Agreement: M14AC00006 Massachusetts Geological Survey/University of Massachusetts; Hurricane Sandy Coastal Recovery and Resiliency - Sand Resources Needs Assessment at Critical Beaches in Massachusetts - Supplement

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Massachusetts Geological Survey/University of Massachusetts

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Final Summary Report (1/24/2019)

Cooperative Agreement Outputs including Project Deliverables:

(1)Mabee, S.B. and Duncan, C. 2019. Sand Resources Needs Assessment at Critical Beaches on the Massachusetts Coast - Supplement, Bureau of Ocean Energy Management Cooperative Agreement M14AC00006 with the Massachusetts Geological Survey/University of Massachusetts Amherst – Technical Report, 188p.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/Documents/ BOEM2_Final_Technical_Report_ver4.pdf

Abstract:

210 km of seismic reflection profile data, bathymetry and side scan sonar data as well as 8 vibracores and 7 grab samples were collected at six locations off the coast of Massachusetts and analyzed to estimate the volume of sand resources (Figure 1). These locations include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. Sites were located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters. Seismic profiles were processed using SeisUnix and SIOSeis software

and interpreted by a marine geologist with the aid of the vibracore and grab samples. Bathymetric and side scan sonar data were analyzed in SonarWiz (ver. 6.0 and 7.0). Surficial geology was interpreted by a marine geologist. Unfortunately, the seismic data collected had severe limitations. No amount of processing improved discrimination of seismic units limiting interpretation (Figure 2). Bathymetry data was also limited. The edges were clipped due to poor quality resulting in non-overlapping swaths (gaps between lines with no data). Attempts to extract bathymetry from the interferometric side scan sonar data failed due to a tilt in the dataset that we were unable to remove. Accordingly, bathymetric and side scan sonar and/or backscatter data were acquired from other sources to help fill in data gaps. In addition, older seismic data collected in 1972, 1975, 1976 and 1980 were helpful in some areas. Even with the inclusion of outside source data, we were only able to provide an isopach map for the Marshfield site; in all other areas we were only able to determine if sand existed and estimated thicknesses.

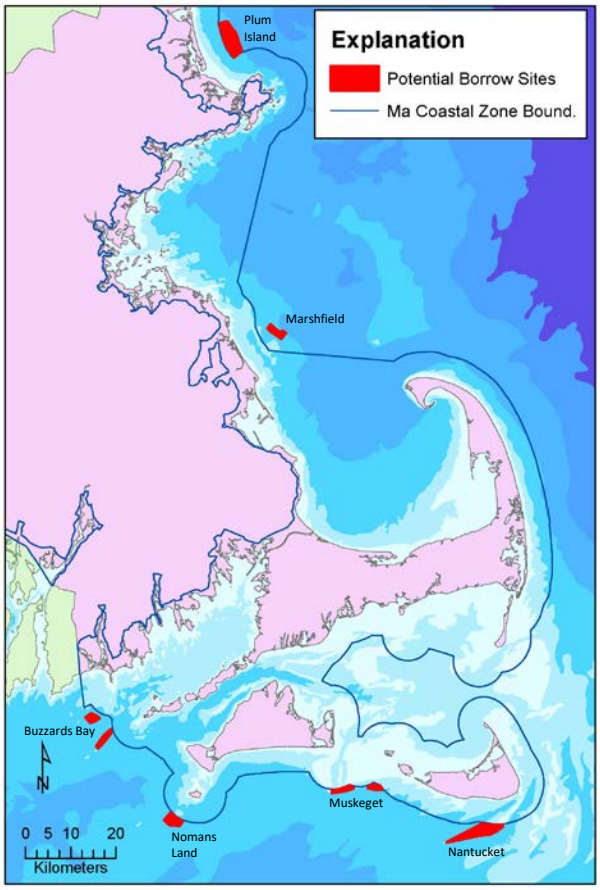

Figure 1. Location of potential sand resource areas evaluated for this project.

The Muskeget Channel, Nantucket and Plum Island site show the greatest promise as a source of sand for beach nourishment projects. At Muskeget Channel, recent sands overlie marine fan deposits and have a combined total thickness ranging from 0 to 10 meters (0 to 30 feet). Underlying the fan deposit are sandy outwash deposits of unknown thickness. No lake or glacial till deposits are expected at this site as it lies outboard of the last glacial terminal moraine. The sediment is consistently fine and fine to medium sand with 1-10% coarse sand. The sediments at Muskeget Channel are slightly finer than the deposits found on nearby Miacomet and Low beaches on Nantucket, which tend to be slightly coarser. The Nantucket site consists of a modern bar complex but a lack of data precludes estimating thickness. Based on the limited vibracore and grab sample data the sediment at the Nantucket site consists of fine and fine to medium sand with occasional pebbles and gravel. These sediments are also slightly finer in texture than the sediment at adjacent beaches on Nantucket Island. Plum Island has the greatest sand potential because it is located near an extensive low-stand delta deposit. The site consists of a highly eroded and undulating fluvial channel system feeding the delta and is overlain by a thin but variable thickness sand sheet. The fluvial deposits are underlain by fine-grained marine sediments. Total thickness of the sand sheet and fluvial

sediments varies from 6 to 12 meters (20 to 39 feet) in the western two-thirds of the site and thickens to 14 to 22 meters (46 to 79 feet) in the eastern third of the site, with the thickest area occurring just east of the site boundary. The sediments consist of fine and fine to medium sand

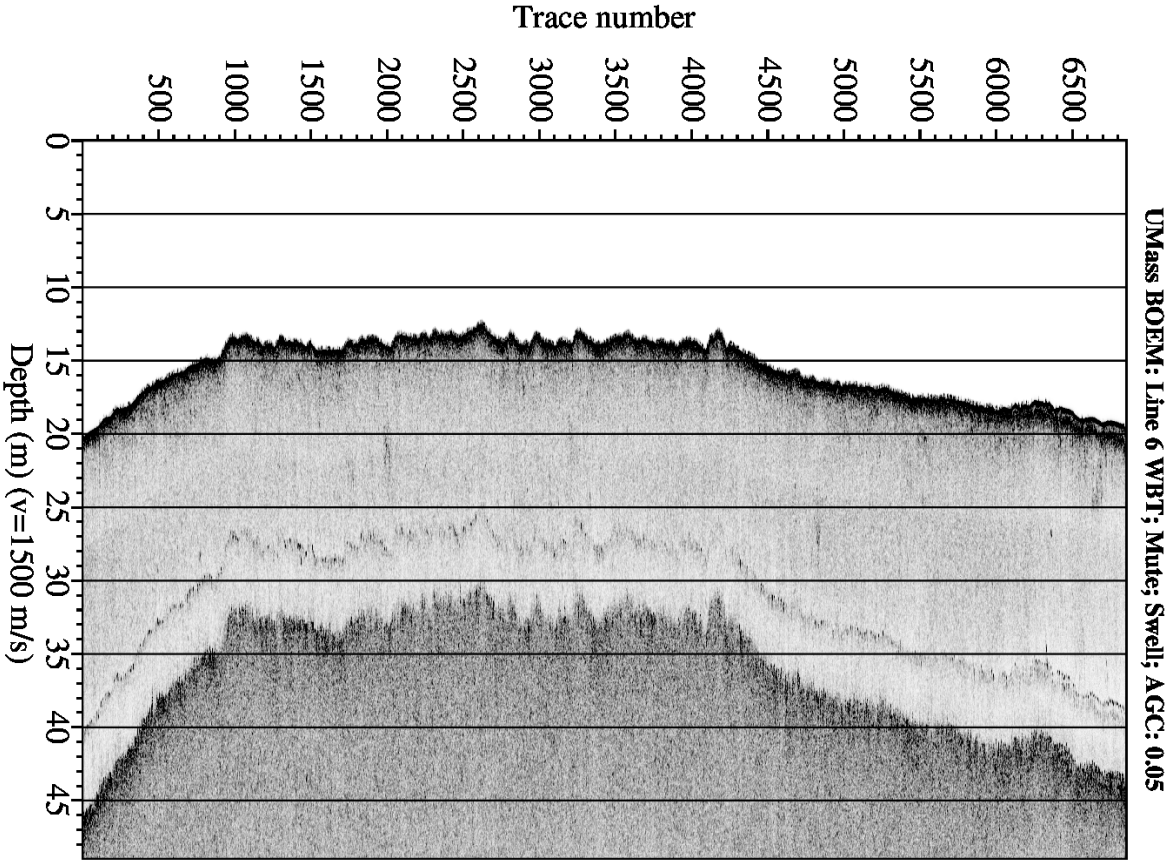

Figure 2. Processed Chirp data collected by CB&I for Line 8 at Nomans Land. Example shows the difficulty in interpreting the geology from the profile.

with pockets of medium to coarse sand and very coarse sand and gravel. The beach at nearby Plum Island has median grain sizes in the coarse to very coarse sand range so are generally compatible with the offshore sediments.

