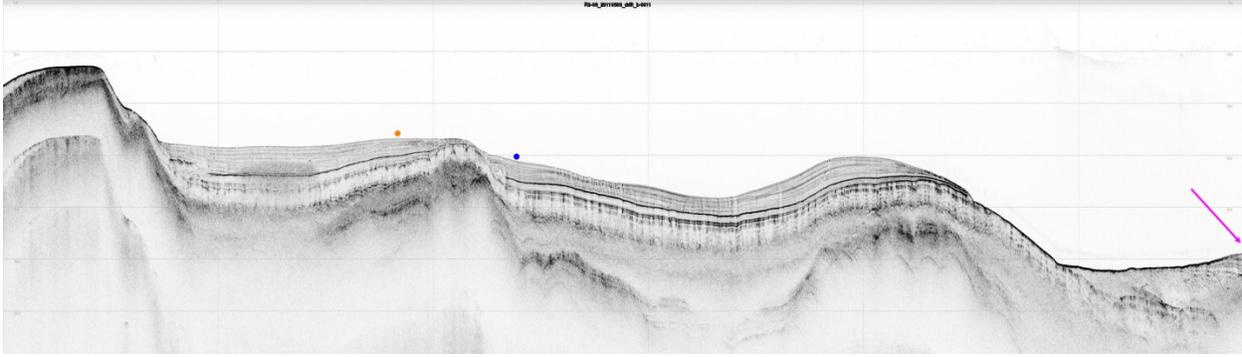


Figure 6. Acoustic profile for Region 3 and line number 6 (R3-06). Viewer is looking to the north. Dots and arrows indicate the location of the various corridors. Orange, blue and magenta are used for the NY2012, NY2010 and VT corridors, respectively. See text for further details.

Region 0: Canadian Border to Cumberland Head (Figures 7, 8, and 9)

Cores from the 2010 survey, S1-S08, and from the 2012 survey, SII-01 through SII-12 penetrated either a grey, high-plasticity clay which would be indicative of CS sediments as well as high organic dark green/brown LC clays. Occasional cores penetrated into sandy sediment the further north in the survey. Variability does exist in the sediment obtained from cores within this region and this variability is observed in the acoustics as well. In most cases the sediment type is similar from the NY10 corridor to the VT line. There are a few exceptions where the sediment type is different (CS to LC, respectively from NY to VT). Due to the close proximity of the NY and VT corridor lines, there is a similarity of the sediment type with the few exceptions already mentioned.

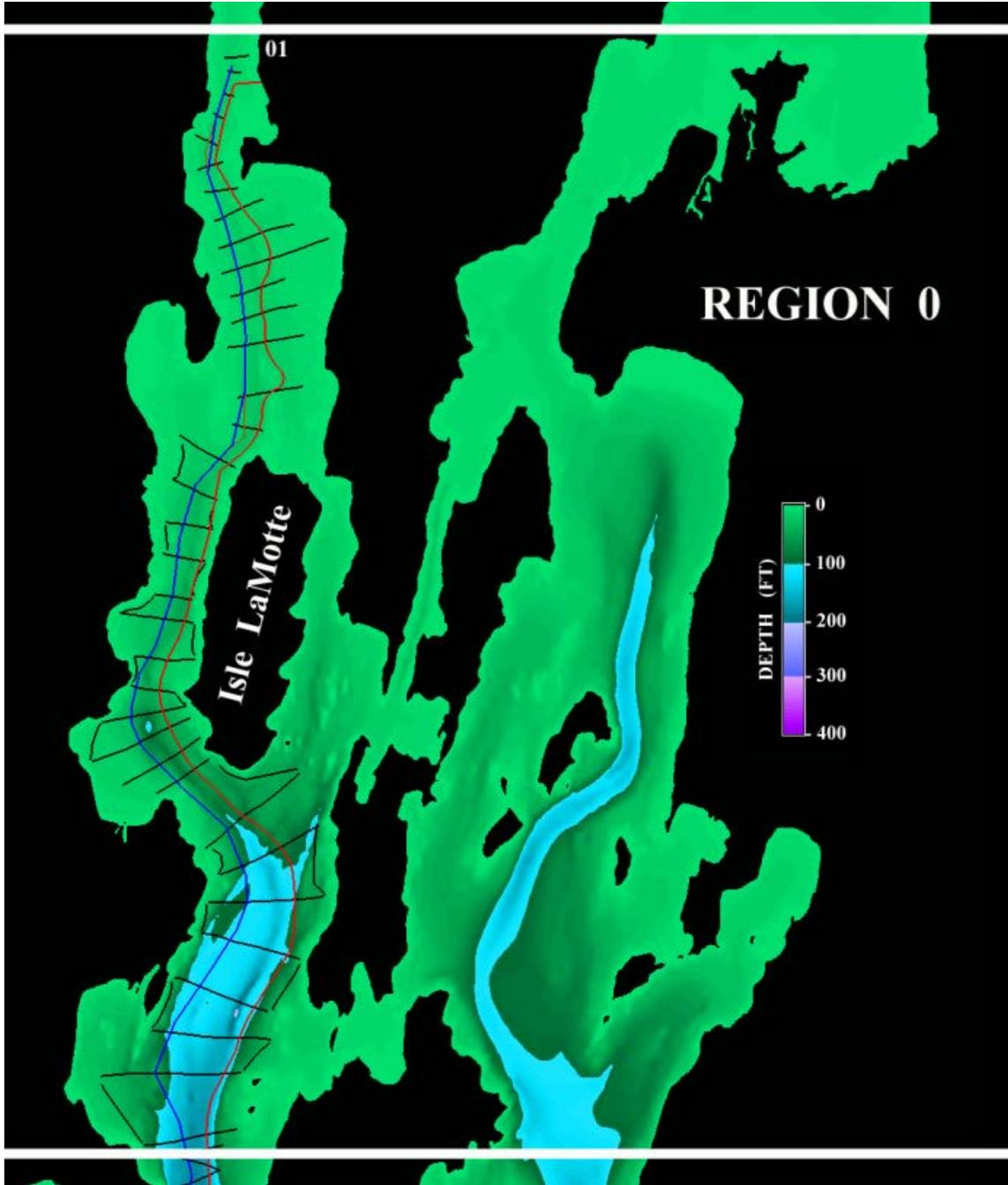


Figure 7. Detailed map of Region 0. NY2010/12 corridors are shown on the western side of the lake (blue line) along with all provided cores (labeled). The proposed VT corridor is located on the eastern side of the lake (red line). Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines. See text for further details.

