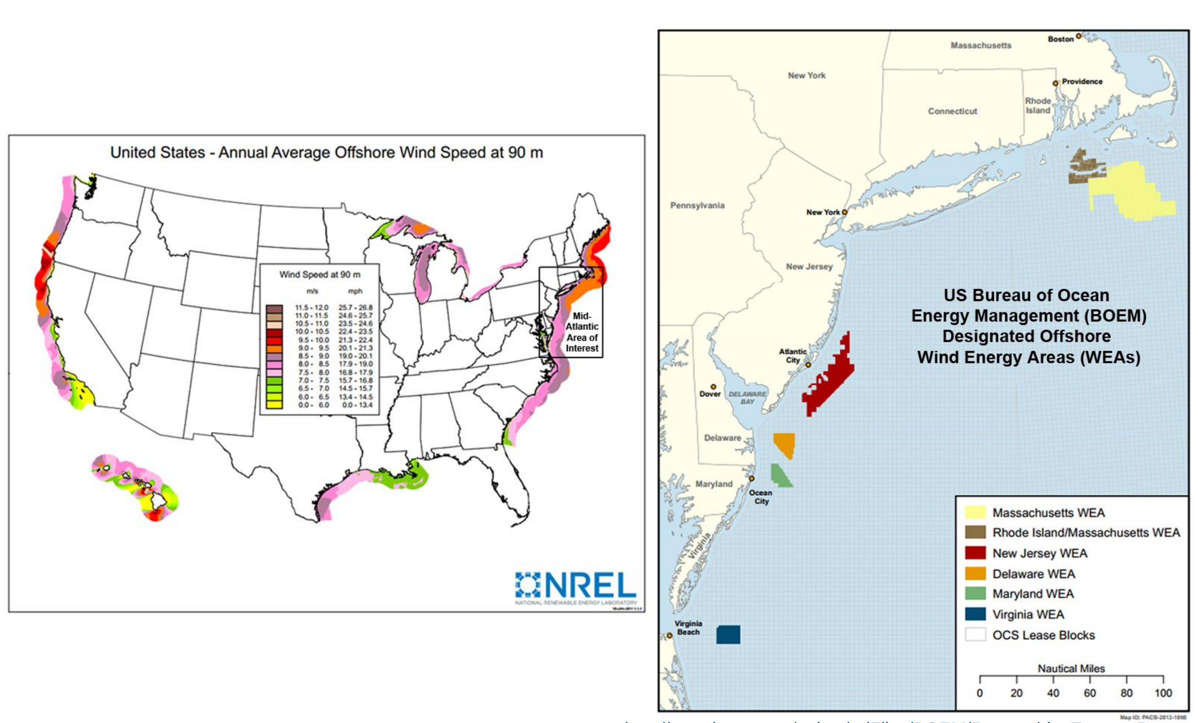
PO.ID 200

Role of Geological Models and Geotechnical Characteristics in Reducing Costs and Uncertainties and Assessing Risks in the Development of Offshore Wind Projects

John Madsen, Alia Ponte, and Coty Cribb
Department of Geological Sciences/University of Delaware, Newark, DE USA

Introduction

This presentation focuses on the variable geological/ geotechnical properties along the Mid-Atlantic continental shelf of the Eastern United States (US) and how knowledge of this variability can be utilized in reducing costs and uncertainties and placing constraints on risks associated with offshore wind projects in this region. The Mid-Atlantic region is particularly important since it extends along the most heavily populated portion of the Eastern US and it is a key focus area for offshore wind energy development.



http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Smart_from_the_Start/Wind_Energy_Areas0607.pdf

Approach

An underutilized data set in the decision making process for siting of large-scale offshore wind projects are a region's geological setting and associated geotechnical characteristics. The geotechnical properties of bottom/sub-bottom sediments are fundamental to the selection and design of turbine foundations, emplacement of transmission cables, and scouring near bottom installations. Since foundations and cabling are significant costs (up to 30% of total), if project siting, and even the location of individual foundations within a project, can be selected based on preferred geological/geotechnical conditions that enable more economical solutions, there is an opportunity to significantly reduce costs associated with developing offshore wind projects.