Marshfield contains a lenticular body of sand and gravel up to 12 meters (39 feet) thick that overlies lake bottom and glacial till deposits. The estimated volume of this material is 40,000,000 cubic meters (52,000,000 cubic yards). The areal extent of the sand and gravel body is approximately 7 square km (2.7 square miles). The deposit is very rocky with medium to coarse quartz sand and was most likely derived from the nearby glacial till deposits. This site may be a suitable supply for Humarock, Scituate, Peggotty and Plymouth beaches on the mainland, which have coarse, very coarse and gravelly to cobbly substrates.

Buzzards Bay is mostly all glacial till or lake bottom sediments and is not considered a suitable site for sand. The thickness of the till and lake bottom sediments is unknown. The till deposits contain numerous large boulders up to 9 meters (30 feet) in size. However, there is evidence of a channel fill deposit at the northeast end of the site that may have been part of a channel system draining glacial lakes in Rhode Island Sound and Buzzards Bay. Thickness of the channel fill may range from 5 to 13 meters (16 to 42 feet) and may warrant further investigation.

The Nomans Land site lies on the terminal moraine of the last glaciation and consists entirely of glacial till of unknown thickness. Large surface boulders up to 3 to 9 meters (10 to 30 feet) are observed on the side scan sonar imagery. Occasional and discontinuous pockets of medium to coarse sand may occur within the deposit occupying < 10% of the area of the unit. The site is not considered suitable as a source of sand.

(2) Duncan, C., Southard, P. and Mabee, S.B., 2018, ESRI MXD File with All the Data Loaded in the Table of Contents for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/

Abstract

This ESRI MXD file contains all the data for the project loaded in the table of contents for six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. The MXD file includes: 1) a basemap layer of the state outline, 2) geophysical survey tracklines with hyperlinks to the processed and interpreted seismic profiles, 3) vibracore and grab sample locations with hyperlinks to pdfs containing photographs of the samples, soil descriptions, granularmetric data for each sample and grain size distribution curves; also embedded are the linked MMPGIS data tables (core layers, samples, Phi, Munsell), 4) raster images of CB&I bathymetry, 5) raster images of 300 kHz and 550 kHz side scan sonar data, 6) raster images of magnetometer data and any anomalies, 7) surficial geology within each area, 8) isopach map(s) of sand where data is dense enough to allow computation of thickness, and 9) other side scan sonar, bathymetry, seismic reflection profiles and grab samples derived from other sources to help with the interpretation of the geology and estimation of sand thickness. All data are presented in NAD 1983 UTM Zone 19N projection.

(3) CB&I, Mabee, S.B., Southard, P., 2018, Raster Images of Bathymetry for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/RawData/GeophysicalData/Bathymetry/

Abstract

This data set contains raster images (tiffs) of bathymetry for six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. Approximately 210 km of swath bathymetry data were collected by CB&I, a private contractor hired by BOEM, using an EdgeTech 6205 fully integrated swath bathymetry and dual frequency sidescan sonar system. Swath bathymetry data were collected July 22, 2015 to July 27, 2015 at a frequency of 550 kHz and horizontal resolution of 3 meters. All bathymetric data were corrected for navigational offsets. Post processing of the raw bathymetry data was done in Hysweep 2015 MBMAX64 Editor. Patch Tests were conducted to precisely determine the static position of the sonar head and to quantify any residual roll, pitch, and yaw biases with respect to the vessel reference frame. Roll, pitch, and yaw biases were applied during post processing. Latency tests were conducted to verify time synchronization of the navigation and bathymetric systems. Post-processed bathymetry was delivered by CB&I as an ASCII "XYZ" file. These data are provided in the NAD 1983 Universal Transverse Mercator (UTM) Zone 19N projection. Final vertical data is presented in meters relative to the North American Vertical Datum of 1988. The XYZ files were imported into ESRI ArcGIS version 10.4.1, converted to rasters and hillshaded before being exported as tiff images (Figure 1). These data were used to assist with mapping the extent of sand resources.

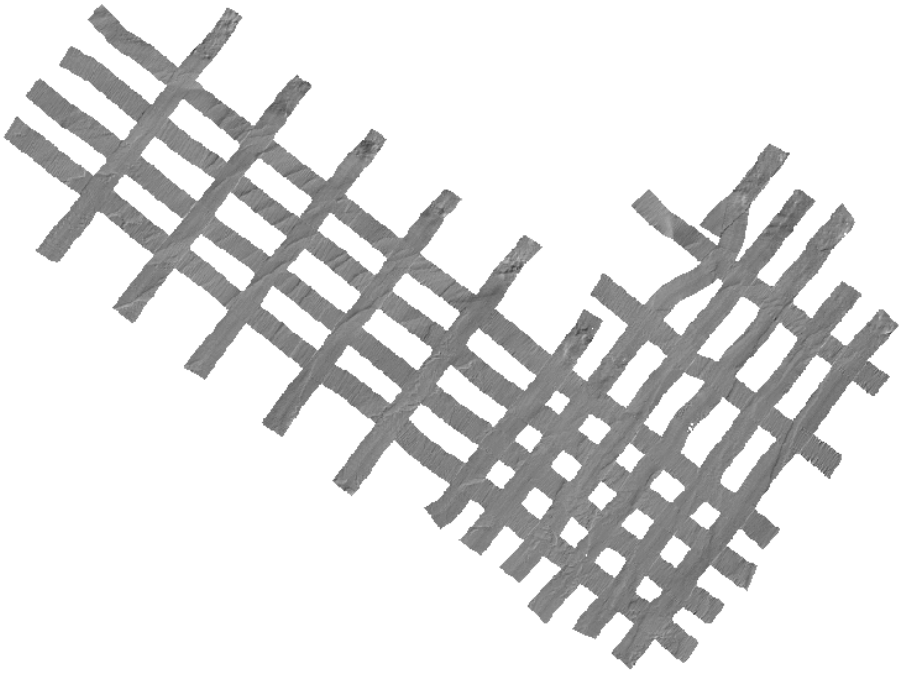

Figure 1. Example of 3 m bathymetry for the Marshfield site collected by CB&I.

(4) Duncan, C., Mabee, S.B. and Southard, P., 2018, Raster Images of Processed Interferometric 550 kHz and 300 kHz Side Scan Sonar Data for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/RawData/GeophysicalData/SideScanSonar/

Abstract:

This data set contains mosaicked raster images (tiffs) of processed side scan sonar data for six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. Approximately 210 km of side scan sonar data were collected by CB&I, a private contractor hired by BOEM. The 550 kHz sonar data was collected using an EdgeTech 6205 fully integrated swath bathymetry and dual frequency side scan sonar system. Resolution was 1 meter and swath width 300 meters. The 300 kHz side scan sonar data was collected using an Edgetech 4200-HFL sonar system and was towed from a marine grade hydraulic winch. Swath width was 300 meters with the ability to identify objects on the seafloor of at least 1 meter in diameter. Side scan sonar data were collected July 22, 2015 to July 27, 2015. Side scan sonar data were imported into SonarWiz version 6.0 and projected in the NAD 1983 Universal Transverse Mercator (UTM) Zone 19N coordinate system. Data were post-processed using standard settings as recommended in Chesapeake Technology, Inc. (CTI)

document “Importing JSF Files into a SonarWiz Project”, Revision 10.0, 12/12/16. Mosaicked and individual trackline images were exported as tiff images and imported into ArcGIS version 10.4.1 for analysis (Figure 1). These data were used to assist with mapping the extent of sand resources.

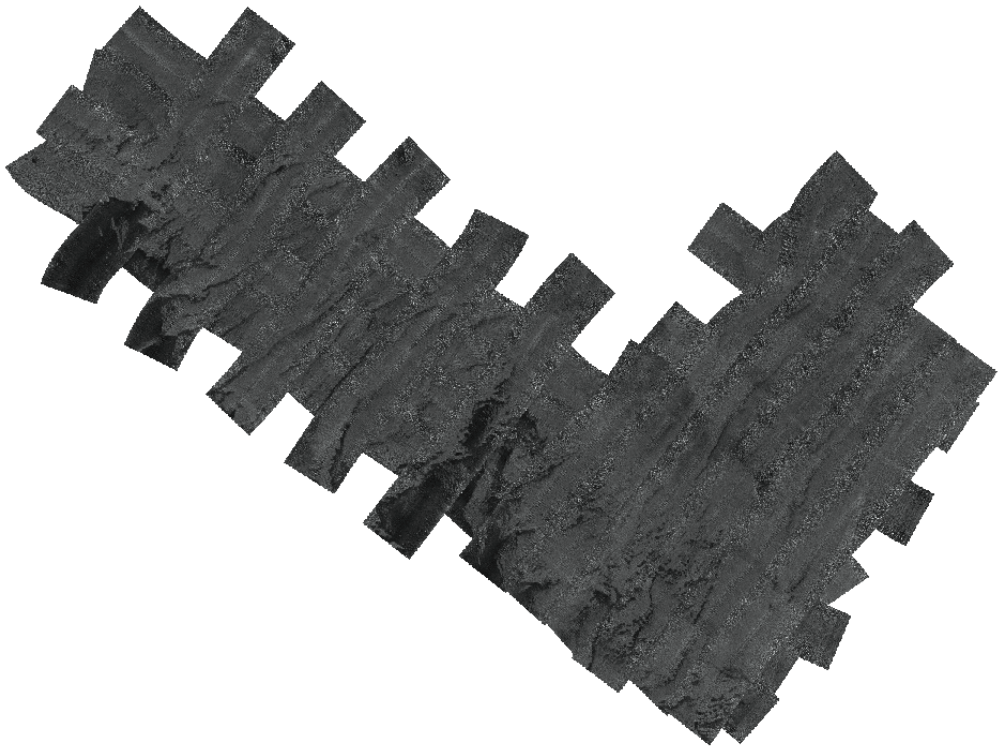

Figure 1. Example of 1 m resolution, 550 kHz side scan sonar data for the Marshfield site. The darker areas indicate finer grained deposits.