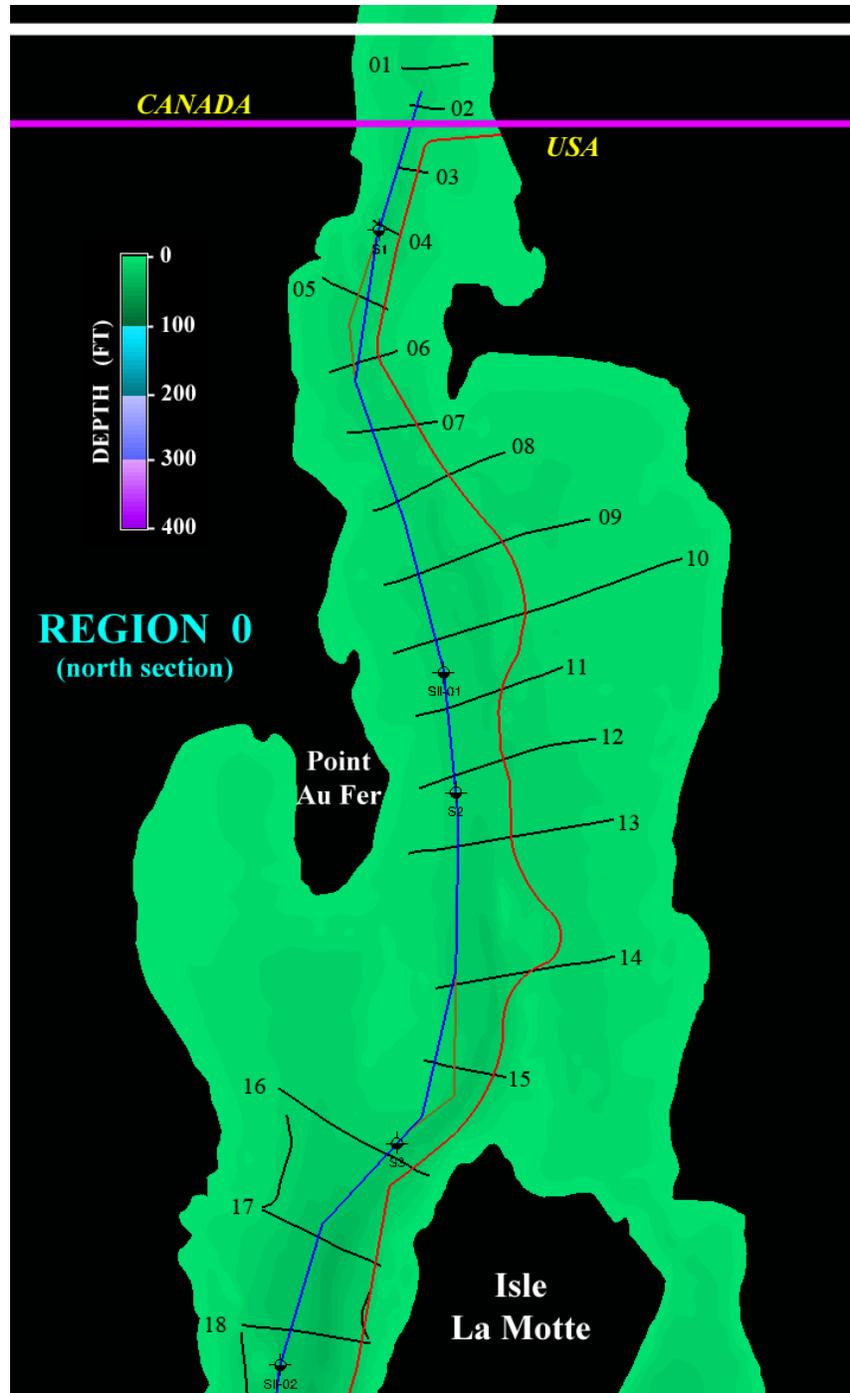


Figure 8. Detailed map of the north section of Region 0. NY2010/12 corridors are shown on the western side of the lake (blue line) along with all provided cores (labeled). The proposed VT corridor is located on the eastern side of the lake (red line). Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

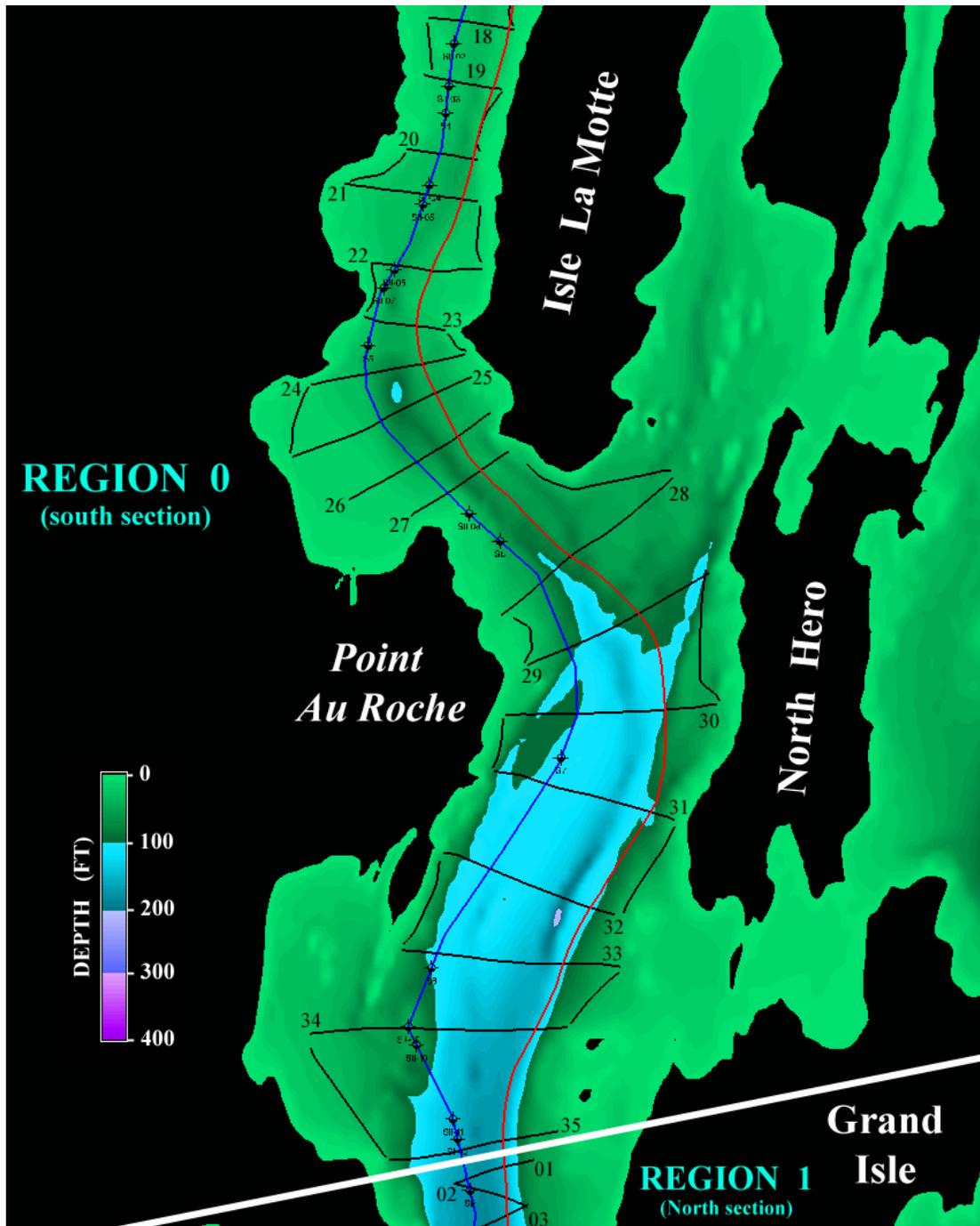


Figure 9. Detailed map of the south section of Region 0. NY2010/12 corridors are shown on the western side of the lake (blue line) along with all provided cores (labeled). The proposed VT corridor is located on the eastern side of the lake (red line). Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

Region 1: North of Cumberland Head to Valcour Island (Figures 10 and 11)

Cores from the NY2010 survey (S9-S11) and those from the NY2012 survey (SII-11 through SII-14) penetrated grey, high-plastic clay which is indicative of CS sediments. Variability does exist in the sediment from these cores and this is observed as well in the acoustics. North of Cumberland Head (above the ferry crossing), the VT corridor is located in a plastered drift (a positive bedform where there is a net accumulation of sediment) which is slowly becoming larger towards the south. These drift sediments are LC sediments, whereas on the NY side most of NY2010 and NY2012 lines are within CS sediments. There is a distinct sediment characteristic change between these two sediment types. The sediment drift continues to grow, prograding westward as a wedge and then becomes less pronounced below Valcour Island (Figure 11). Starting with R1-11 and heading southward on the NY side (see Figure 12 for R1-20 as an example), south of Cumberland Head to Valcour Island, a furrow field had developed (Manley et al., 1999). Furrows, which are long linear channels cut into the sediment, are created by secondary boundary layer helical flow along the bottom of the lake (Manley et al., 1999). However, the VT line is always located in laminated LC sediments associated within the plastered drift.

