Characterization of glacial and interglacial deposits in the German North Sea from the integration of CPT and UHR MCS wind farm data

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The North Sea plays a key role in the development of offshore wind, and especially in the past years it has seen a rapid expansion of such projects. The suitability for the development of wind farms in this area relies on a combination of favorable conditions such as relatively shallow water depths, a strong wind regime and short distances to shore. Nevertheless, various construction challenges need to be taken into consideration. The North Sea was predominantly shaped by extensive glaciations during the Quaternary (Huuse & Lykke-Andersen 2000). A complex geological evolution including repeated ice stream activity, sediment transport and erosion processes, as well as diverse depositional environments interacting with older regional features has resulted in highly heterogeneous conditions in the shallow sub-seafloor. Foundation types for offshore wind turbines and installation depths generally depend on the geotechnical characteristics of the encountered sediments, which are intrinsic to their depositional environment. Thus, geophysical and geotechnical data from windfarm development areas is valuable for a better understanding of the overall geological setting and the expected deposits in these areas, which helps significantly in creating dependable subsurface models. In the German sector of the North Sea, regional high-resolution seismic data has been typically very limited. However, in the last years with the onset of offshore wind expansion, site characterization datasets gathered on behalf of the Federal Maritime and Hydrographic Agency have become available to the public and consequently, high-resolution puzzle pieces have been added to a growing overview of the shallow geology in the area.

Fraunhofer IWES was the geophysical contractor for these datasets and over the last years has been integrating regional geological findings from wind farm areas in the western German North Sea sector. For this contribution three windfarm sites were selected for an integrated analysis of Ultra-High Resolution Multi-Channel Seismic (UHR MCS), Cone Penetration Testing (CPT) and borehole data. The initial geological analysis of these datasets (Ramboll & BSH 2022 a,b,c) was used to identify and compare similar structural features present in the surveyed area as well as the main seismostratigraphic units that can be followed throughout the region. The encountered sedimentary sequence includes Neogene to Early Pleistocene sand deposits, which have been incised by N-S and NW-SE trending tunnel valleys from the Elsterian glaciation. These valleys are often filled with glacial sediments, subsequent fluvial, lacustrine or even marine deposits (Coughlan et al., 2018). Soft Holsteinian interglacial sediments were interpreted to overlay these valleys and have been partially eroded by minor Saalian glacial valley incisions. Lateral variations over short distances among the encountered deposits were identified, and typical geotechnical values for risk-prone units (i.e., fine-grained layers and tunnel valleys) were constrained. It is shown that the data integration of large, surveyed areas together with a regional understanding of the geological history allows a comprehensive interpretation and aids in further predictions about neighbouring areas concerning the geotechnical character of specific deposits.

References

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