(5) Clement, W.P., Lewis, R.., Southard, P. and Mabee, S.B., 2018, Raster Images of Processed and Interpreted Subbottom Seismic Profile Data for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/RawData/GeophysicalData/ChirpSubbottom/

Abstract

This data set contains raster images (tiffs) of processed and interpreted seismic reflection profile data for six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within

water depths of approximately 30 meters. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. Approximately 210 km of seismic data were collected by CB&I, a private contractor hired by BOEM, using an EdgeTech 3200 sub-bottom profiler with a 512i towfish. The data were collected using a sweep frequency ulse between 0.5 and 12 kHz. Data were corrected for navigational offsets and towed laybacks. Data were collected July 20, 2015 to July 26, 2015. Jsf files were imported into SIOSEIS to remove wave effects and apply gain adjustments. SeisUnix was used to plot the data using a

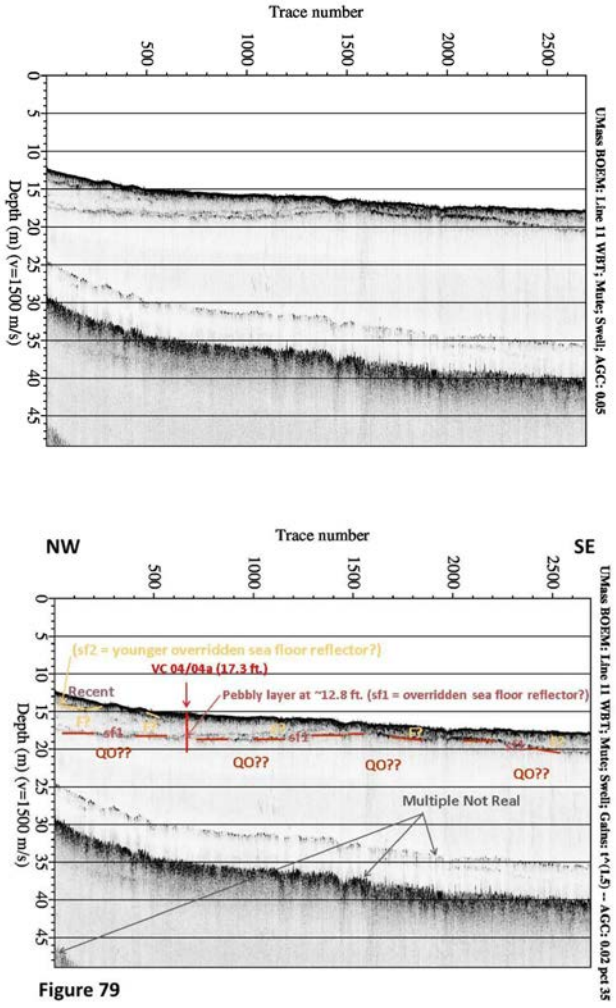

Figure 1. Example of image of BOEM MA Seismic Line 11 in Muskeget Channel. Upper image is the processed data and lower image is the interpreted section. This is among the best profiles in the data set. F = marine fan (ebb and flood delta), QO = outwash, Recent = recent sand or sand and gravel deposits.

velocity of 1500 m/sec to convert travel time to depth. Processed profiles were exported as tiffs and examined by Ralph Lewis, marine geologist, to interpret the geology from the seismic units (Figure 1). These data were used to help decipher the thickness of recent sand deposits. However, the quality of the seismic profile data limited their usefulness for interpretation.

(6) Southard, P., Duncan, C. and Mabee, S.B., 2018, Images, Point Shapefile and MMPGIS Relational Geodatabase of Vibracores and Sediment Grab Samples for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/MGS-BOEM2017.gdb

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/RawData/GeotechnicalData/

Abstract

Eight vibracores at seven locations and seven sediment grab samples were collected at six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. Three-inch diameter cores were collected using an Alpine pneumatic vibracore. Penetration depth ranged from 4.6 feet to 18 feet. Each core was photographed, and layers subsampled for grain size analysis (Figures 1 and 2). Grab samples were collected with a petite Ponar grab sampler, photographed and subsampled for grain size analysis. All work was completed by CB&I and compiled in a pdf. A point shapefile was also provided by CB&I showing the locations of the samples. This is provided in the NAD 1983 UTM Zone 19N coordinate system. Data from the core logs and grab samples were also entered into a relational geodatabase following the MMPGIS schema. Tables in the geodatabase that were populated include Environmental Samples, Core Layers, Samples, Munsell color and Phi units. These data were used to help interpret the geology.

Figure 1. Photograph of Core VC02 taken in Muskeget Channel.

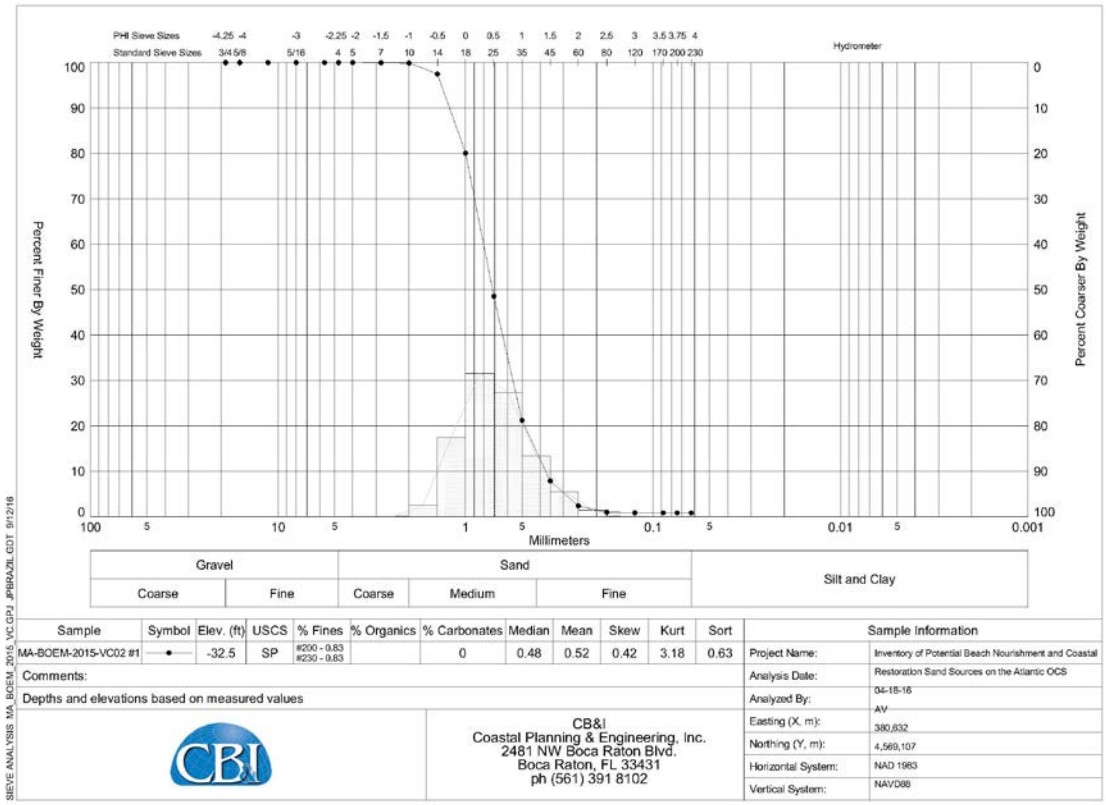

Figure 2. Grain size distribution curve for sample 1 from vibracore VC02 taken in Muskeget Channel.

(7) Gartner, J. and Mabee, S.B., 2018, Raster Images of Magnetometer Data and Anomalies for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/RawData/GeophysicalData/Magnetometer/

Abstract:

This data set contains raster images (tiffs) of processed magnetometer data and anomalies for six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters (Figure 1). The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. Approximately 210 km of magnetometer data were collected by CB&I, a private contractor hired by BOEM, using a Geometrics G-882 Digital Cesium Marine Magnetometer provided in .RAW Hypack file format. The magnetometer was towed 10 m behind the side scan sonar towfish and maintained at a depth of no greater than 6 m above the seafloor. Data were collected July 20, 2015 to July 26, 2015. Data were corrected for navigational offsets and layback. Tiff images of the magnetometer data and any anomalies were exported from SonarWiz (version 6.0).