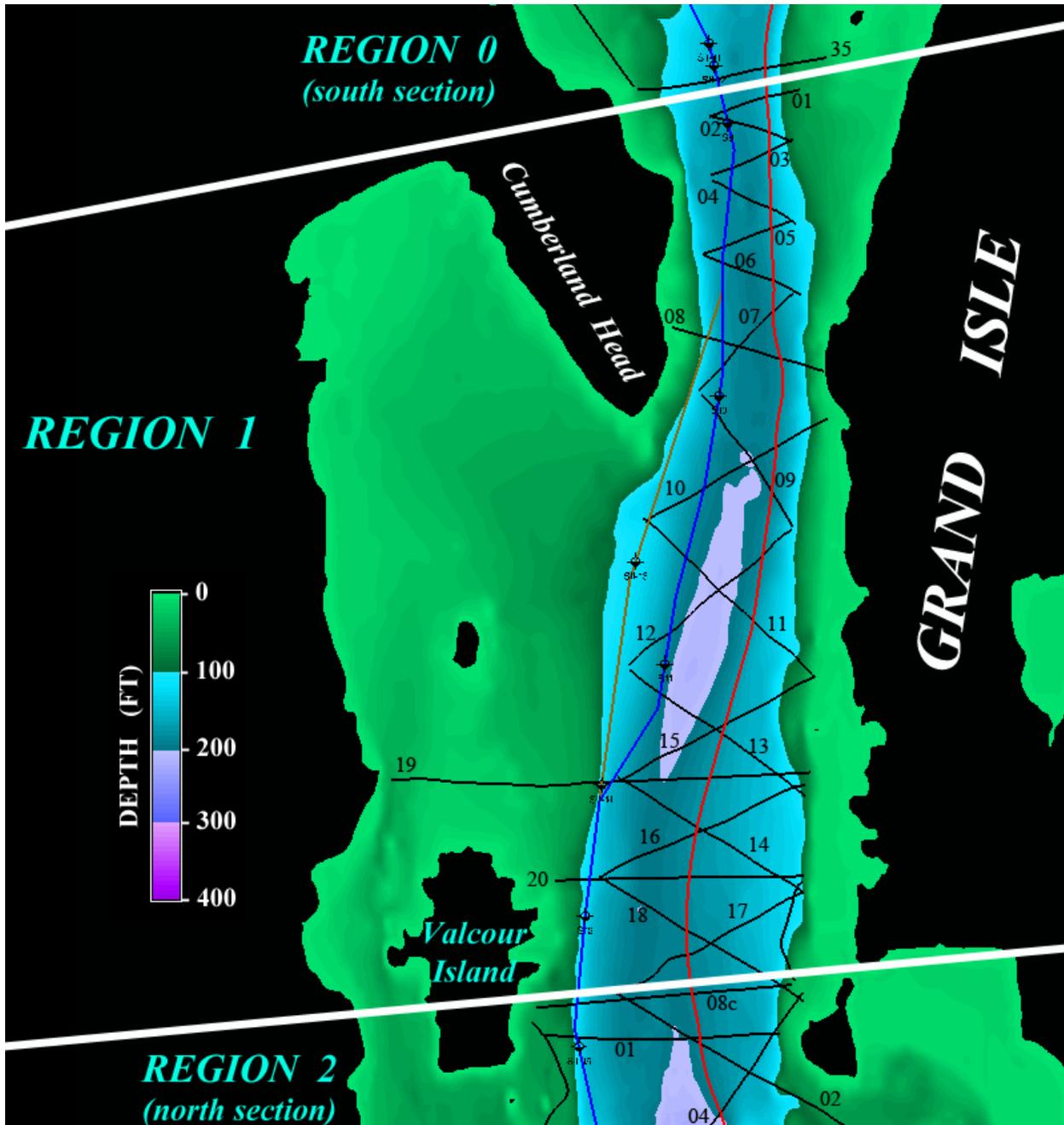


Figure 10. Detailed map containing Region 1. NY and VT corridors are blue and red lines, respectively. Provided cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines. Numbers next to the lines define the name of the line. See text for further details.

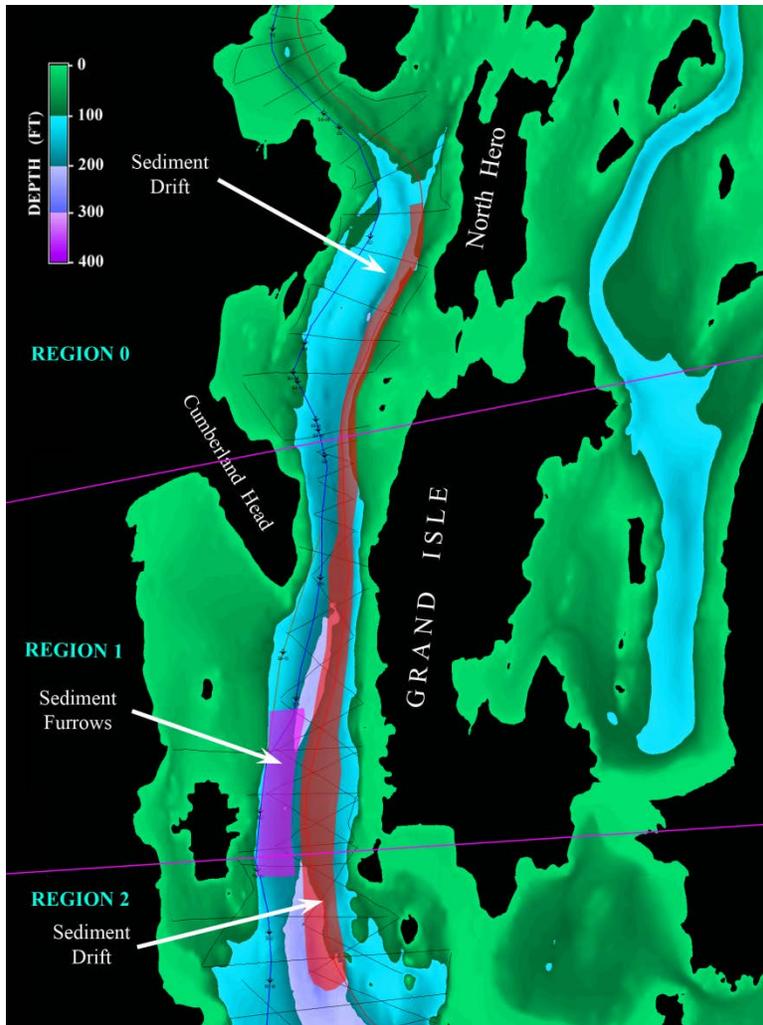


Figure 11. The locations of specific bedforms within Regions 0 to 2. Note the location of the NY and VT corridors in relation to these features. See text for further details.

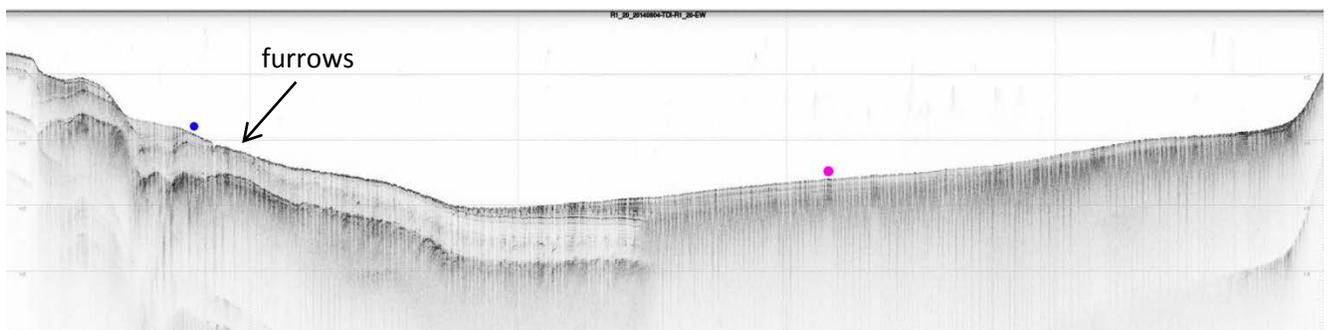


Figure 12. Acoustic profile R1-20, showing the beginning of a furrow field to the east of the NY2010 corridor (blue dot) while the VT corridor (magenta dot) is located within a sediment drift.

Region 2: Valcour Island to North of Hunt Rise (Figures 13 through 16)

Cores from the 2010 survey S13 and S14, and cores from the 2011 survey SII-15-SII-17 all penetrated a grey, high-plastically clay. Core imagery confirms this as well. Hunt, 1972 took a core near S13 core site and his analysis shows the grey clay to be of Champlain Sea in origin (contains diagnostic marine foraminifera). The proposed VT corridor is in laminated LC sediments and located in a small sedimentary drift (Figure 14). This drift has some gas content due to the acoustic nature observed on the seismic profile.

