Announcement M13AS00014: Hurricane Sandy Coastal Recovery and Resiliency - Resource Identification, Delineation and Management Practices

Agreement: M14AC00003 Delaware Geological Survey/University of Delaware; Delaware Offshore Sand Resource Investigation

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Delaware Geological Survey/University of Delaware

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Summary Report

The following project deliverables and databases have been generated as a result of the Hurricane Sandy State Cooperative Agreement between BOEM and the Delaware Geological Survey. Work is proceeding on the deliverable for the project, a surficial geologic map of the area offshore of Delaware with specific focus on identification of potential sand resources for beach replenishment.

Cooperative Agreement Outputs including Project Deliverables:

Surficial geologic map of offshore Delaware (Project Deliverable)

The primary deliverable for this project is a geologic map connecting the geology onshore with the geology offshore from the shoreline to a distance of approximately 7 miles that contains sand resources available for beach replenishment. By mapping the offshore geology, specific areas can be targeted for more detailed sand resource evaluation. Standard geologic mapping practices were followed. Over 450 geologic vibracore records were analyzed and categorized in terms of surficial geology, down-hole stratigraphy, and fossil content. Of these cores, more than half are housed in the DGS Core and Sample Repository. Cores underwent a process of quality control and analysis to assure that they were described in detail, photographed, sampled for shell and other fossil content, and geologic units and contacts picked. They were rewrapped in plastic tubing, cut to length, and transferred to core boxes for permanent repository storage. All data related to the cores are managed in Access databases. Lithologic data supplemented subsurface and seafloor geophysical datasets, which aided correlation efforts and helped establish map unit boundaries.

The geologic map shows the distribution of sediments offshore that are part of the modern depositional regime as well as older sedimentary bodies that occur at areas of non-deposition/erosion at the sea floor. Mapping was undertaken at a standard scale of 1:24,000. The map was produced in the GIS environment using ESRI ArcMap 10.5.1. Map units are associated with appropriate metadata using ISO formats. The agreement deliverable will be available as an ESRI GIS Geodatabase.

Citation: Mattheus, C.R., Ramsey, K.W., and Tomlinson, J.T., 2019, Geologic Map of Offshore Delaware: Delaware Geological Survey Geologic Map, unpublished, scale 1:24,000.

Geologic map units (shown below) are established for offshore Delaware based on textural characteristics of sedimentary deposits, mineralogy, color, fossil content, and chronologic constraint (C-14 ages and AAR age estimates). Many of these are adapted from existing templates of coastal plain units (Ramsey, 2010), while others have been newly established (**Figure 1**). Several lithologic cross sections, based on an integration of seismic and core data, show the subsurface architecture in coast-parallel and perpendicular orientations in Federal waters (**Figure 2**).