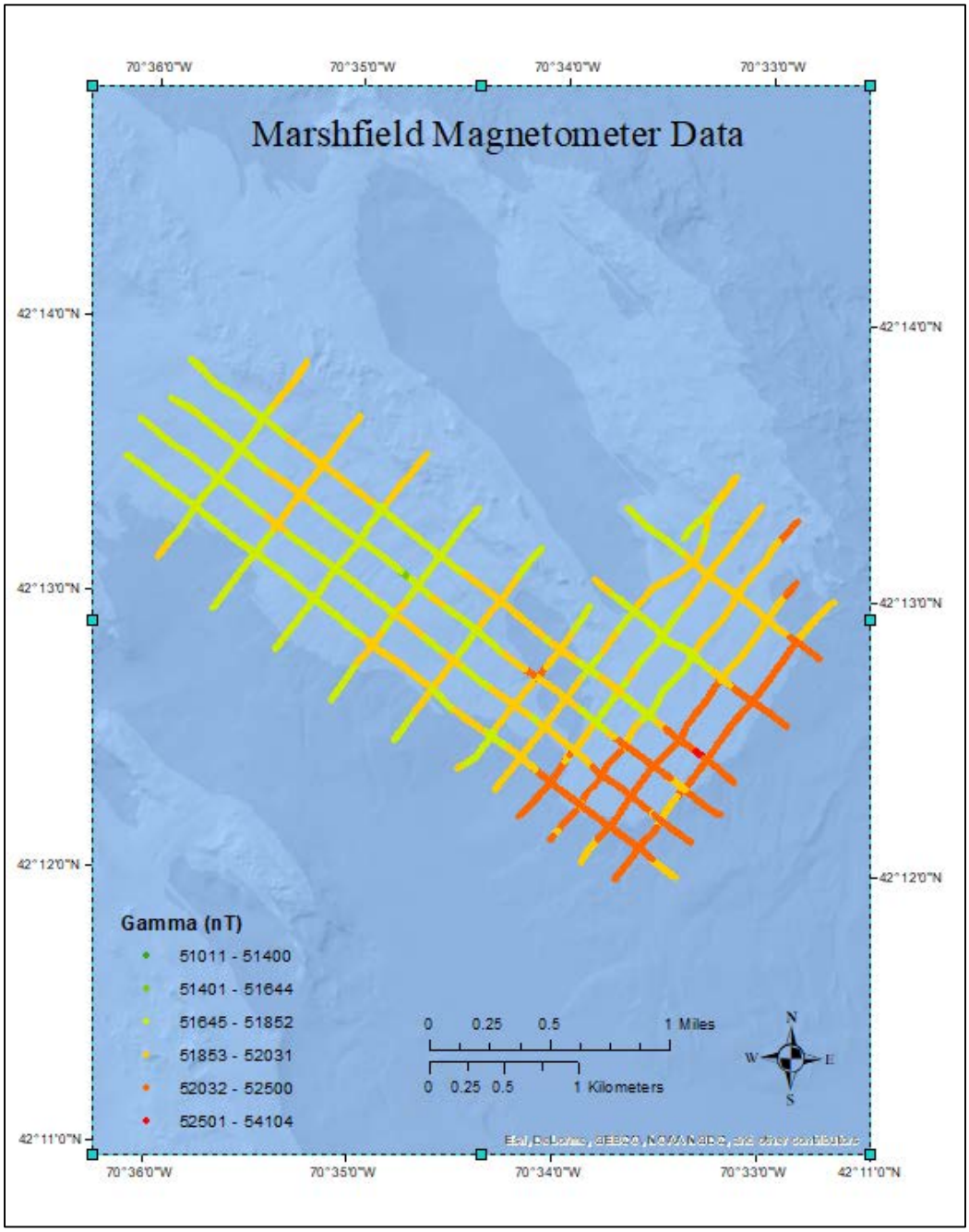

Figure 1. Example plot of magnetometer values for the Marshfield site.

(8) MassGIS, 2006/2007, ESRI Shapefiles of the outline of Massachusetts (Outline25K_Poly) and Surrounding States (NEMask_Poly).

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/Vectors/StateOutlines/

Abstract

This data layer provides the polygon of Massachusetts and the surrounding New England states. This is provided as a point of reference for the six potential offshore sand resource areas.

(9) CB&I, 2015, As-run Geophysical Survey Tracklines for Six Sites Located Off the Massachusetts Coast, CB&I Deliverable.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/Vectors/Tracklines/

Abstract

These data represent the as-run reconnaissance geophysical survey tracklines determined from the offset and layback-corrected magnetometer towfish navigation data (Figure 1). These data were collected July 20, 2015 to July 26, 2015 and are provided in NAD 1983 Universal Transverse Mercator (UTM) Zone 19N projection.

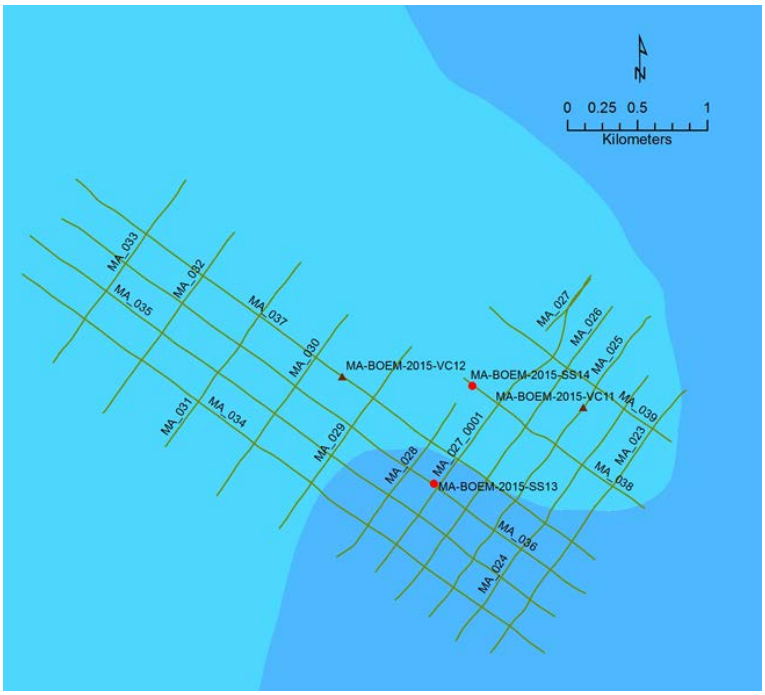

Figure 1. Map showing the location of geophysical survey tracklines for the Marshfield site. Also shown are the locations of vibracores (triangles) and grab samples (circles).

(10) Southard, P., Duncan, C., Lewis, R. and Mabee, S.B., 2018, Other Bathymetric Data Used to Assist Interpretation of the Geology for Six Sites Located Off the Massachusetts Coast.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/Rasters/Bathymetry/

Abstract

Six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters were examined to determine the extent and thickness of offshore sand resources. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. To assist with the interpretation of the geology for each site several other bathymetric data sources were examined (Figure 1). These other data sources are not provided as explicit deliverables for this project because the data have already been compiled and published. Rather, the links and/or references to the data and accompanying reports are provided in the table below (Table 1).

Table 1. Listing of Other Bathymetric Data Sources Including Links to the Data and Accompanying Reports

Marshfield	Pendleton, E.A., Baldwin, W.E., Barnhardt, W.A., Ackerman, S.D., Foster, D.S., Andrews, B.D., and Schwab, W.C., 2013, Shallow geology, seafloor texture, and physiographic zones of the Inner Continental Shelf from Nahant to northern Cape Cod Bay, Massachusetts: U.S. Geological Survey Open-File Report 2012–1157, 53 p., http://pubs.usgs.gov/of/2012/1157/
Plum Island	Barnhardt, W.A., Andrews, B.D., Ackerman, S.D., Baldwin, W.E., and Hein, C.J., 2009, High-resolution geologic mapping of the inner continental shelf; Cape Ann to Salisbury Beach, Massachusetts: U.S. Geological Survey Open-File Report 2007-1373, variously paged, DVD-ROM and available online at http://pubs.usgs.gov/of/2007/1373/
Buzzards Bay	Foster, D.S., Baldwin, W.E., Barnhardt, W.A., Schwab, W.C., Ackerman, S.D., Andrews, B.D., Pendleton, E.A., 2016, Shallow geology, sea-floor texture, and physiographic zones of Buzzards Bay, Massachusetts (ver. 1.1, June 2016): U.S. Geological Survey Open-File Report 2014–1220, https://dx.doi.org/10.3133/ofr20141220. Just reaches the east side of Buzzards Bay site.