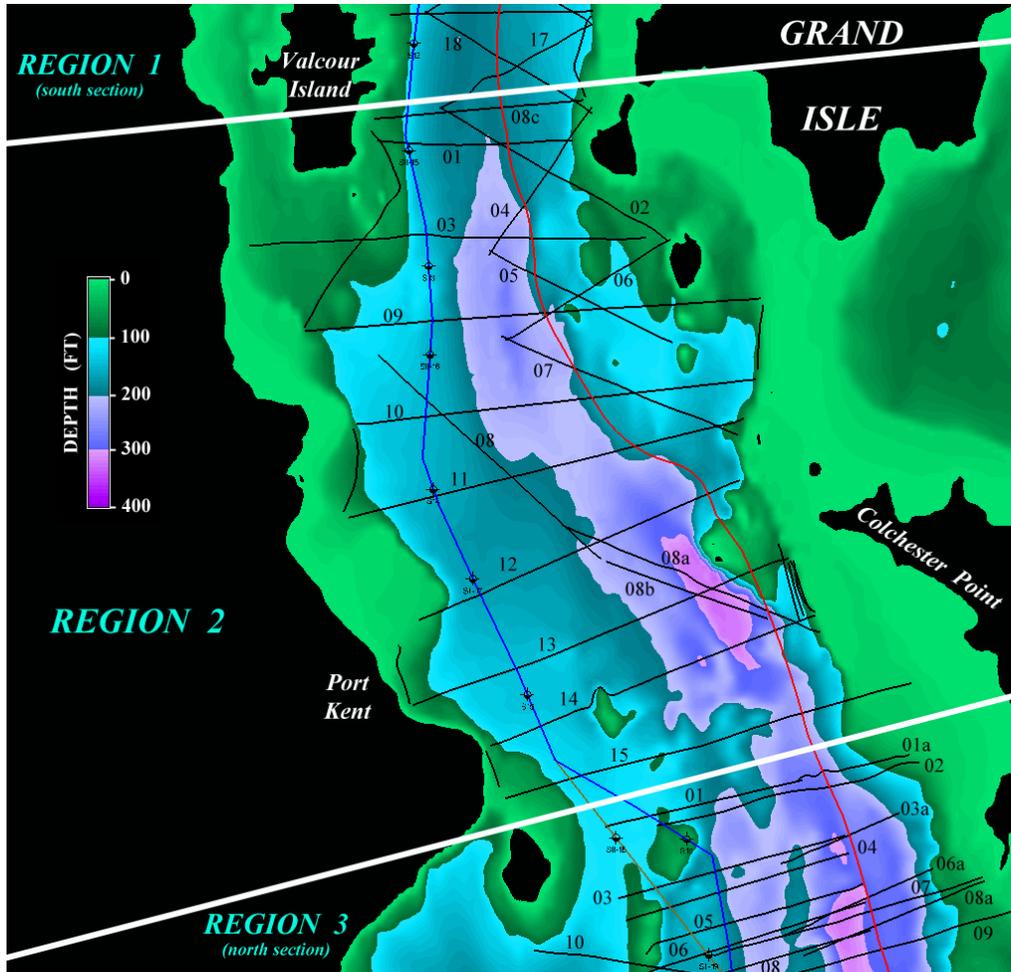


Figure 13. Detailed map containing Regions 1 to 3. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

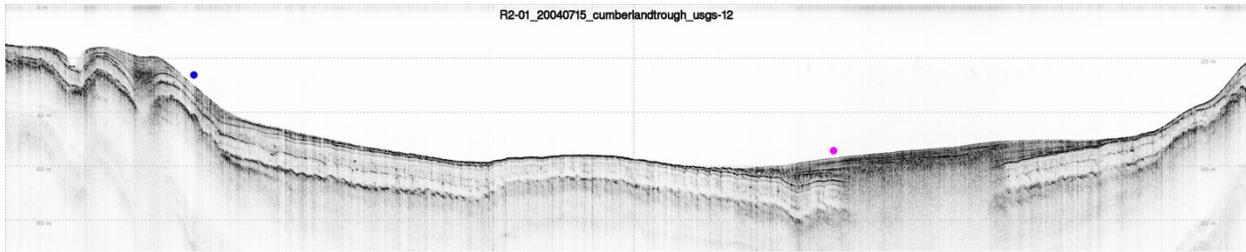


Figure 14. Acoustic profile R2-01. NY2010 lies in LC sediments over CS sediments on a basement high. The VT corridor lies within gas laden laminated LC sediments within a sedimentary drift.

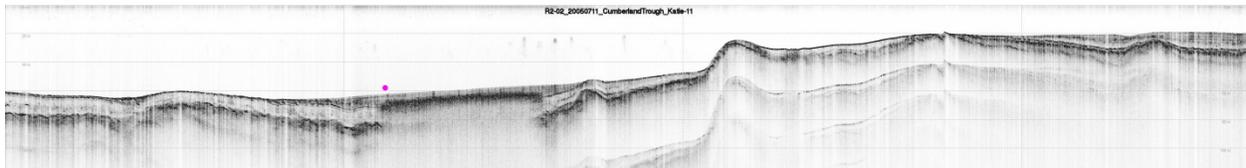


Figure 15. Acoustic profile R2-02. The VT corridor lies at the edge of gas laden laminated LC sediments within the same sedimentary drift.

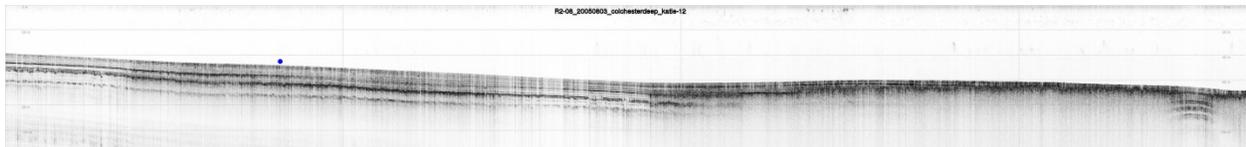


Figure 16. Acoustic profile R2-08. NY2010 lies in highly laminated LC sediments.

Region 3: Hunt Rise to north of Four Brother Islands (Figures 17 through 31)

Cores from the NY2012 survey, SII-18 – 19, sampled light grey, high-plasticity clay indicative of CS sediments. Seismic lines show acoustically that the NY2012 corridor is often located in CS sediments (which are confirmed by cores). Region 3 however, has many small sedimentary drifts that come and go on the shallower plateau associated with Schuyler Reef (Figure 18). Continuing to the south, lines R3-04 through R3-10 have the VT corridor primarily located in Drift A (Manley et al., 2012) which is made of Lake Champlain sediment (Figure 19). This is a large depositional sedimentary feature that is associated with water column shear (Manley et al., 2011).

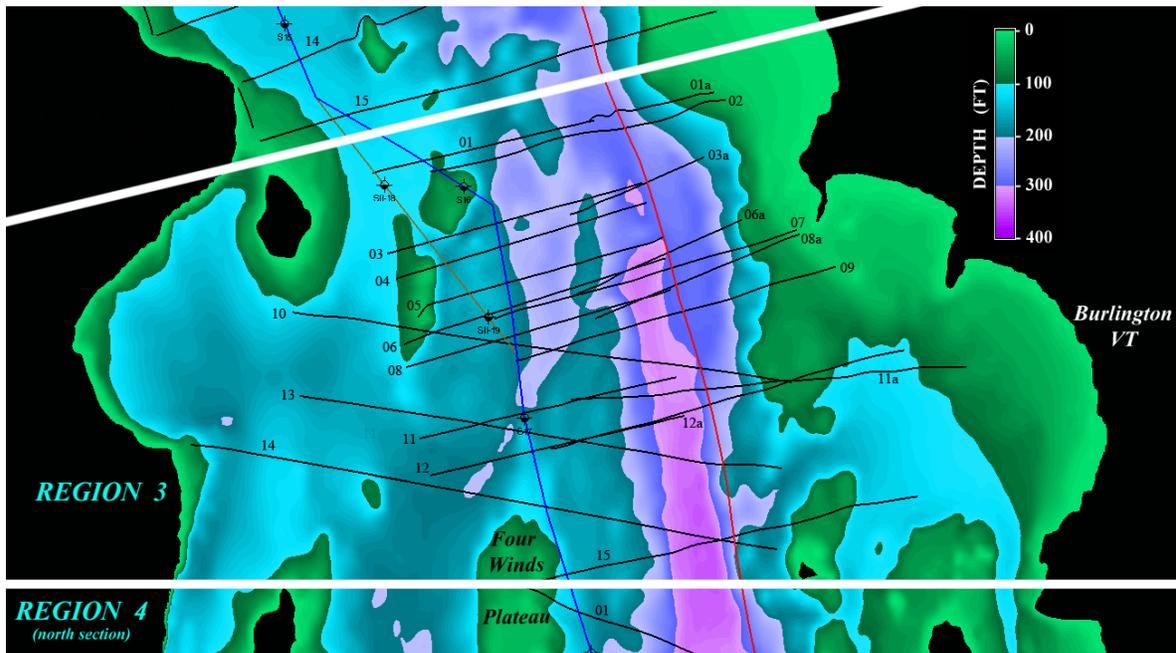


Figure 17. Detailed map containing Regions 3 and 4. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