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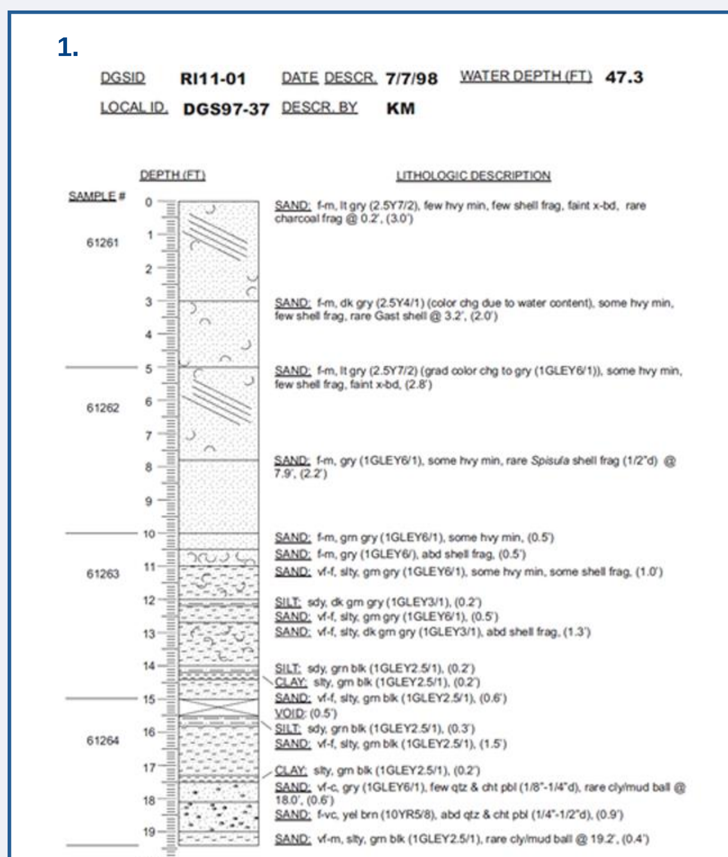

Geologic setting determines sediments and bedrock present where offshore wind projects are located.

In most coastal offshore geologic settings, spatial (both areal and vertical) distribution of sediments/bedrock is variable.

http://www.offshoreenergy.dk/offshoreenergy/publications/on-off-magazines/articles/foundations-of-the-future.aspx

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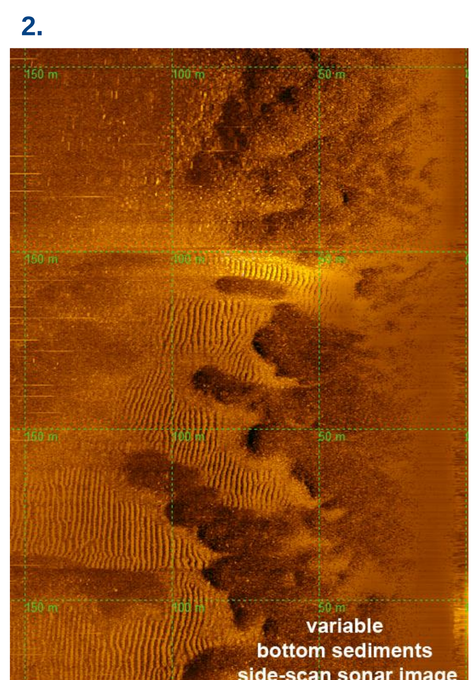