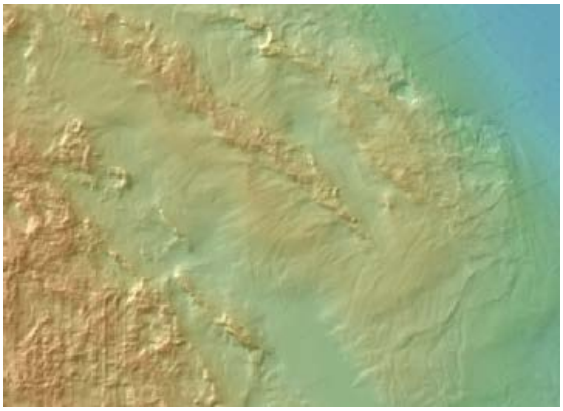

Figure 1. 30 meter resolution bathymetry from Pendleton et al. (2013) used to assist interpretation of geology at the Marshfield site.

(11) Southard, P., Duncan, C., Lewis, R. and Mabee, S.B., 2018, Other Side Scan Sonar Data Used to Assist Interpretation of the Geology for Six Sites Located Off the Massachusetts Coast.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/Rasters/Backscatter/

Abstract

Six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters were examined to determine the extent and thickness of offshore sand resources. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. To assist with the interpretation of the geology for each site several other side scan sonar data sources were examined (Figure 1). These other data sources are not provided as explicit deliverables for this project because the data have already been compiled and published. Rather, the links and/or references to the data and accompanying reports are provided in the table below (Table 1).

Table 1. Listing of Other Side Scan Sonar Data Sources Including Links to the Data and Accompanying Reports

Marshfield	Pendleton, E.A., Baldwin, W.E., Barnhardt, W.A., Ackerman, S.D., Foster, D.S., Andrews, B.D., and Schwab, W.C., 2013, Shallow geology, seafloor texture, and physiographic zones of the Inner Continental Shelf from Nahant to northern Cape Cod Bay, Massachusetts: U.S. Geological Survey Open-File Report 2012–1157, 53 p., http://pubs.usgs.gov/of/2012/1157/
Plum Island	Barnhardt, W.A., Andrews, B.D., Ackerman, S.D., Baldwin, W.E., and Hein, C.J., 2009, High-resolution geologic mapping of the inner continental shelf; Cape Ann to Salisbury Beach, Massachusetts: U.S. Geological Survey Open-File Report 2007-1373, variously paged, DVD-ROM and available online at http://pubs.usgs.gov/of/2007/1373/

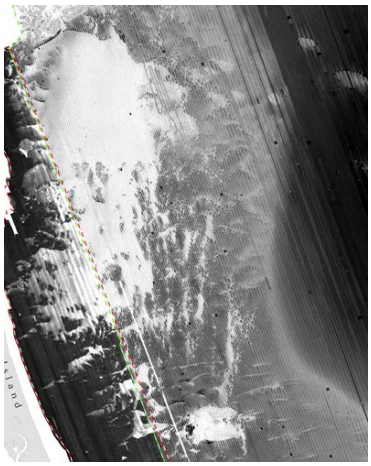

Figure 1. Screen shot of 5-meter (offshore) and 1-meter (inshore) acoustic backscatter intensity in the vicinity of the Plum Island site collected by the USGS in 2004 and 2005(Barnhardt et al., 2009). This is an example of other data used to help interpret the geology.

(12) Southard, P., Duncan, C., Lewis, R. and Mabee, S.B., 2018, Other Seismic Profile Data Used to Assist Interpretation of the Geology for Six Sites Located Off the Massachusetts Coast.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/Vectors/OtherSeismic/

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/Images/Seismic/

Abstract

Six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters were examined to determine the extent and thickness of offshore sand resources. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. To assist with the interpretation of the geology for each site several other sources of seismic profile data were examined (Figure 1). These other data sources are not provided as explicit deliverables for this project because the data have already been compiled and published. Rather, the links and/or references to the data and accompanying reports are provided in the table below (Table 1).

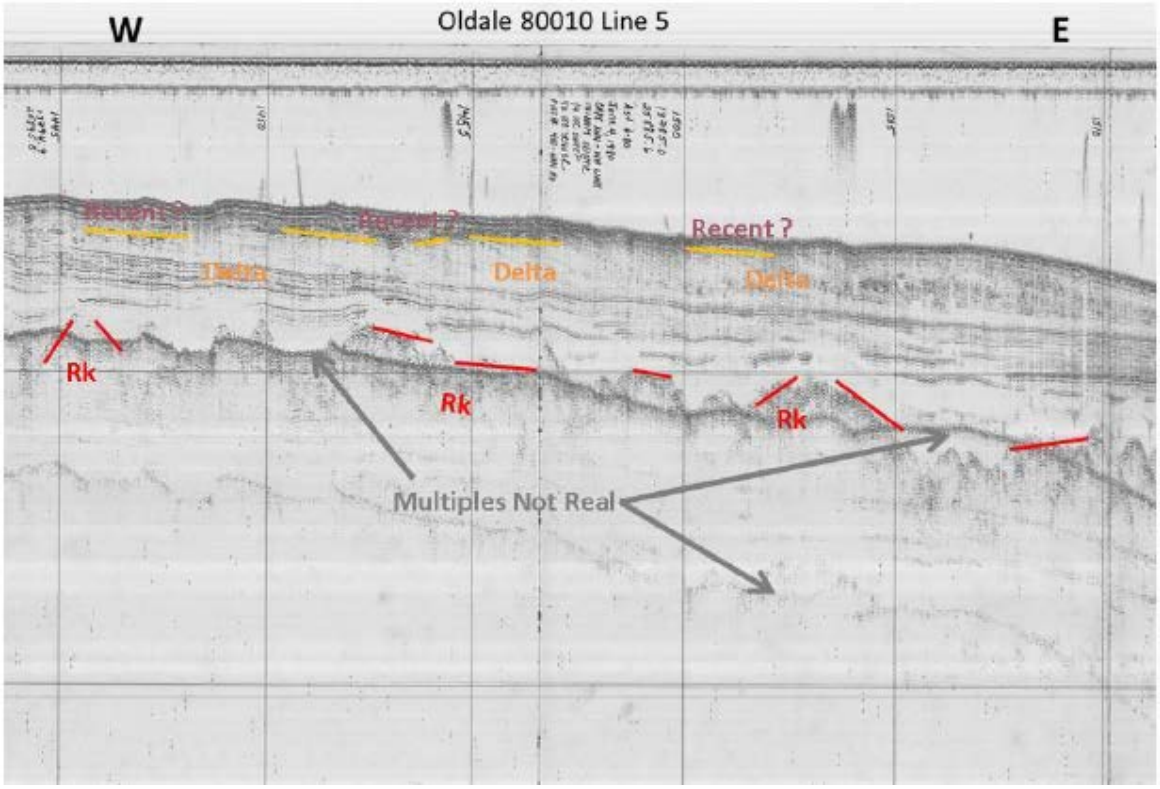

Figure 1. Seismic profile data collected by Oldale in 1980. This line crosses the Plum Island site and provides additional insight into the geology. Interpretation of seismic units by Ralph Lewis.

Table 1. Listing of Other Sources of Seismic Data Including Links to the Data and Accompanying Reports

Marshfield	Raytheon Company, Ocean Systems Center, 1972, Final Report of the Massachusetts Coastal Mineral Inventory Survey, prepared for the Commonwealth of Massachusetts, Department of Natural Resources, Division of Mineral Resources, Seismic lines 8, 9, 10.
Plum Island	Oldale Data: https://cmgds.marine.usgs.gov/fan_info.php?fan=1980-010-FA Oldale Report: Oldale, R.N. and Wommack, L.E., 1987, Maps and seismic profiles showing geology of the inner Continental Shelf, Cape Ann, Massachusetts to New Hampshire, U.S. Geological Survey, Miscellaneous Field Studies Map MF-1892, 2 plates, https://pubs.er.usgs.gov/publication/mf1892 Barnhardt Data: https://pubs.usgs.gov/of/2007/1373/GIS/hyperlink_images/SeismicProfiles.zip Barnhardt Report: Barnhardt, W.A., Andrews, B.D., Ackerman, S.D., Baldwin, W.E., and Hein, C.J., 2009, High-resolution geologic mapping of the inner continental shelf; Cape Ann to Salisbury Beach, Massachusetts: U.S. Geological Survey Open-File Report 2007-1373, variously paged, DVD-ROM and available online at https://pubs.usgs.gov/of/2007/1373/ Hein Data: https://www.geo.umass.edu/stategeologist/Products/Surficial_Geology/Newburyport_East/Newburyport_East_GIS.zip Hein Maps: https://mgs.geo.umass.edu/biblio/onshore-offshore-surficial-geologic-map-newburyport-east-and-northern-half-ipswich
Buzzards Bay	O'Hara Data: https://cmgds.marine.usgs.gov/fan_info.php?fan=1975-011-FA O'Hara Report: O'Hara, C.J. and Oldale, R.N., 1980, Maps showing geology and shallow structure of eastern Rhode Island Sound and Vineyard Sound, Massachusetts, Miscellaneous Field Studies Map- U.S. Geological Survey, Report: MF-1186, 5 sheets. https://pubs.er.usgs.gov/publication/mf1186
Nomans Land	O'Hara Data: https://cmgds.marine.usgs.gov/fan_info.php?fan=1980-012-FA O'Hara Report: McMullen, K.Y., Poppe, L.J., and Soderberg, N.K., 2009, Digital seismic-reflection data from eastern Rhode Island Sound and vicinity, 1975–1980: U.S. Geological Survey Open-File Report 2009–1003, 2 DVD-ROMs. (Also available at https://pubs.usgs.gov/of/2009/1003/)
Nantucket	Oldale Data: https://cotuit.er.usgs.gov/data/1976-036-FA/SE/Scans/Sparker/FA76036_256-257_1245-0438_MSP_L5.tif (last accessed spring 2018, no longer accessible) Oldale Cruise Report: https://cotuit.er.usgs.gov/data/1976-036-FA/NL/001/01/76036rpt.pdf (last accessed spring 2018, no longer accessible)
Muskeget Channel	Oldale Data: https://cotuit.er.usgs.gov/data/1976-036-FA/SE/Scans/Sparker/FA76036_256-257_1245-0438_MSP_L5.tif (last accessed spring 2018, no longer accessible) Oldale Cruise Report: https://cotuit.er.usgs.gov/data/1976-036-FA/NL/001/01/76036rpt.pdf (last accessed spring 2018, no longer accessible)