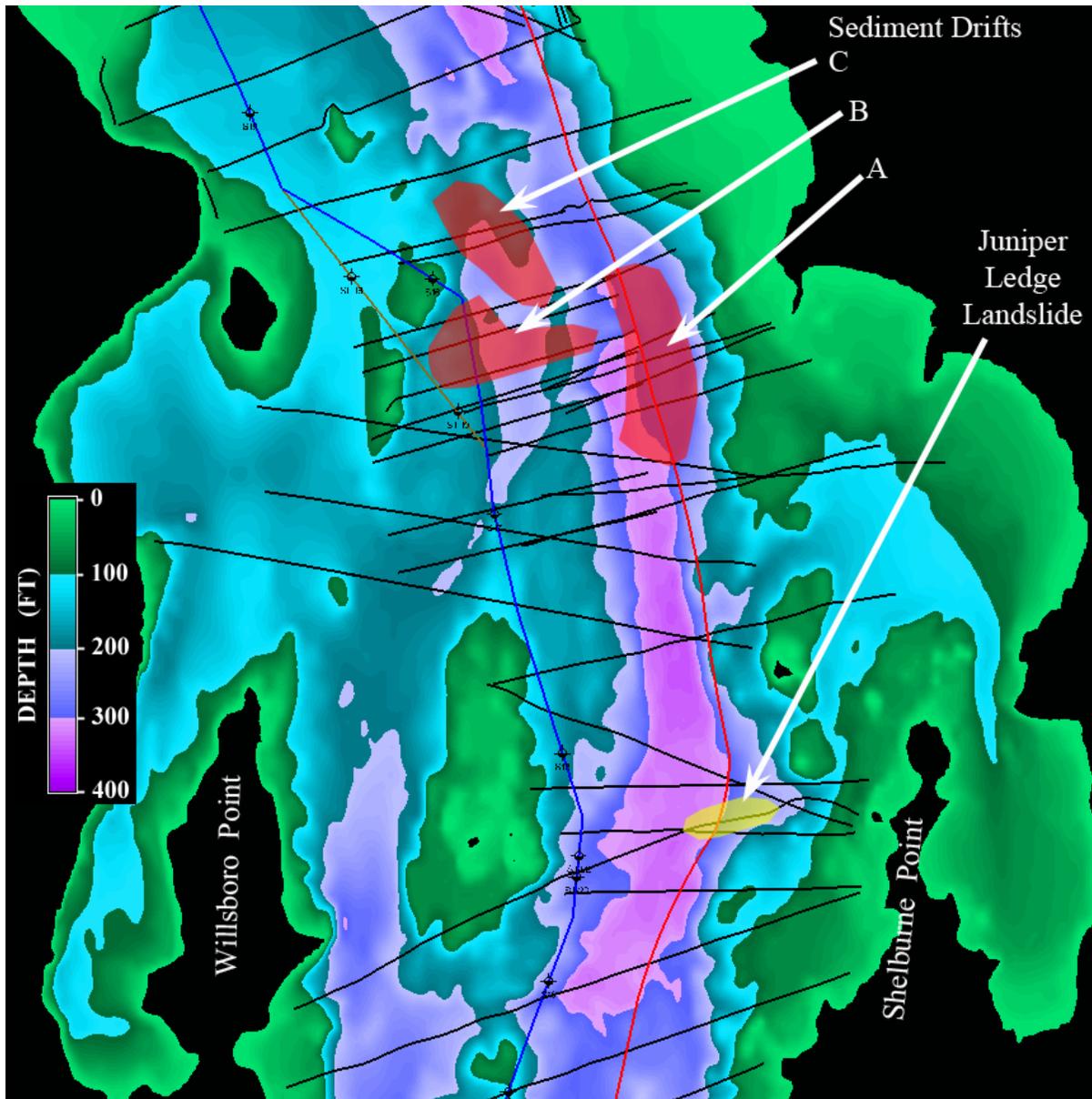


Figure 18. Sedimentary drifts of LC sediments were developed on top of various bathymetric structures and formed an overabundance of sediments as well as circulation dynamics (Manley et al., 2011; Weeks, 2012). Small localized landslides can also be seen in the lake basin.

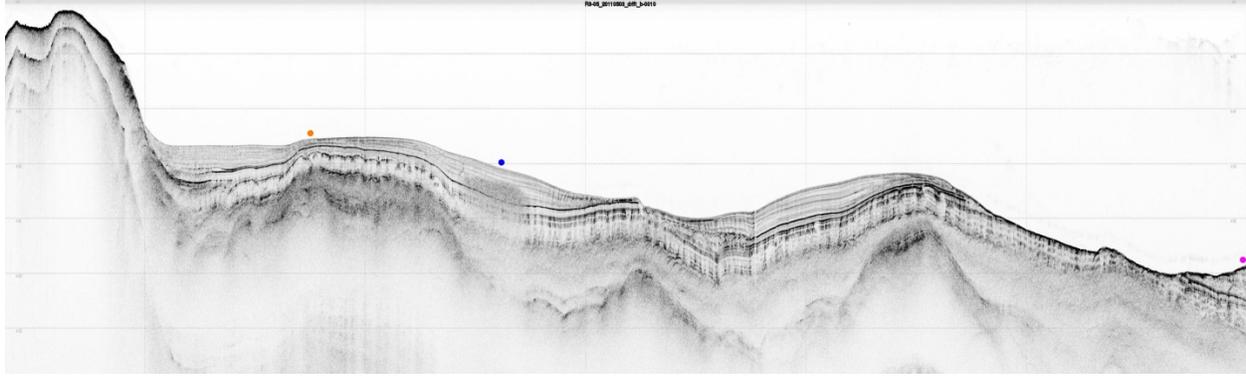


Figure 19. Acoustic profile R3-05 which will act as a representative profile for the sequence of lines R3-04 to R3-10. The VT corridor is still located in LC sediments in Drift A.

Region 4: Four Brothers Islands to Boquet River Point (Figures 20 and 21)

Core S18-S20 from the NY2010 survey sampled dark green to brown soft clay which is characteristic of LC sediments. Cores from the NY2012 survey, SII-22 to SII-25, contained high-plasticity clay indicative of CS sediments as well as a dark green coloration indicative of recent LC sediments. In particular, SII-24 was located on the NY2010 corridor and sampled on a basement high that was CS sediments. This correlates well with the R4-07 seismic line which shows the acoustically transparent nature of the CS sediments in this region. Most notably in this section there are surface, as well as subsurface slumps. Most of these slumps are 2-3 m below the sediment-water interface and thus should not pose any issues with the VT line.