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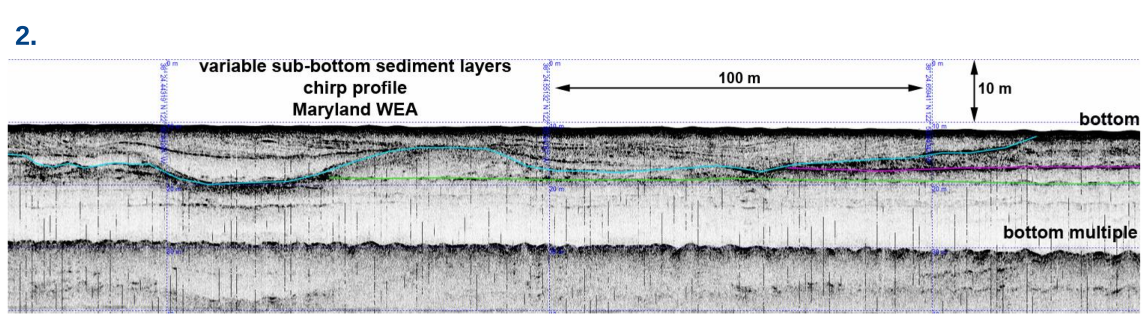
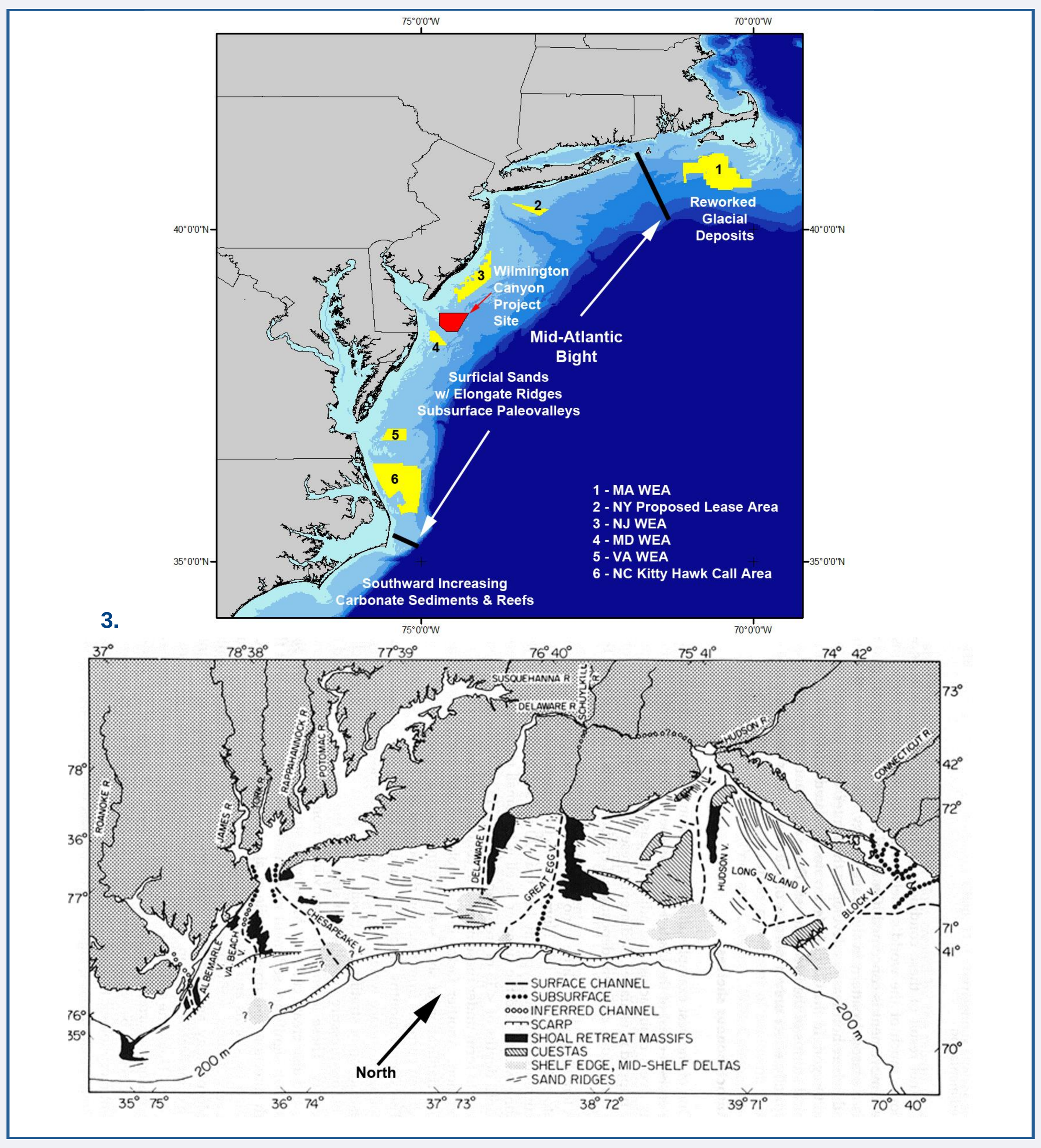
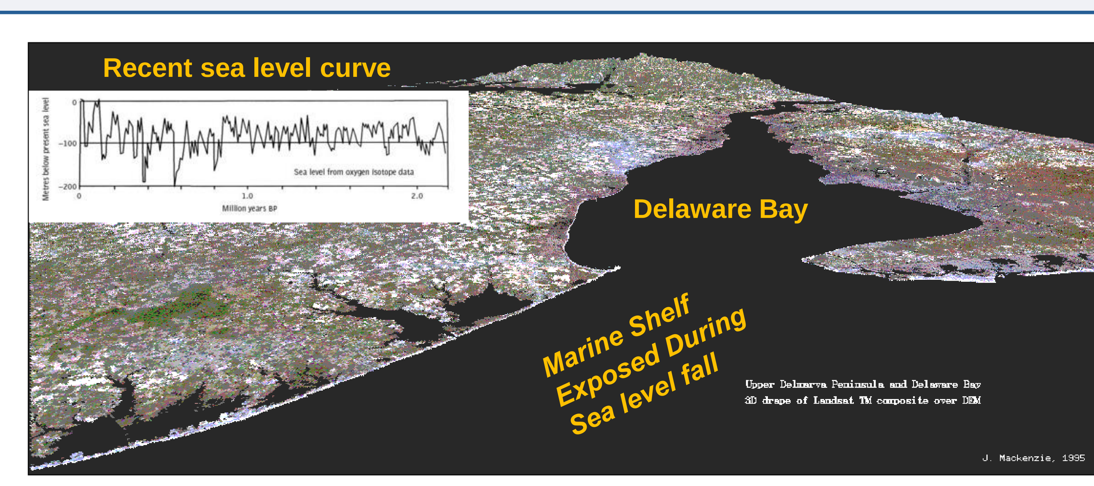