(13) Duncan, C. and Mabee, S.B., 2018, Other Grab Samples Used to Assist Interpretation of the Geology for Six Sites Located Off the Massachusetts Coast, Massachusetts Geological Survey Data Release.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/GISdata/Vectors/OtherSamples/

Abstract

Six sites located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters were examined to determine the extent and thickness of offshore sand resources. The six sites include Plum Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. To assist with the interpretation of the geology for

each site nearby grab samples from the usSEABED database were examined (Figure 1). These other data sources are included as separate shapefiles for this project. The data can also be viewed in the Massachusetts Office of Coastal Zone Management Massachusetts Ocean Resource Information System (MORIS) and accessed at: http://maps.massgis.state.ma.us/map_ol/moris.php The reference guide for the usSEABED database can be accessed at: http://maps.massgis.state.ma.us/czm/moris/pdfs/usSEABED_report.pdf

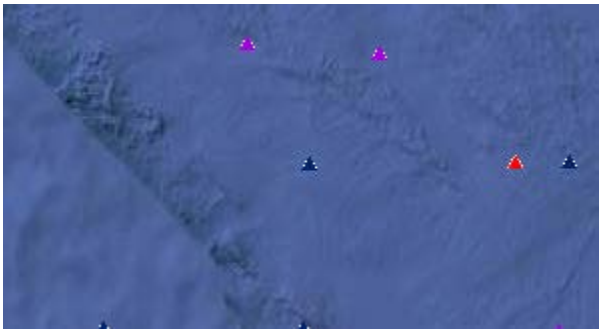

Figure 1. usSEABED sediment sample data in the vicinity of the Marshfield site (from MA Coastal Zone Management Massachusetts Ocean Resource Information System website).

Associated Cooperative Agreement Outputs:

(1) DiTroia, A.L., 2018, Legacy Sediment Controls on Post-Glacial Beaches, University of Massachusetts, Amherst, Department of Geosciences, M.S. Thesis, 38p.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/Presentations/ADiTroia_MastersThesis.pdf

Abstract

Here we examine seasonal grain-size trends on 18 representative beaches in the Northeastern US and dispersed along the post-glacial coast of Massachusetts (USA). Over 800 grain size samples were collected along 200 summer and winter cross-shore beach elevation surveys. Obtained grain size and beach slope data are compared to coastal morphology (Figure 1), sediment source (Figure 2), wave height, and tidal magnitude in order to ascertain controls on beach characteristics. The median grain size and intertidal beach slope are positively correlated in the study region. However, grain sizes along post-glaciated beaches in the study are as much as an order of magnitude coarser for the same beach slopes when compared to beaches for other regions of the US (Figure 3). Grain size and slope for beaches in the northeastern US also exhibit less correlation with oceanographic processes (i.e. wave climate and tidal magnitude). Instead, grain size trends are primarily driven by the composition of nearby glacial deposits that serve as

the primary source of sediment to beaches in the study region. Results provide quantitative support for the distribution and composition of legacy glacial deposits serving as the predominant governor of beach grain size along post-glaciated coastlines of the Atlantic continental margin.

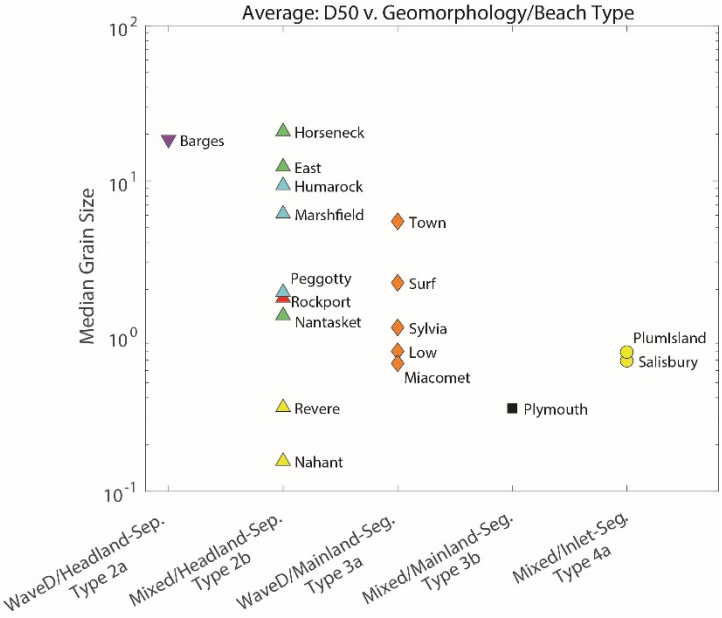

Figure 1. Each of the 18 beaches are plotted based on geomorphology as described by Fitzgerald (1999) vs. grain size. Shape of points correspond to geomorphic environment and colors correspond to sediment source (see Figure 2 below).

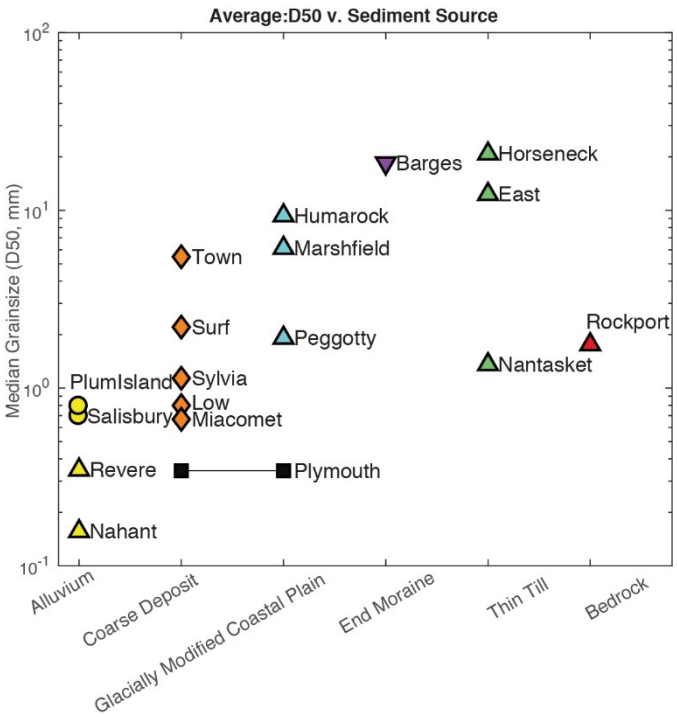

Figure 2. Graph of each beach and its associated sediment source vs. grain size. Each color corresponds to its sediment source and each shape represents its geomorphologic environment.