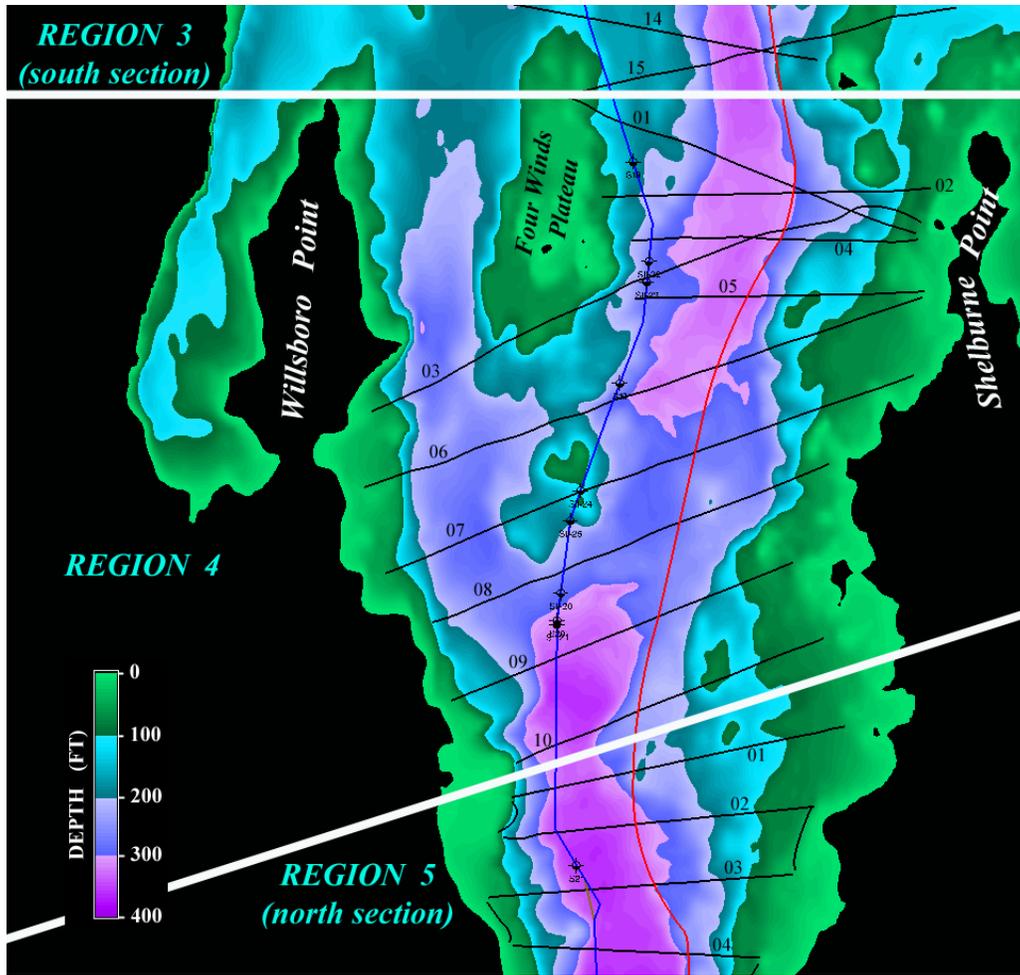


Figure 20. Detailed map containing Regions 4 and 5. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

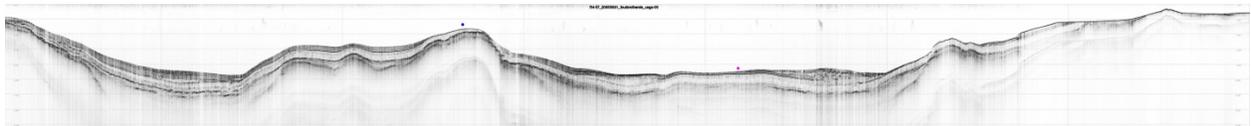


Figure 21. Acoustic profile R4-07. The NY2010 corridor is located on transparent CS sediments (Core S11-24) while the VT line is located in laminated LC sediments.

Region 5: Boquet River Point to Split Rock Thompson Point (Figures 22, 23 and 24)

Cores from the 2010 survey S22-S23 sampled dark green to brown soft clay which is characteristic of LC sediments. Cores from the 2012 survey, core SII-27 obtained similar sediment. Seismic lines R5-01 through R5-11 show that the sediment type between the NY10 and VT corridors is similar.

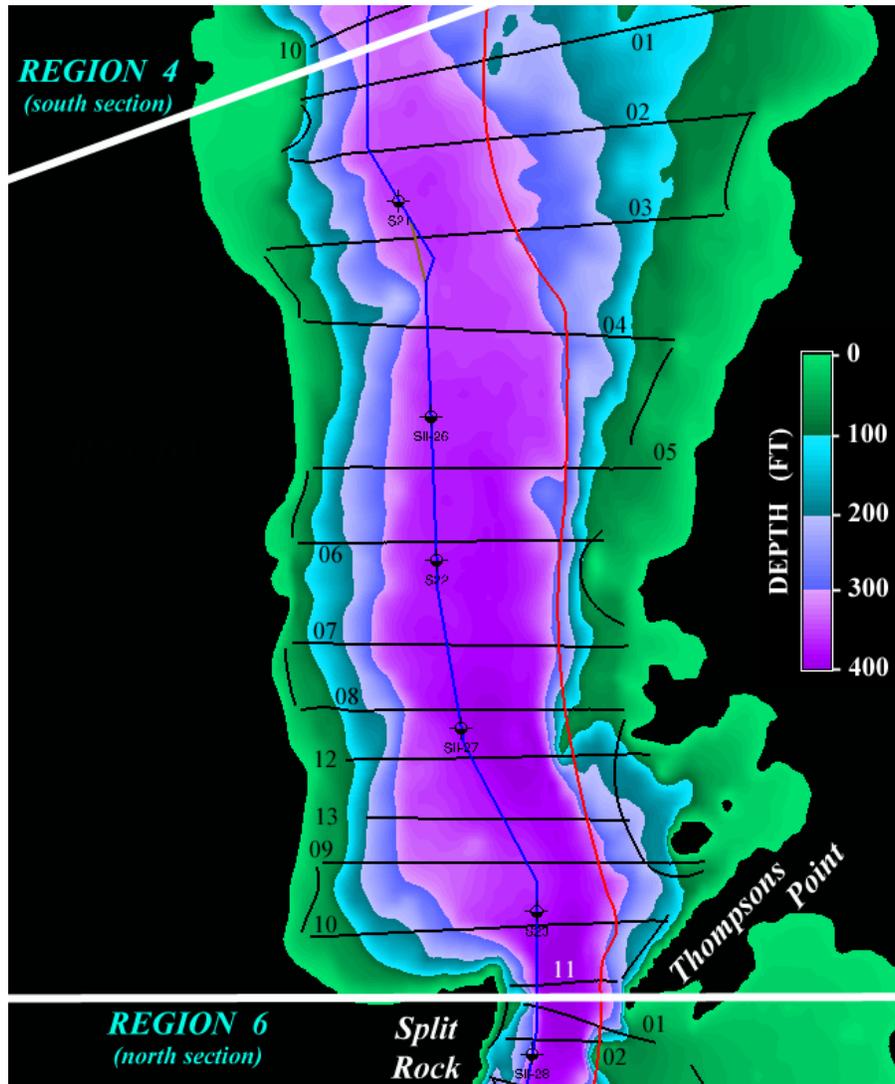


Figure 22. Detailed map containing Regions 5 and 6. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

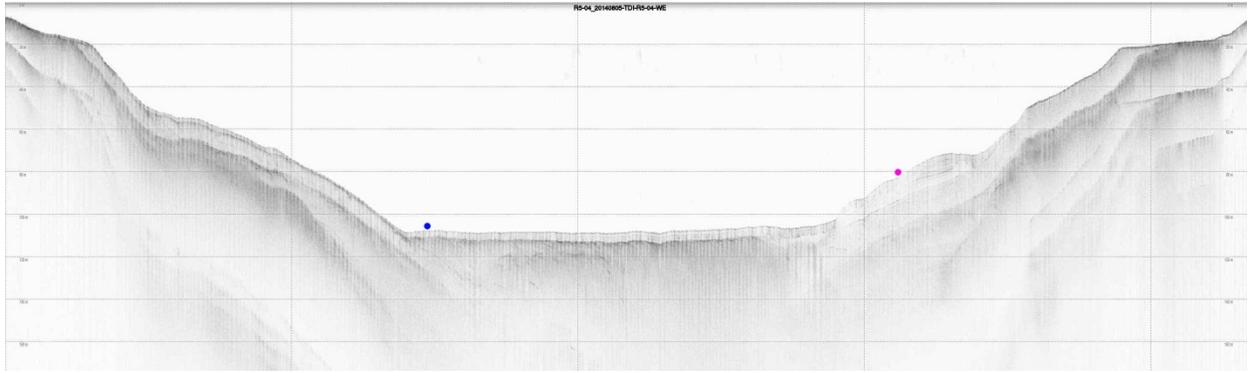


Figure 23. Acoustic profile R5-04. Both corridors are in LC sediments.

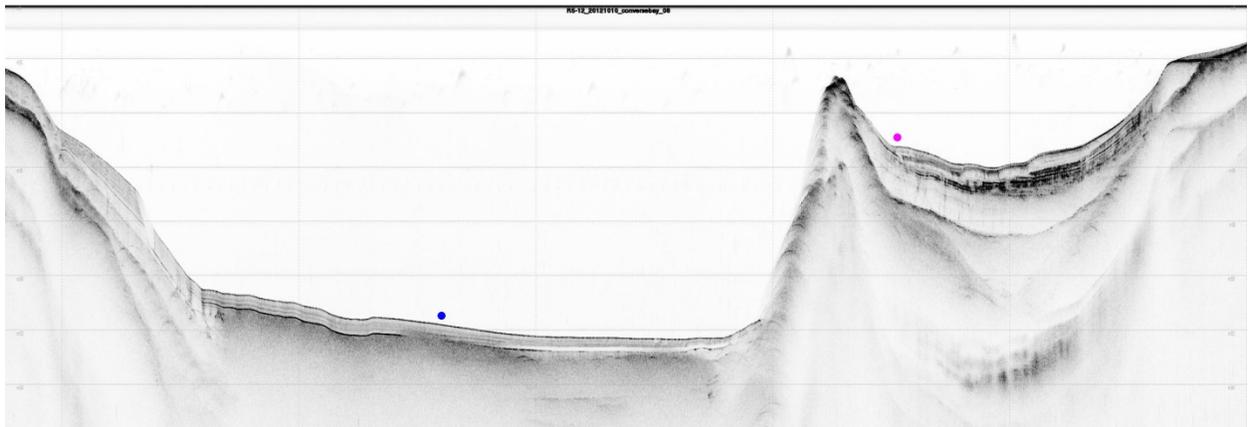


Figure 24. Acoustic profile R5-12. Both corridors are in LC sediments..