Methods

Geological Models: The Mid-Atlantic Bight extends for a distance of approximately 650 km along the US Eastern continental shelf from west of Rhode Island then southward to North Carolina.



The region over the last several million years has geologically evolved under conditions of sea level rise/fall resulting in three-dimensionally variable sedimentary deposits. These sediments are in turn characterized by differences in their geotechnical properties which fundamentally impact engineering solutions (e.g., foundation selection/design, transmission cable emplacement).



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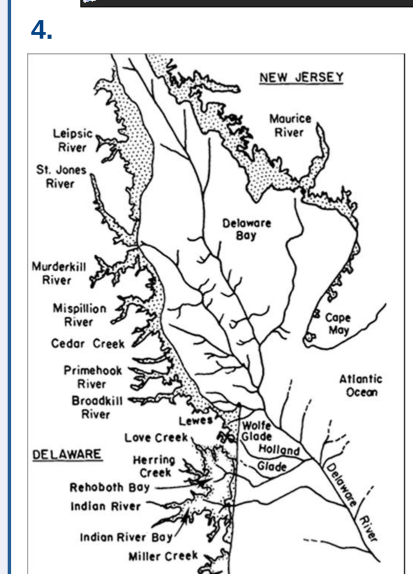
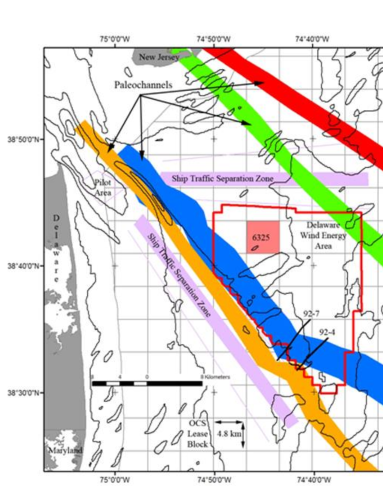


