Sounding Out Risk for Offshore Installations

Introduction to PanGeo Technology

- Acoustic Corer

May 2016
OUR MARKETS AND OUR EXPANDING FOOTPRINT

Newfoundland, Canada: Corporate Headquarters. Operation Support, Data Interpretation & Processing, Sales & Marketing

Aberdeen, Scotland: Global Operations & Sales

Doha, Qatar: Sales

GOM

West Africa

Brazil

North Sea

Baltic Sea

Middle East

APAC

Barents Sea

East Coast Canada / North East USA
Pangéo’s 3D Acoustic Technology: Sub-seabed Imaging

- Technology development and service delivery company specializing in 3D acoustic imaging solutions
- Established in 2006: Technology commercialized in 2011 with “Zero LTI” and strong market validation
- Headquartered in St John’s, Newfoundland Canada with an operational base in Aberdeen, Scotland and sales office in Qatar. Industry partners and agents to service GOM, Nigeria and APAC.

*Acoustic Corer*

- Sub-seabed 3D imaging: Acquires acoustic core 12 m in diameter to depth up to 30 m
- Application: Micro Site Investigations to identifying geo-hazards for pile installations both in Oil & Gas / Renewables Energy

Mitigating risk for offshore installations and creating value for seabed survey activities
PROBLEMS WITH COMPLEX SEABEDS: LEAD TO UNCERTAINTY

Buried Boulders: Installation challenges

Cavities/Voids: Grout loss

Buried Spudcan Footprints: Rig Move Risk

Thinning Beds Over Weak Soils: Punch throughs

Variable Geotechnical Properties: Foundation Design Uncertainty
THE CONSEQUENCE OF UNCERTAINTY

- At best...... uncertainties in seabed conditions lead to cost overruns and schedule delays

- At worst..... damage to or loss of infrastructure

... survey data inadequate in predicting foundation installation conditions
INDUSTRY PULL TO ENHANCE SITE INVESTIGATION ➤ ACOUSTIC CORER

Seabed Mapping (Continuous Seismic)

Conventional Sub-bottom Profiling Lacks Resolution

Mitigates risks by providing high-resolution image of sub-seabed layers and geohazards in a large volume acoustic core

Geo Hazard Surveying (Acoustic Corer)

Complements Boreholes & CPTs

Soil Mechanics (Boreholes & CPT’s)

Technology Gap

Installation

Wide lateral area acoustic core

Conventional Sampling Lacks Coverage

Conventional Sub-bottom Profiling Lacks Resolution

Soil Mechanics (Boreholes & CPT’s)
UNIQUE FUSION OF DATA DESCRIBES A COMPLEX SEABED

- Imaging Geohazards
  - Cavities/Voids
  - Boulders (20cm)
  - Gassy soils
  - Unexploded ordnance (UXO)

- Delineating subsea stratigraphy
  - Bedrock (chalk)
  - Discontinuous permafrost
  - Gravel/cobble layers
  - Dipping Slippage Planes/Beds

...this characterizes the true sediment variability through a volume
The Acoustic Platform: Stationary Data Acquisition

High and low frequency chirp sonar projectors, parametric source and hydrophone arrays
FIRST LOOK™ 3D QC VISUALIZATION

Relative Acoustic Intensity

0 dB
10 dB
20 dB
30 dB

PanGeo Subsea Inc. Coreview 3D - StatoilHydro Site 1 Scan 2
• Acquisition and processing of multiple data sets are needed to validate final results and to maximize confidence during data interpretation.

• High-resolution, high-density, multi-aspect data acquisition (SAS), up to 20,000 data points to confirm true target signals from noise related inclusions.

• Data is also collected at varying offset along two orthogonal lines (JYG-Cross) with a total of 5,800 traces to form the folds
GEOHAZARD IMAGING: BOULDERS
High Frequency Chirp

Profile View

Parametric Sonar

Plan View

Gas

Z = 6.20 m dbsf
ENHANCING THE SUB-SEABED SOIL PROFILE: AC VS BOREHOLE

ACOUSTIC CORE

- Silt
- Sand
- Sand/Clay transition
- Clay
- Acoustic anomaly
- Clay
- Erosion boundary
- Clay
- Acoustic anomaly
- Bedrock

BOREHOLE

- Alternating layers of upward fining sand and sand/silt
- Borehole BH-S1

AC01-S1 Interpretation

S1

Sub-Bottom Profile Data

- 541.25 ms
- 547.50 ms

Northing (m)

Depth Below Seafloor (m)

- 0.0 m
- -5.0 m
- -10.0 m
- -15.0 m
- -20.0 m
- -25.0 m

AC01-S1

14 m

BH-S1

40 m

0.1 m

500 m
Two adjacent cone penetrometer test (CPT) profiles produced different cone resistance results.

CPT 1 hits hard gravel layer at 11m and terminates

CPT 2 bypasses gravel bed
FINALLY - SIMPLIFYING INFORMATION INTO ANOMALY MAPS

Plan View of Anomalies

AC Cross-Section: Thinning Clay Layer

<table>
<thead>
<tr>
<th>Site</th>
<th>Anomaly ID</th>
<th>Easting (m)</th>
<th>Northing (m)</th>
<th>Depth Below Seafloor (m)</th>
<th>Equivalent Diameter Re: -3dB</th>
<th>Shape</th>
<th>Confidence Ranking (H/M/L)</th>
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<td>Irregular shaped void</td>
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AC Case Study: Mitigating Risk for Pile Refusal

- 5 Offshore Wind Turbines mounted on 4 legged platform
- Challenge: Complex Soil - Boulder Clay with variable geotechnical properties
- Scope of Work
  - Desk top study of existing geophysical and geotechnical data
  - Phase 1: One AC at each of the five platform locations
  - Statistical analysis of initial 5 AC results to assess risk of boulders and access value of expanding scope
  - Phase 2: Scope expansion to an Acoustic Core at each pile location: total of 20 AC’s
  - Statistical analysis of combined scope to support micro-siting of pile installation
GEOHAZARDS IMAGING AC 3D DATA SET - ON VESSEL

PROVILE VIEW

Stratigraphy
Dense Moraine at 6m & 10m

PLAN VIEW

Boulders
Boulder Clusters
Anomaly at depth of 16.8 m was within 1 meters of planned pile location: unacceptable risk - pile location adjusted
# AC Commercial Track Record: Europe, North America, ME

![Image of AC Commercial's track record map highlighting their projects across Europe and North America.](image)

## AC Commercial Track Record Table

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<thead>
<tr>
<th>Client</th>
<th>Project</th>
<th>Location</th>
<th>Water Depth (M)</th>
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<td>'14 ADMA</td>
<td>TAP Extension Project Installation</td>
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ACOUSTIC CORER™ - VALUE PROPOSITION

- Reduce risk by sampling full site volume
- Resolves conflict between physical cores and CPTs in complex seabeds.
- Reduces the number of physical cores required
- Mitigates against cost overruns and schedule delays
- Improved survey data reduces overall project risk

*High quality soil characterization, reducing subsea project risks and associated costs from pile refusals, slippages and punch-throughs*
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