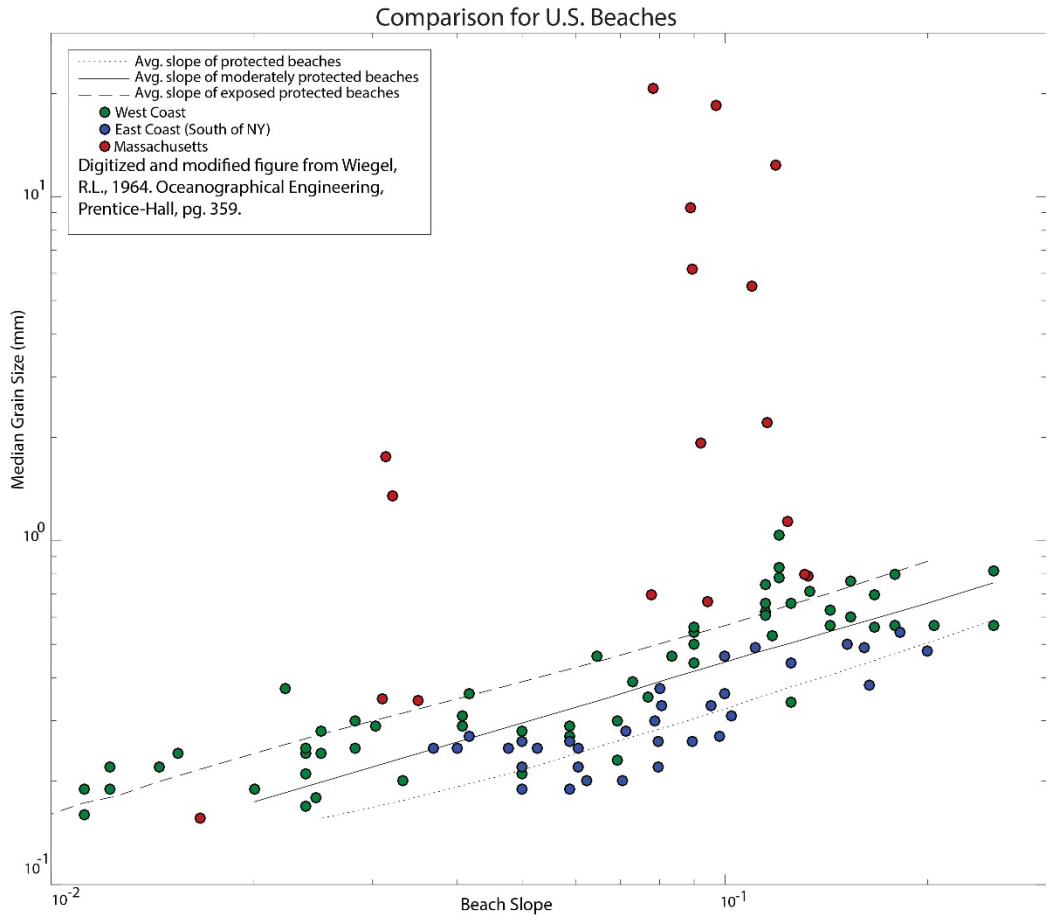

Figure 3. Plot of median grain size vs. beach slope for Massachusetts beaches compared with West Coast and southern East Coast (U.S.) beaches.

(2) Beach, D., Woodruff, J., Baranes, H. and DiTroia, A.L., 2018, Method Evaluation for Assessing Changes in Beach Morphology Following 2018 Boston Flood Events of Record, poster presented at the annual American Shore and Beach Preservation Association meeting in Galveston, TX, October 30 to November 2, 2018, in partial fulfillment of Doug Beach's Master's project.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/Presentations/BeachABSPAPoster.png

Abstract

Beach erosion and coastal community vulnerability is a never-ending vigil that must be both scrupulous and adaptive to evolve with climate change. Peggotty Beach, located in Scituate,

Massachusetts, is one such community that has faced very aggressive erosion rates over the past half century. The proposed Marshfield borrow area is located just offshore from Peggotty Beach. The goal of this project is to collect Unmanned Aerial Vehicle (UAV) elevation data and assess changes in beach face sand volume and beach profile in response to seasonal changes as well as major storm events. Profiles constructed with UAV-generated elevation data will be compared with traditional GNSS surveying transects. The project uses various RTK instruments to gather both elevation data within nominal parameters as well as establishing critical Ground Control Points (GCP) for UAV surveys. The UAV captures images along the entire length of the beach (Figures 1 and 2). Agisoft software is used to stitch the images together and create a digital elevation model (Figures 3 and 4), as well as orthomosaic images. Multiple images over a single storm event was collected and differences in area and elevation used to estimate volumetric sediment change. Comparsison of standard survey profiles with UAV-dervived profiles agree within 5 cm for a majority of the land coverage. With equipment and methodology firmly established, a standard protocol will be developed for rapid beach erosion assessments.

Figure 1. Orthomosaic image of Peggotty Beach and adjacent marsh, Scituate, Massachusetts. Data collected by UAV in January 2018.

Figure 2. Example orthomosaic developed for Peggotty Beach, Scituate, Massachusetts and adjacent marsh acquired with UAV following the March 11, 2018 storm event.

Figure 3. Elevation model developed for Peggotty Beach, Scituate, Massachusetts from imagery collected in January 2018.

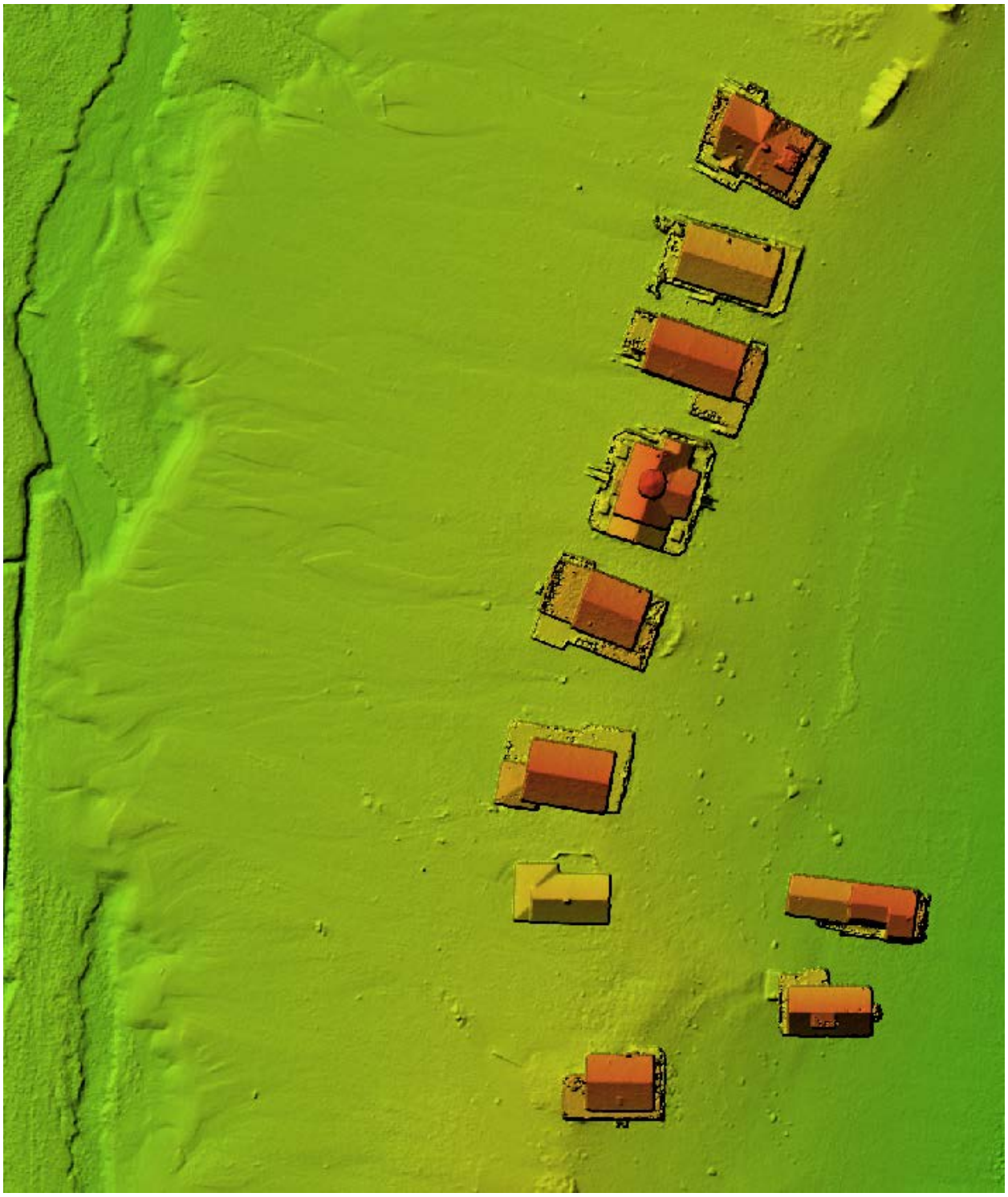

Figure 4. Elevation model developed for Peggotty Beach, Scituate, Massachusetts from imagery collected 2 days after the March 11, 2018 storm event. Compare with Figure 3.

(3)DiTroia, A.L., Woodruff, J., Venti, N., Mabee, S.B. and Beach, D., 2018, Legacy Sediment Controls on Grain Size for Paraglacial Beaches, poster presentation made to the American Geophysical Union, Ocean Sciences meeting in Portland, OR, February 11-16, 2018.