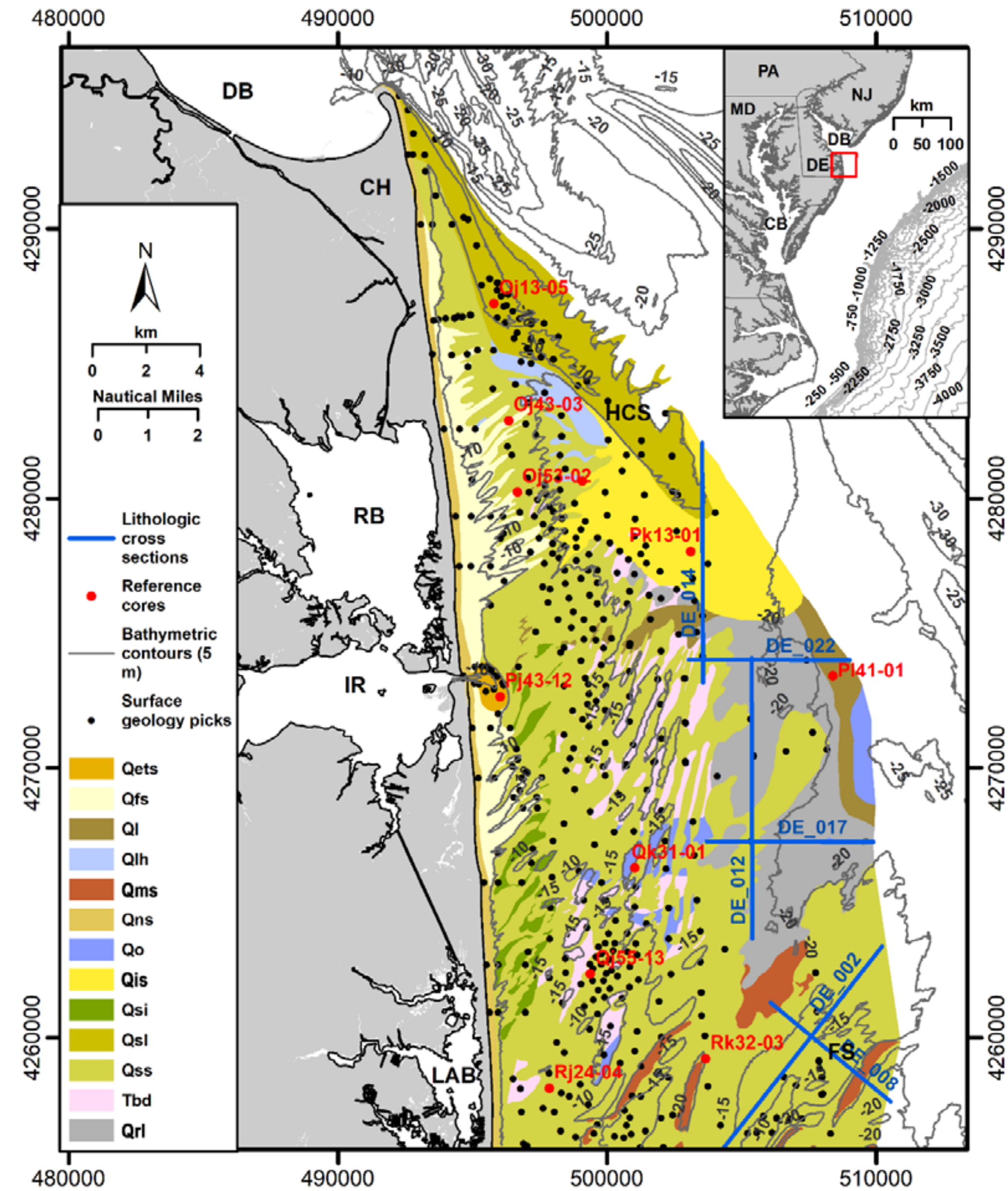

__Figure 1__ - Surface geology map based on core information, seismic mapping, and seafloor topography (based on a 2015 USGS DEM built from 2007 NOAA data). Minimum unit thickness is 1 foot. If, for example the surface unit was a 0.5 foot gravel lag deposit overlying the Beaverdam Formation, the latter was used as the map unit. Reference cores are plotted (red) as are the locations of seismic cross sections shown in Figure 2. Unit descriptions are provided in Table 1.

