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High Resolution Imaging and Quantitative Analysis of HV Cable and Pipeline Trenching in the Marine Environment

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Summary

The life time performance of both HV cables (ORE inter-array and export cables and cross-continental shelf interconnectors) and oil and gas pipelines are limited by the physical properties of the sediment in which the cable/pipeline is buried. In the case of HV cables the burial material and burial depth have implications for heat dissipation from the cable, which in turn plays a primary role in cable rating and its lifetime operation and maintenance. For a pipeline changes in the density and strength of the overburden material can impact on buckling potential once in operation. Our current understanding of the key physical parameters of the sediment (e.g. grain size, porosity, permeability, thermal conductivity, relative density and strength) are based on in situ measurements of the ambient condition and rarely take account of physical property changes during the trenching process. We provide initial acoustic inversion results from high resolution 3D Chirp volumes from both a prototype scale, CPT calibrated, tank experiment and in situ trenched cables in a range of substrates. We shall demonstrate the potential of acoustic inversion to non-destructively quantify trench disturbance in this critical engineering scenarios.

High Resolution Imaging and Quantitative Analysis of HV cable and pipeline trenching in the marine environment: implications for lifetime performance of infrastructure.

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The life time performance of both HV cables (ORE inter-array and export cables and cross-continental shelf interconnectors) and oil and gas pipelines are limited by the physical properties of the sediment in which the cable/pipeline is buried. In the case of HV cables the burial material and burial depth have implications for heat dissipation from the cable, which in turn plays a primary role in cable rating and its lifetime operation and maintenance. For a pipeline changes in the density and strength of the overburden material can impact on buckling potential once in operation. Our current understanding of the key physical parameters of the sediment (e.g. grain size, porosity, permeability, thermal conductivity, relative density and strength) are based on in situ measurements of the ambient condition and rarely take account of physical property changes during the trenching process. We present initial results from the application of acoustic inversion techniques, developed by Vardy, to high resolution 3D Chirp volumes in order to non-destructively assess seabed physical property change in response to trenching.

The paper will present data from both a prototype laboratory experiment undertaken in the ORE Catapult simulated seabed facility in Blyth and volumes acquired from trenched cables on the NW European Shelf. Firstly, 3D volumes were acquired over a cable buried in a highly heterogeneous substrate within the simulated seabed facility. After lowering water levels a total of 16 ROV-cone CPT measurements were taken at different locations within the surveyed area. Results from focused acoustic inversion are compared against the in situ CPT data and demonstrate the ability of the inversion technique to quantify small to medium scale lateral changes in relative density, porosity (void ratio) and cone resistance.

Secondly, volumes have been acquired over both jetted volumes in sands and trenched volumes in clay bedrock. Both qualitative and quantitative changes can be identified in the physical properties within the narrow area of the trench and demonstrate the potential of acoustic inversion of high resolution true 3D volumes to non-destructively capture these changes. Currently, attempts are being made to acquire 4D volumes over these locations to assess the level of temporal changes of the trench-fill properties.