As sea-level falls, coast line migrates seaward. Portions of marine shelf exposed as land. Rivers extend across newly exposed land surface eroding material and transporting sediments further seaward on shelf.



Along the Mid-Atlantic Bight networks of paleochannels, created by ancient river systems during periods of lower sea level, occur in the sea bed. During subsequent sea level rise, these paleochannels were in-filled by coarser- to finer-grained sediments. As a result, sub-bottom sediments are quite variable both in terms of their classification and their spatial (including vertical) distribution.

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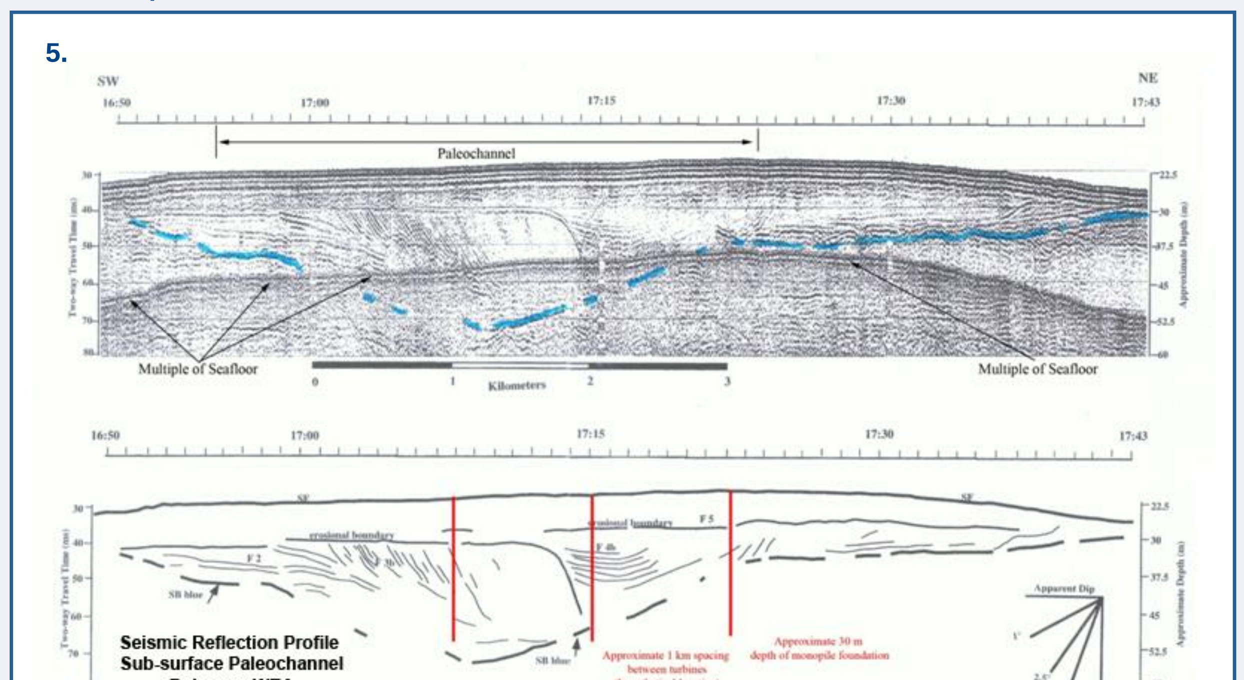
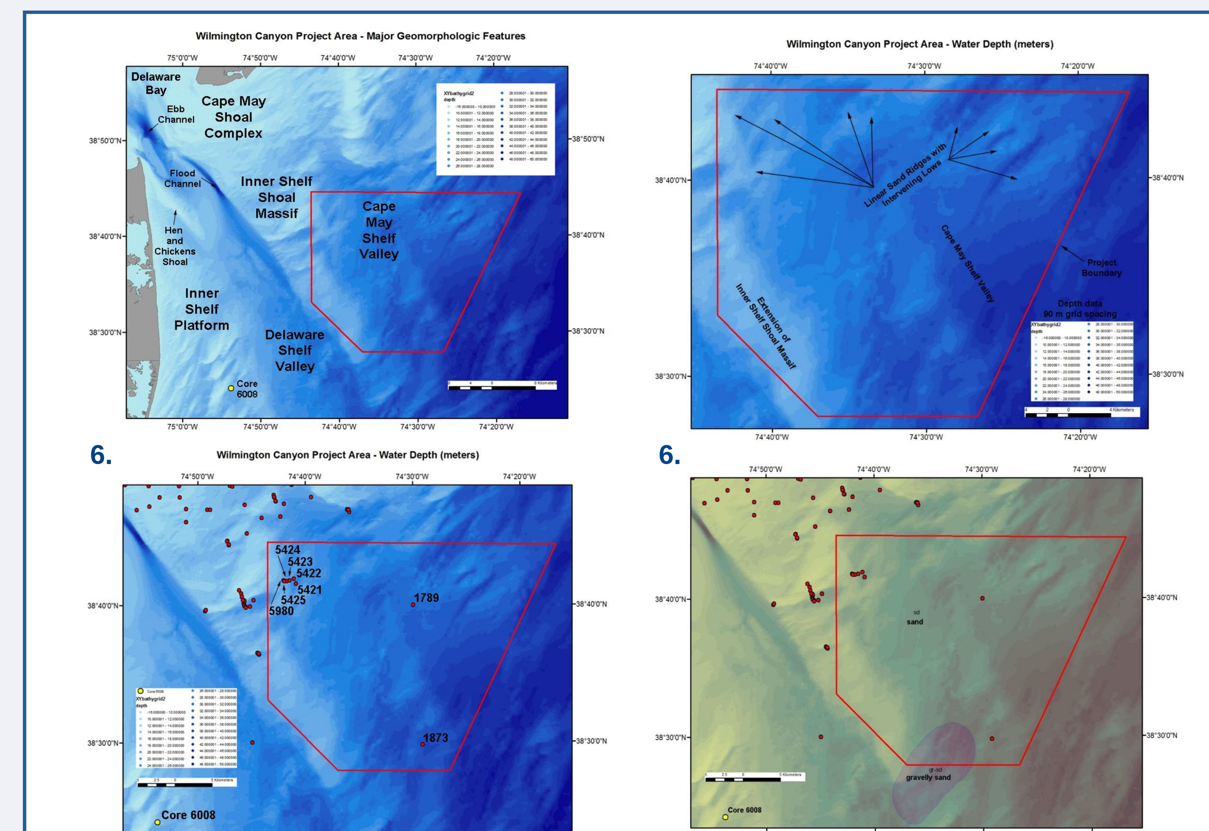