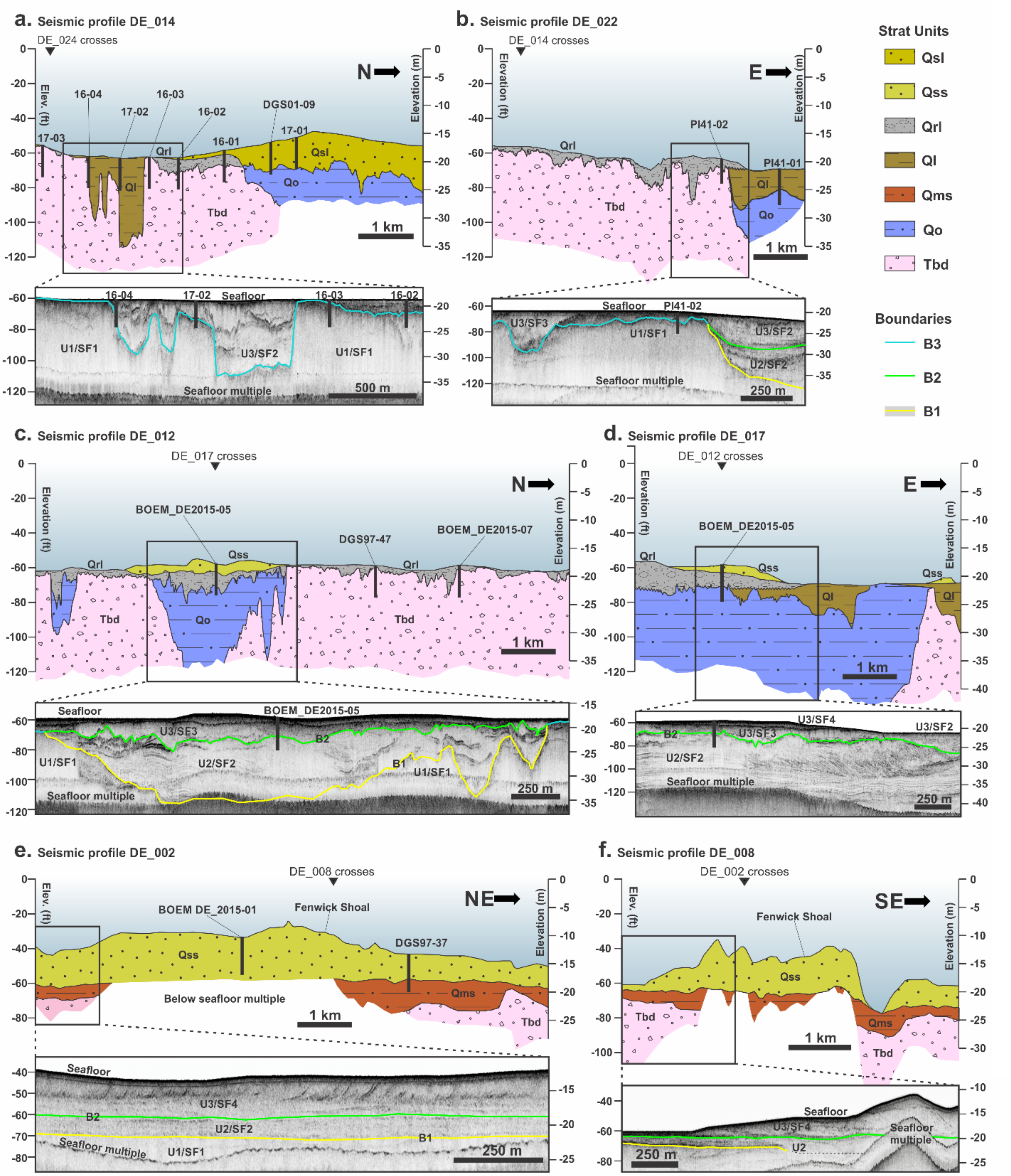

Figure 2 - *Lithologic cross sections based on the integration of core and seismic data with accompanying excerpts of corresponding seismic images. Units are color-coded to match Figure 1. The Qsl unit comprising the Hen and Chickens Shoal in seismic profile DE_014 is comprised of interbedded Qis and Qsl, but is shown as Qsl at this scale given that lithologies prominence. Refer to technical report for further explanation.*

The Delaware Geological Survey Sediment Texture Database and Resource Rating

Newly generated texture data (BOEM cores) have been integrated with prior information and incorporated into a newly created sediment-texture database. Statistical measures of median, mean, sorting, skewness, and kurtosis are calculated from raw sample weight inputs (total and by individual size fraction). To date, over 2,100 records are contained within the database.

Offshore Delaware seafloor stratigraphic units are primarily sand and are texturally heterogeneous (Figure 1). Previous work classifying resource potential (McKenna and Ramsey, 2002) did not have the benefit of stratigraphic unit identification or distribution of the stratigraphic units at the seafloor. Sediments from core sites were classified for resource potential using a stack-unit classification method (Berg et al., 1984; Kempton and Cartwright, 1984; Andres, 1991). Resource ratings of Excellent, Good, Fair, or Poor were assigned for each core site based on thickness of textural units (e.g., gravel, sand, mud) down core. Resource rating maps were drawn by mapping contiguous areas of each resource rating. The stack-unit methodology proved to be useful for identifying potential sand resource areas but the classification itself is tedious and is not likely to be implemented by anyone other than the original authors. As a part of this study, a simpler classification methodology was explored using standard textural statistics from sediment samples and a classification scheme already adopted for use by Federal agencies. This classification scheme is evaluated in the context of the geologic framework of the Delaware offshore (e.g., association of texture and stratigraphic units; Figures 1 and 2). Textural analyses from cores from two pilot areas were chosen that correspond approximately with the BOEM ASAP areas (Figure 3).

