Offshore Geohazard Site Investigation
Upstream Oil and Gas Perspective
(Nigerian Oilfield Case Study)
What are Offshore Geohazards?

Introduction

Methods

Results & Interpretation

Conclusion
Why is Offshore Geohazard Site Investigation Required?

Required to obtain detailed seabed and sub-seabed information of any area where offshore activities are to take place.
Why is Offshore Geohazard Site Investigation Required?

Introduction

Methods

Results & Interpretation

Conclusion
Why is Offshore Geohazard Site Investigation Required?

Introduction

Methods

Results & Interpretation

Conclusion
How is the Investigation Conducted?

Combines the science of HYDROGRAPHY, GEOPHYSICS and GEOTECHNICS
How is the Investigation Conducted?

Methods

As the ship passes over a survey area, fan-shaped sonar beams four times as wide at the depth of the water scan the seabed. It takes many passes to produce a continuous set of images.
Key Tools and Equipment

**Investigation Crew**
- Surveyors
- Engineers
- Geophysicists
- Geologists

**Specialized Geohazard Vessel**

[Image of a specialized geohazard vessel with various equipment and labels such as DGPS, SSS, SBP, MAGGY, and MBES.]
Key Tools and Equipment

Differential Global Positioning System (DGPS)
Key Tools and Equipment

Bathymetry (Single Beam & Multi beam Echo sounders)

- Transmitted and returned acoustic pulse
- Measured depth is function of:
  - pulse travel time (t)
  - pulse velocity in water (v)

\[ D = \frac{1}{2} \times v \times t \]
Key Tools and Equipment

Bathymetry (Multi beam Echo sounder)

Uneven Seafloor Topography
**Key Tools and Equipment**

**Seabed Features (Sidescan Sonar Record)**

- **Barge Wreck**
- **Sonar Tow line**
- **Barge Wreck**
Key Tools and Equipment

Seabed Features (Sidescan Sonar Movie)
Key Tools and Equipment

Seabed Features (Marine Magnetometer)
Key Tools and Equipment

Shallow Geology (Sub-bottom Profiler)
Key Tools and Equipment

Two-Dimensional 2D Seismic (Streamer & Seismic Gun Source)
Key Tools and Equipment

Introduction
Methods
Results & Interpretation
Conclusion

Two-Dimensional 2D Seismic (Streamer & Seismic Gun Source)
Key Tools and Equipment

Two-Dimensional 2D Seismic (Streamer & Seismic Gun Source)
Key Tools and Equipment

Geotechnical Investigations (Grab Samplers, Piston Corers)

Introduction  Methods  Results & Interpretation  Conclusion
Equipment Interfacing & Integration

Mobilised Geohazard Vessel
Navigation Screen

Online Geohazard Survey

Introduction  Methods  Results & Interpretation  Conclusion
Online Geohazard Survey
Geohazard Site Investigation Methods

3km by 3km Survey Grid

Gulf of Guinea

Niger-Delta Sedimentary Basin In Nigeria

Purpose
Floating Production Storage and Offloading (FPSO) Tanker And Drilling Activities

Introduction  Methods  Results & Interpretation  Conclusion
Bathymetric Overview of Study Area (Single Beam)

Results & Interpretation
Bathymetric Relief of Study Area (Multi Beam)

- 30 m
- 31 m
- 32 m

Wreck

Introduction          Methods          Results & Interpretation          Conclusion
Seismic Profile of the Study Area

Introduction

Methods

Results & Interpretation

Conclusion
### Stratigraphic Summary from 2D Seismic Survey

<table>
<thead>
<tr>
<th>Below Mud Level BML (m)</th>
<th>Seismic Character</th>
<th>Lithology</th>
<th>Seismic Anomalies</th>
<th>Shallow Gas Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-37</td>
<td>Low-amplitude seismic character.</td>
<td>Mostly sandy silt and clay-rich</td>
<td>Few</td>
<td>Low</td>
</tr>
<tr>
<td>38-400</td>
<td>Generally low- to moderate amplitude</td>
<td>Clays and silts with thin sand seams.</td>
<td>Scattered amplitude anomalies and moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>401-907</td>
<td>Low-to moderate-amplitude sequence of incoherent reflections.</td>
<td>Generally clays and silts with thin sand seams.</td>
<td>Anomalies in this Unit are moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
## Summary of Geotechnical and Laboratory Test on Core Samples

<table>
<thead>
<tr>
<th>CS NO</th>
<th>Depth (m)</th>
<th>Natural m.c. (%)</th>
<th>Bulk Density Mg/m³</th>
<th>Dry Density Mg/m³</th>
<th>Specific Gravity</th>
<th>Undrained Cohesion kN/m²</th>
<th>Angle of Friction (°)</th>
<th>Pressure Range kN/m²</th>
<th>Coefficient of Compressibility (mₐ) m²/MN</th>
<th>Coefficient of Consolidation (cᵥ) m²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.07</td>
<td>53</td>
<td>1.68</td>
<td>1.06</td>
<td>2.58</td>
<td>7</td>
<td>3</td>
<td>25 - 50</td>
<td>0.685</td>
<td>5.177</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 - 100</td>
<td>0.318</td>
<td>3.451</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 - 200</td>
<td>0.318</td>
<td>1.035</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 - 400</td>
<td>0.318</td>
<td>0.690</td>
</tr>
<tr>
<td>2</td>
<td>2.85</td>
<td>66</td>
<td>1.49</td>
<td>0.88</td>
<td>2.50</td>
<td>13</td>
<td>3</td>
<td>25 - 50</td>
<td>0.824</td>
<td>0.287</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 - 100</td>
<td>1.292</td>
<td>0.188</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 - 200</td>
<td>0.583</td>
<td>0.138</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 - 400</td>
<td>0.472</td>
<td>0.259</td>
</tr>
<tr>
<td>3</td>
<td>1.86</td>
<td>37</td>
<td>1.76</td>
<td>1.24</td>
<td>2.53</td>
<td>10</td>
<td>2</td>
<td>25 - 50</td>
<td>1.874</td>
<td>1.218</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 - 100</td>
<td>0.515</td>
<td>0.595</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 - 200</td>
<td>0.351</td>
<td>0.599</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 - 400</td>
<td>0.196</td>
<td>0.424</td>
</tr>
<tr>
<td>4</td>
<td>1.96</td>
<td>70</td>
<td>1.47</td>
<td>0.84</td>
<td>2.48</td>
<td>10</td>
<td>2</td>
<td>25 - 50</td>
<td>1.040</td>
<td>0.188</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 - 100</td>
<td>1.465</td>
<td>0.288</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 - 200</td>
<td>0.542</td>
<td>0.266</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 - 400</td>
<td>0.204</td>
<td>0.471</td>
</tr>
<tr>
<td>5</td>
<td>2.01</td>
<td>31</td>
<td>1.82</td>
<td>1.35</td>
<td>2.52</td>
<td>12</td>
<td>3</td>
<td>25 - 50</td>
<td>0.418</td>
<td>8.284</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 - 100</td>
<td>0.488</td>
<td>0.631</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 - 200</td>
<td>0.232</td>
<td>0.345</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 - 400</td>
<td>0.220</td>
<td>0.230</td>
</tr>
</tbody>
</table>
1. Same parts of the study area are considered to be gas charged therefore any drilling activity must be avoided in these areas. The North-West and the Southern parts of the study area.

2. There is no potential risks to placing the Floating Production Storage and Offloading (FPSO) at the study area

3. The study area clear from any form of debris or obstructions.
Geohazard Site Investigation is critical to all offshore oil and gas activities and has to be conducted prior to field operations to avoid accidents.