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/Presentations/ADiTroia_AGUPoster_FINAL.pdf

Abstract

Numerous studies assess various factors controlling grain size along a diverse set of beach systems. These systems have mainly been categorized qualitatively and their classification schemes largely overlook the importance of geology and the major effect that it can play on grain size in coastal environments. Here we examine quantitative seasonal grain-size controls as measured from 18 beaches dispersed along the paraglacial—derived from unstable geomorphic conditions after glacial activity—coast of Massachusetts (USA). Grain size and slope data were collected and compared to coastal morphology, surficial geology, wave height, and tidal magnitude in order to ascertain controls on particle size and beach profile. In general, our results agree with a previously proposed classification of paraglacial beach systems focusing on change in grain size in relation to breaking wave height and relative tidal range. Beyond this, our results highlight glacial deposits and spatial variability of paraglacial source sediment as a governor of beach grain size. More so than oceanographic processes (i.e. wave climate and tidal magnitude), popularly used to explain other popular beach classification schemes, the analysis suggests that distribution and composition of this glacial legacy sediment plays a prominent role in determining particle size of Massachusetts' beaches. Thus, for beach nourishment along paraglacial coasts, grain size of native materials on a beach might not necessarily represent the true condition that can be supported by the site's oceanographic setting. These results highlight the importance of integrating quantitative analysis along with geology in characterization of beaches. Integrating these results into a larger data set will allow for a more inclusive analysis, and comparing to previously developed characterization schemes will examine broader applicability of these initial findings.

(4) Lewis, R., 2017, Interpretation of BOEM Chirp Seismic and Sample Data from Selected Potential Sand and Gravel Resource Areas in Massachusetts Waters, prepared for the Department of Geosciences, University of Massachusetts, 95p. (in Appendix of Technical Report)

ftp://eclogite.geo.umass.edu/pub/stategeologist/BOEM2Data/MA_M14AC00006_Beaches2018/Documents//BOEM2_Final_Technical_Report_ver4.pdf

Abstract

This report interprets the Chirp seismic reflection profiles from 59 survey lines collected by CB&I during the summer of 2015 for six areas located 5.6 (3 miles) to 14.8 (8 miles) km off the Massachusetts coast within water depths of approximately 30 meters. The six sites include Plum

Island, Marshfield, Nantucket, Muskeget Channel, Nomans Land and Buzzards Bay. The seismic data were collected by CB&I in the summer of 2015 and processed by Dr. William Clement at the University of Massachusetts in 2017. A total of 210 km of survey lines were obtained. Due to the poor quality of the chirp data (Muskeget Channel being the exception), interpretation relied extensively on existing mapped regional geology and other seismic and bathymetric data. In Marshfield, "boomer" data collected by Raytheon for a 1972 Massachusetts Coastal Mineral Inventory Survey and swath bathymetry were used to aid interpretation (Figure 1). In addition, "uniboom" data collected by Oldale at the USGS in 1980 and swath bathymetry guided interpretation in Plum Island. In Buzzard's Bay, the BOEM data are close to "boomer" data from a 1975 USGS cruise (ASTR-75) but existing swath bathymetry was of limited use. Two "boomer" lines from a 1980 USGS cruise (AST-80-6B) by Oldale lie close to the BOEM data at Nomans Land. The Nantucket and Muskeget Channel survey areas are close to "sparker" Line 5, USGS Cruise Fay 036 (1976), and include helpful bathymetric data. Geologic units identified include recent sand or sand and gravel deposits, marine fan, fluvial, channel fill and delta deposits, fine-grained lake and marine deposits, glacial outwash, coastal plain deposits and bedrock outcrops (see example Figure 2).

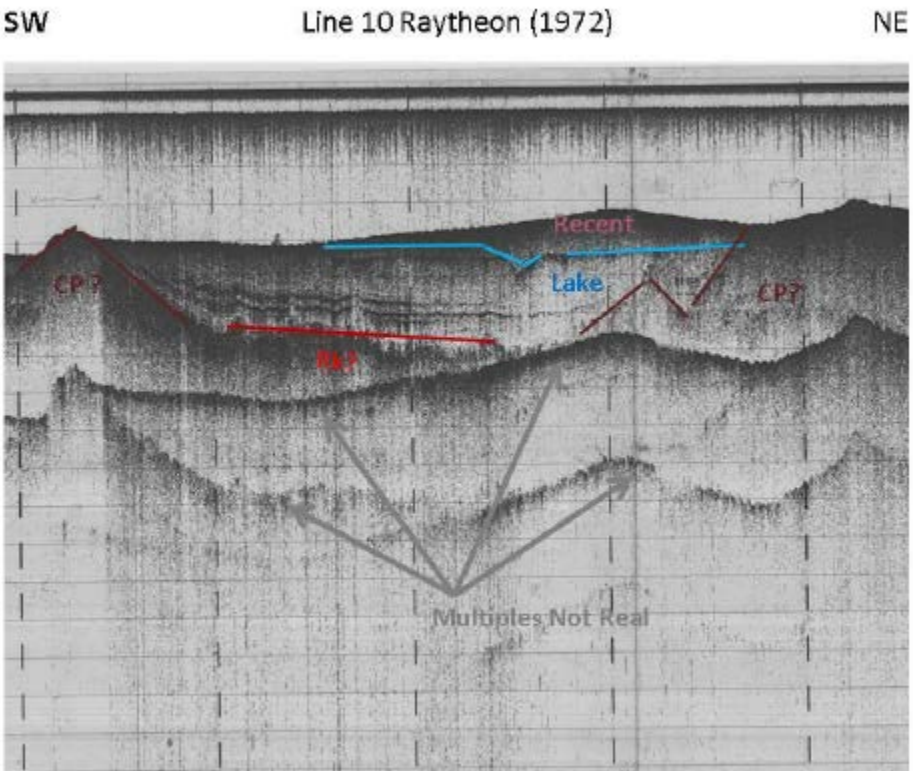

Figure 1. Interpretation of Line 10 from seismic data collected by Raytheon in 1972 in the Marshfield area. CP = coastal plain deposits, Rk = bedrock, Lake = fine-grained lake deposits, Recent = sand or sand and gravel.

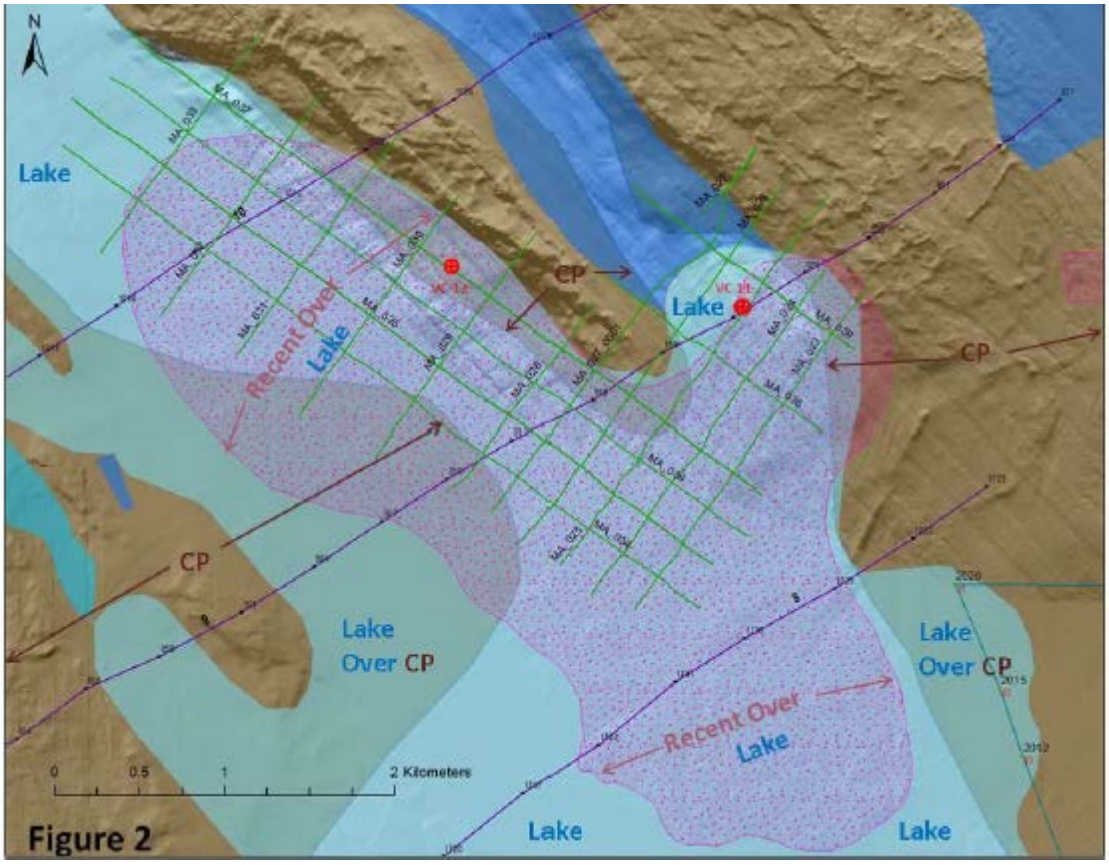

Figure 2. Draft geologic map of the Marshfield site derived in part from the new Quaternary Geologic Map of Massachusetts. Map shows BOEM survey lines (green) and BOEM cores VC-11 and VC-12, Raytheon tracklines 8-10 (purple), and extent of recent sands lying over fine grained lake deposits and coastal plain deposits (CP).