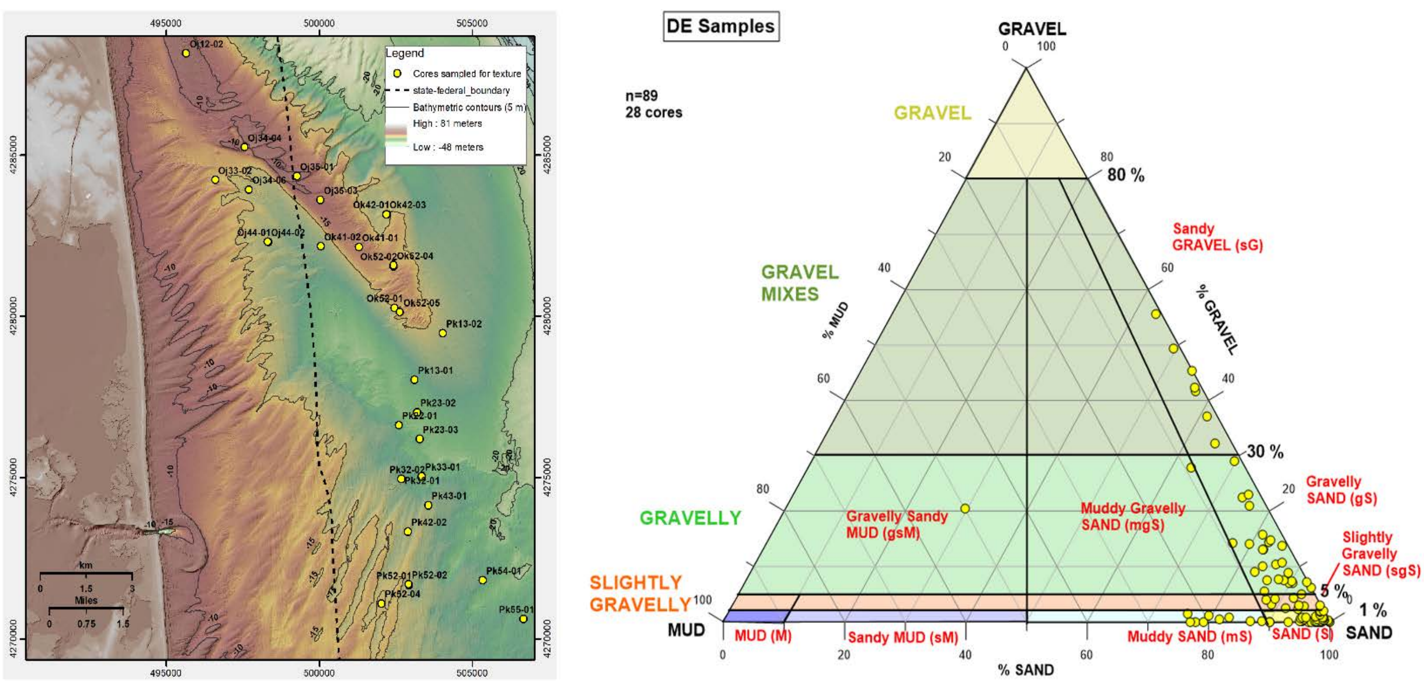

Figure 3 – *CMECS Ternary diagram plotting texture results from the top six feet of 28 sediment cores with map showing core locations.*

Volumetric Analysis of Sandy Lithosomes in Federal Waters

Lithologic mapping based on seismic and core data has resulted in the isolation of three distinct sand bodies for volumetric analysis (from south to north): 1) the Fenwick Shoals, 2) the central region shoal, and 3) the tip of Hen and Chickens Shoal (Figure 4). Sand volumes were assessed as follows: Isopach models were generated as the difference between seafloor elevation and the first high-amplitude bottom reflector in areas of verified sheet sand occurrence

(Seafloor elevation minus base of sheet sand elevation = thickness). The map area of the sand body, assessed from seismic data interpretations and seafloor topography (2015 USGS dataset), was calculated in ArcMap and multiplied by the mean pixel value of the corresponding isopach model, yielding an estimate of volume. The metrics presented are raw and adapted from the outputs of this procedure. Volumes represent an estimate or approximation based on the data at hand. Negative pixel values for the central shoal region and the Fenwick Shoal suggest some issues involving interpolation and raster subtraction, likely related to differences in age of the datasets (cores collected from 2015-2017 versus seafloor elevation data from 2007). Estimates based on this analysis are on the order of 297 million yd^3 for the Fenwick Shoal, 26 million yd^3 for the central region, and 109 million yd^3 for the distal end of the Hen and Chickens Shoal.