Region 6: Split Rock - Thompson Point to Button Bay (Figure 25)

Cores from the 2010 survey are S23-S26 and sampled dark green to brown soft clay which is characteristic of LC sediments. Cores from the 2011 survey, cores SII-28 – SII-30 contained similar dark green/brown sediments from Lake Champlain. In general this region has similar sediment between both corridors.

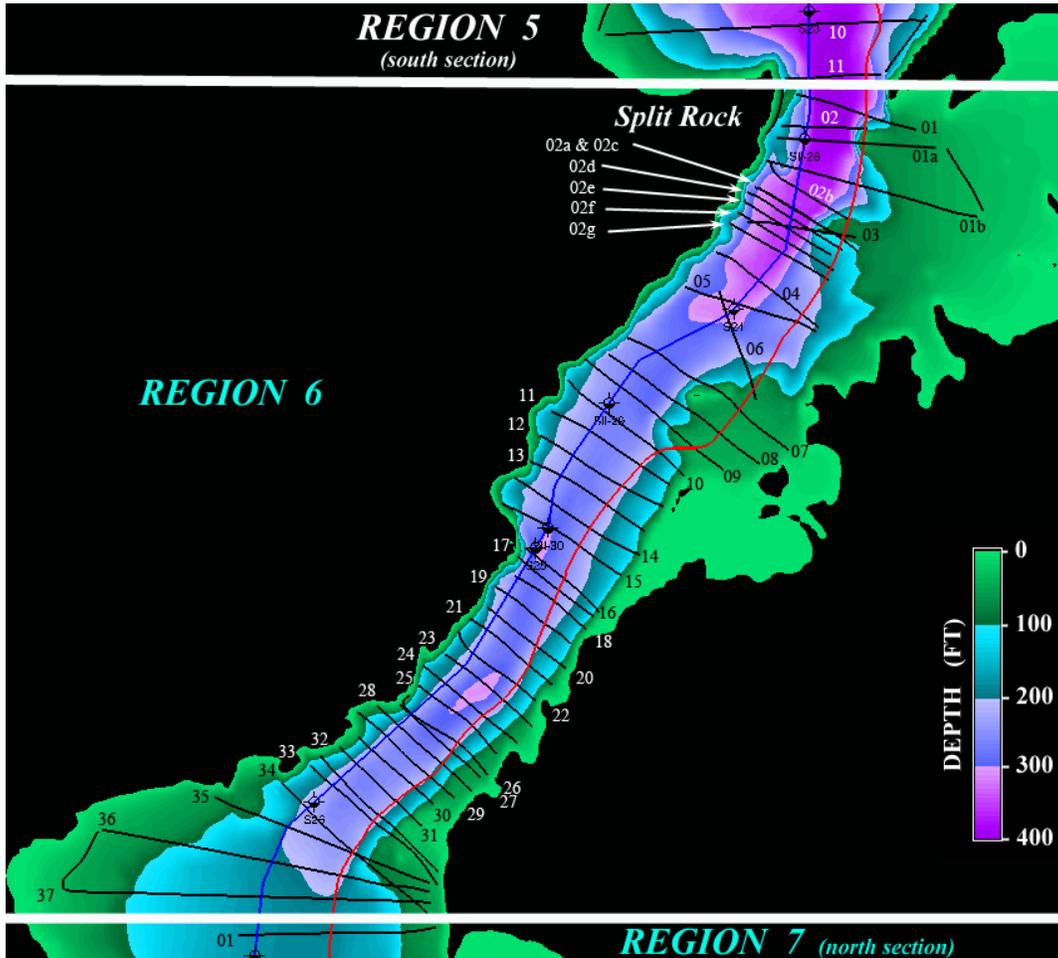


Figure 25. Detailed map containing Region 6. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

Region 7: Button Bay to Potash Point (Figure 26)

Cores from the NY2010 survey (S27 and S28) sampled dark green to brown soft clay which is characteristic of LC sediments. Cores from the NY2012 survey, SII-32 and SII-33, contained similar dark green/brown sediments also representing LC sediments. As this section of the lake narrows, the NY2010 and VT corridor lines approach each other. This region has similar sediment between both corridors.

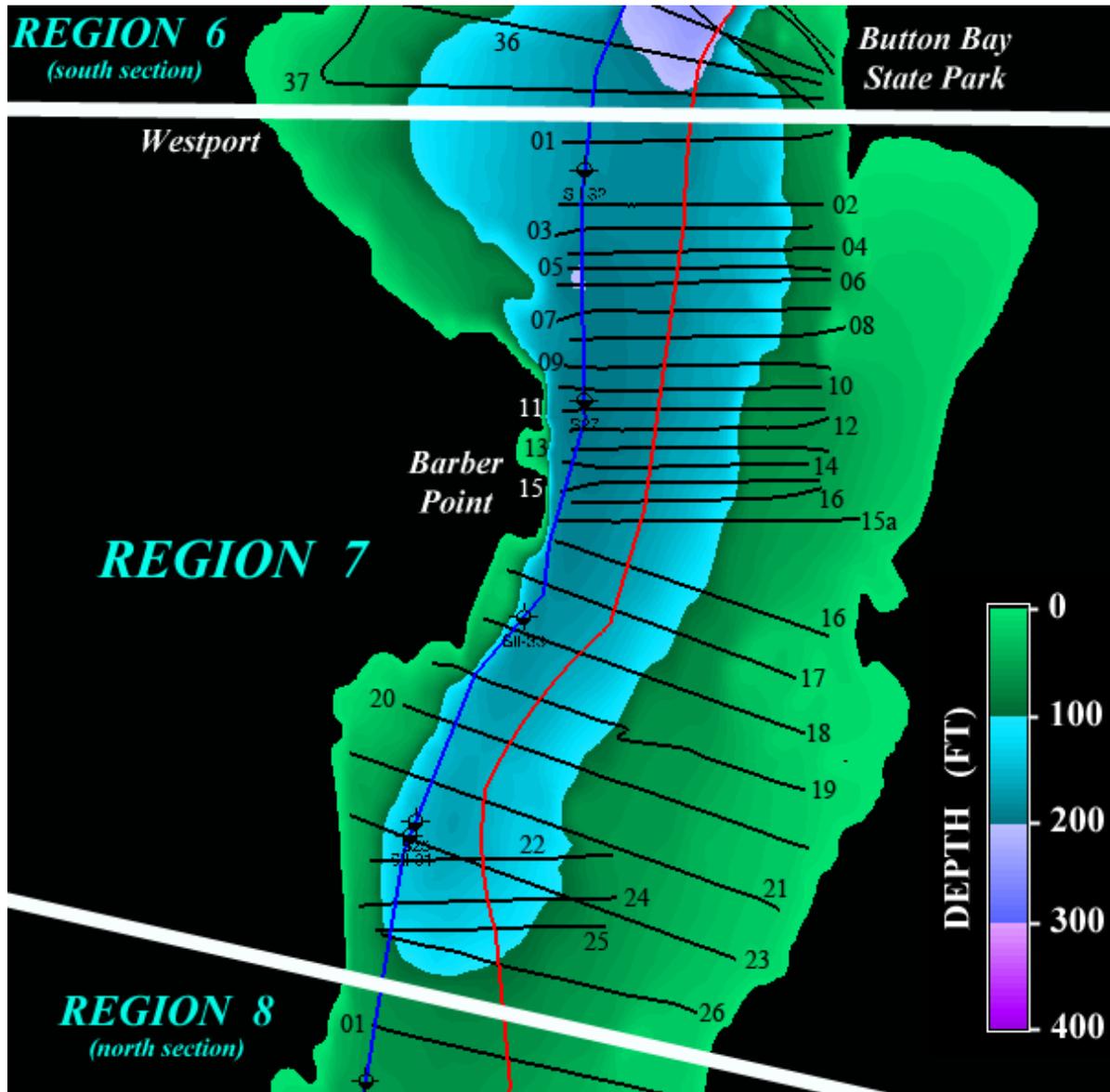


Figure 26. Detailed map containing Regions 6, 7 and 8. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

Region 8: Potash Point to Crown Point Bridge (Figure 27)

Cores S29-S31 from the NY2010 survey sampled dark green to brown soft clay which is characteristic of LC sediments. Cores from the NY2012 survey, SII-34 and SII-35, contained similar dark green/brown coloration that is also representative of LC sediments. The NY2010 and VT corridor lines are further decreasing their distance between one another in this narrow section of the lake. This region has similar sediment between both corridors. However nearer the Crown Point Bridge, the thickness of the LC sediments is becoming thinner and the interface with the CS sediments is very close to the lake bottom. In some places the suggested VT line may go through LC sediments and into CS sediments.