Results

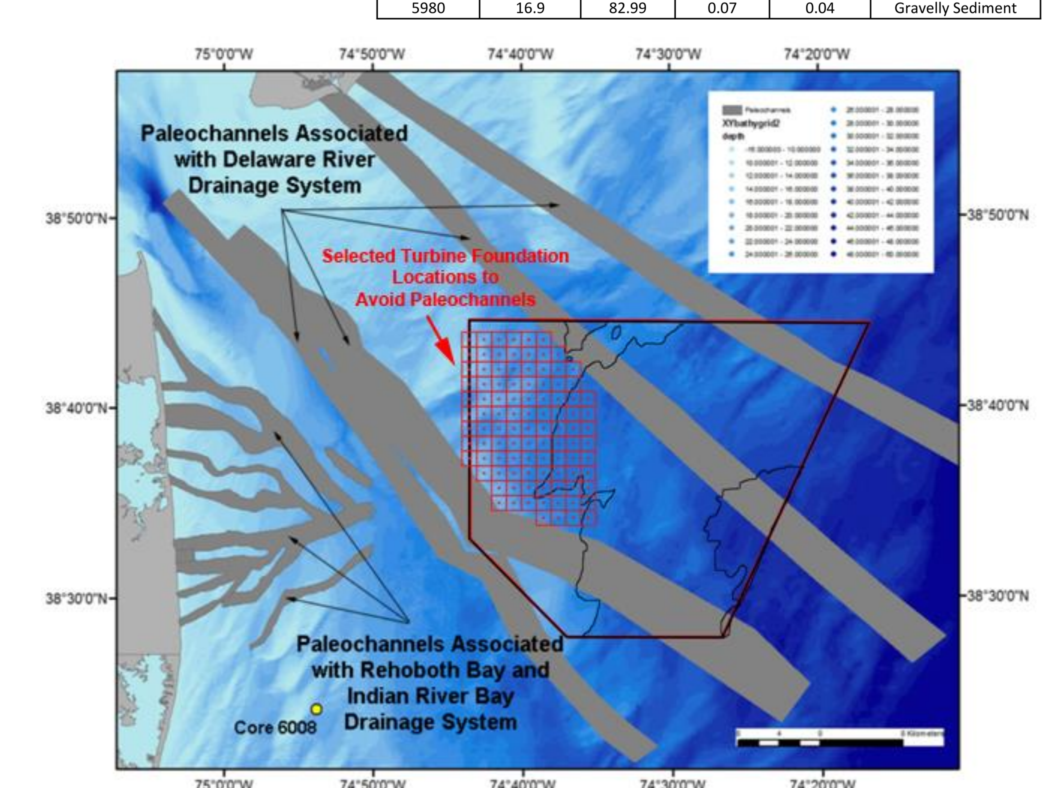
Geotechnical Characteristics: Paleochannel locations, and their associated variable sediment types, can be mapped and their complexity in terms of variable geotechnical properties, can be taken into consideration when selecting, designing, and siting turbine foundations. Avoidance of these paleochannels, and their associated heterogeneous sediments, can result in simpler, more economical designs for foundations.

Shown below is an example use of existing geological and geophysical data to infer geotechnical characteristics (geotechnical data is sorely lacking in the Mid-Atlantic Bight region) and to use this information to site wind turbine foundations in the study area for a system design project that was funded by the US Department of Energy.



Bottom Sediments Sands to Gravelly Sediment

Sample #	% Gravel	% Sand	% Silt	% Clay	Classification
1789	0	100	0	0	Sand
1873	0	100	0	0	Sand
5421	0	98.7	0.83	0.47	Sand
5422	0.72	98.29	0.68	0.31	Sand
5423	1.09	97.96	0.66	0.29	Sand
5424	39.46	59.97	0.48	0.10	Gravelly Sediment
5425	24.88	74.59	0.38	0.15	Gravelly Sediment
5980	16.9	82.99	0.07	0.04	Gravelly Sediment



Conclusions

The geological setting, and its implications for geotechnical characteristics, should be considered with other first-order factors including wind resources, water depths, wave and current conditions, access to onshore grid infrastructure, and ecological and human impacts, in determining optimal sites for offshore wind projects.

The identification of preferential sites based on geotechnical properties requires integration of geological and geophysical data with soil/sediment characteristics. Utilizing these data can result in cost effective design solutions for foundations, cabling installation, and scour prevention. It also can reduce physical uncertainties, and, within a marine spatial mapping framework, be used in developing project risk assessment.

References and Acknowledgements

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6. Data derived from CONMAPSG: Continental Margin Mapping (CONMAP) sediments grainsize distribution for the United States East Coast Continental Margin, United States Geological Survey.

Funding for this project provided by the US Department of Energy and the US National Science Foundation.