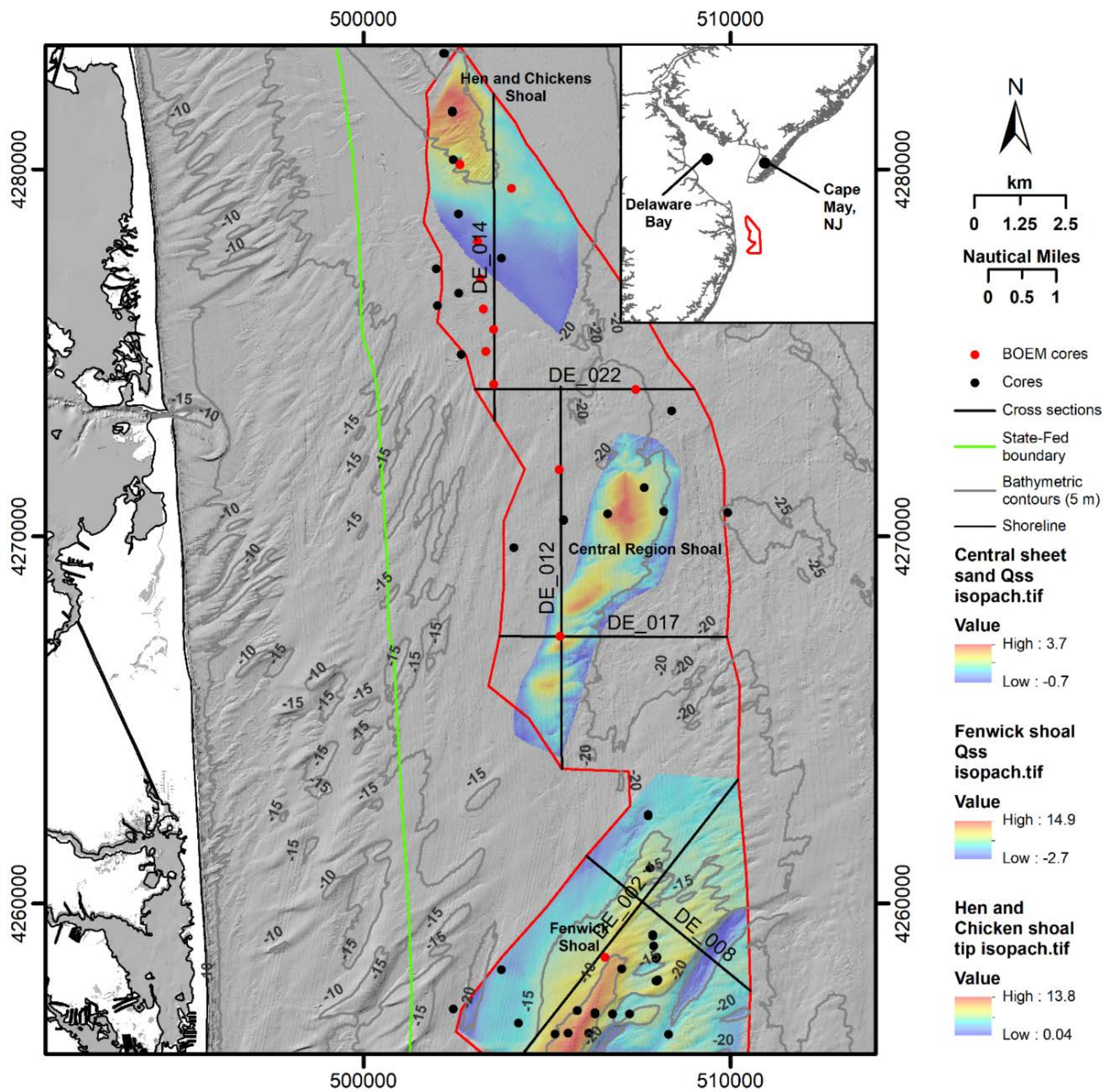

Figure 4 *– Isopach models of three sand bodies fitting the textural criteria for beach nourishment. The thicknesses are based on the 2015 USGS bathymetric dataset and the stratigraphic picks at the base of the surficial unit (from seismic and core). Negative isopach values are a product of the gridding process of the lower bounding surface and its subtraction from the much higher resolution 2015 USGS DEM. They correspond to isolated groupings of pixels and should have minimal influence on the overall analysis of sediment volumes.*

WORKS CITED

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