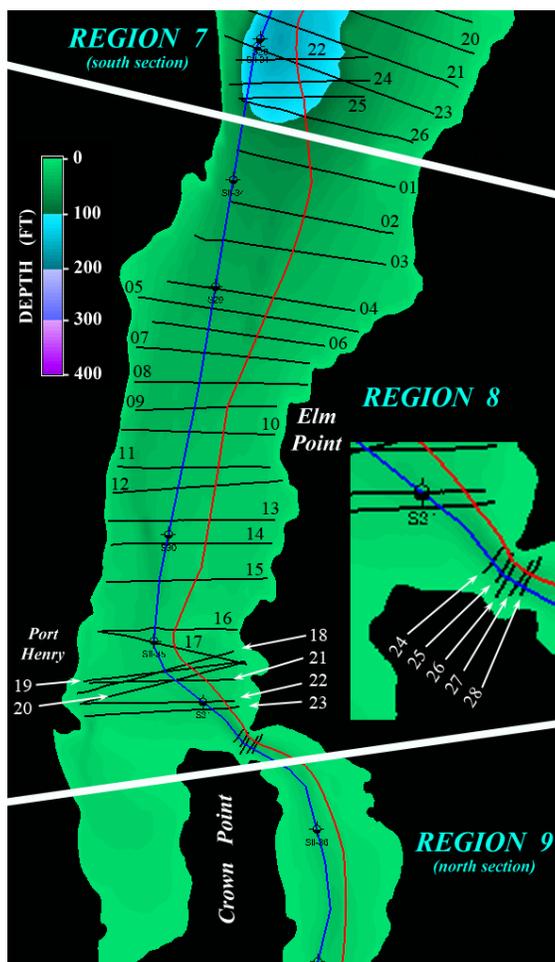


Figure 27. Detailed map containing Regions 7, 8 and 9. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

Region 9: West Bridport VT to Crown Point NY (Figure 28)

Core SII-38 from the NY2012 survey contained soft, grey to brown high-plastic silt or clay with black organic and wood fragments. From this description, it is most likely LC classification. Due to the close proximity of the two corridor lines, the sediment should be the same. Seismic lines are inconclusive due to the gassy nature of the sediment.

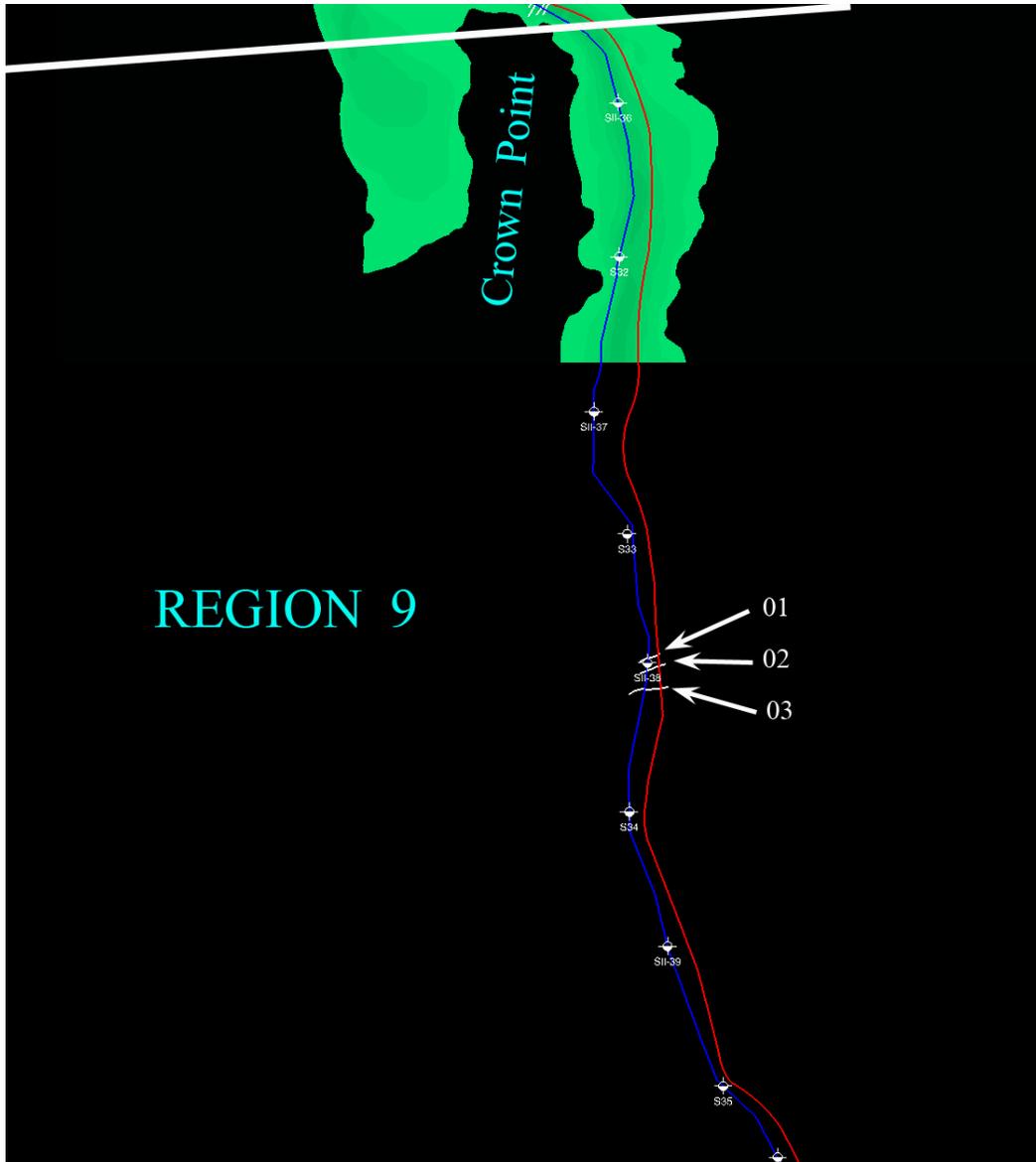


Figure 28. Detailed map containing Regions 8 and 9. NY and VT corridors are blue and red lines, respectively. Cores are labeled symbols. Regional separator is shown as a thick white line. Close-approach lines are shown as thin black lines along with its line number. See text for further details.

Region 9 does not require any additional surveying, even though there is an overall lack of data, for the following reasons:

- 1) The South Lake is extremely narrow with average cross deep-channel distances being less than several hundred meters.
- 2) Circulation studies in this region have often referred to the South Lake (Region 9) to be a river environment with long-term northerly flow (Myer and Gruending, 1979; Manley, 2004). Occasionally, complete top to bottom flow reversals of the long-term northward currents can be forced by extreme wind forcing events. Deep-flow reversals (i.e., found only in the bottom portion of the river) can also occur from extreme internal seiche events but they not been found to propagate more than 15 km south of the Crown Point Bridge (Manley, 2004). Both reversal events can be considered short lived compared to the long-term northerly flow of the South Lake and should not be considered causational factors that would create any significant variants to sediment types within Region 9.
- 3) Acoustic profiling in the South Lake is typically non-revealing since gas in the near-surface sediment prohibits any significant acoustic penetration into the deeper layers. This lack of gaining any layering information below a few feet was the primary reason that the Lake Studies research (using the SB216) was never conducted in the South Lake.
- 4) When considering all the above (i.e., the very close proximity of the NY and VT corridor lines, the consistent nature of sediment type within the South Lake, the lack of any revealing information that can be obtained from further sub-bottom profiling and the river-like nature of the region), sediment characteristics between the NY and VT corridor lines should be considered similar and no further sub-bottom surveys should be conducted.

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