OCCURRENCE OF GAS CHARGED SEDIMENTS AND POCK MARKS IN "SEMOB" FIELDS OFFSHORE WESTERN NIGER DELTA: IMPLICATIONS FOR OFFSHORE OPERATIONS.

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ABSTRACT

The safe delivery of operations in offshore province is dependent on the availability high fidelity information of the geological state of the sea floor. Sediments and sedimentary processes determine the sea bed composition and bathymetry. The study was done in the inner shelf environment of Gulf of Guinea, in Niger Delta. The acoustic equipment used are sided scan sonar and sub-bottom profiler and they work with geophysical principles of sea floor sediments acoustic reflectivity and refraction. The acquisition, processing and interpretation of data reveal the existence of gas charged sediments between the sea bed and the lithified layer(strong seismostratigraphic layer) and the existence of genetically related depressions with surrounding rings of sand called pock marks which vary between 3m-10m in diameter on the sea floor. The gas charged sediments thickness ranges from 20m-25m. The areas of the 'Semob' fields that have gas charged sediments and pock marks, are liable to endanger the installation and safety of subsea facilities, offshore operations and sea going vessels. Therefore, are geohazards areas and should be avoided.

Keywords: Gas charged sediments, pockmarks, sea floor, lithology, geohazards.

INTRODUCTION

The sediments and sedimentary processes of the sea floor is a high-fidelity information tool critical to oil field development in the offshore province. This is to obviate problems related to instability and drifting of drilling rigs, collapse of offshore subsea facilities including production platforms and grounding of operations vessels. This study is a Sedimentological and acoustic investigation of the inner shelf environment of Western Niger Delta offshore-Gulf of Guinea(Babangida,2015).Generally, analyses of the occurrence and distribution of gas charged sediments show fluid venting areas as potential sites for pockmarks occurrence (Tesmi, 2008). In 'Semob' fields, there is heavy existence of oil and gas. Gas which is more mobile tends to sort for routes of escape through the sediments thereby exciting the sediments. Whenever there is weakness in the overlaying sediments at the surface, it appears as marks on the sea bed which are called pockmarks. Hydrocarbon seepages are of great significance to explorations because they are often direct indicators of the existence of petroleum systems (Chuku and Ibe, 2015, , Tesmi,2008 and Lonck, 2004).The relationship between seabed morphology with shallow gas venting features are well known from Mid Norway, Nile deep-sea fan, Costa Rica(Emery,1976).Therefore, we made an attempt to analyze the seabed morphology, shallow subsurface structures and shallow deposits in 'Semob' fields using high resolution side scan sonar, sub-bottom profiler (SBP) and single beam swath bathymetry data.

AIM AND OBJECTIVES

The aim of this research is to identify geohazards(gas charged sediments and pock marks) of the seafloor in Semob field and their implications for offshore installation and safety in the western Niger Delta.
The objectives include:

1. To Determine sea bed sediments
2. Determine shallow subsurface profile
3. To Identify the existing sea floor features
4. To determine the possible geohazards of the sea floor in the fields.

STUDY AREA/LOCATION

The study area is about 10.2 square kilometres. It is situated 10meters to 12kilometers off the coast line from the south western end of Benin River in western Niger Delta.

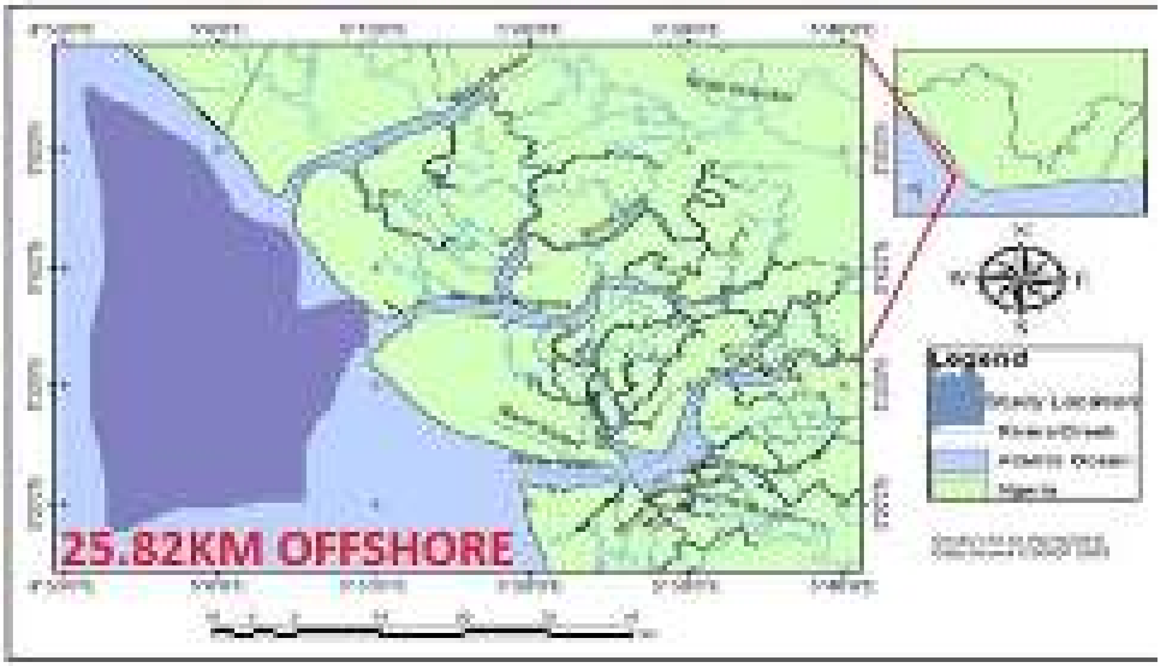

Figure 1: Location Map of the Study Location 15km offshore Western Niger Delta.(Modified after Chuku and Ibe, 2015).

GEOLOGICAL SETTING OF THE STUDY BASIN

The Niger Delta is situated in Gulf of Guinea on the West central Africa coast and occupies the southern part of Nigeria between latitudes 4^{0}00'N and 6^{0}00'N and longitudes 3^{0}00'E and 9^{0}00'E(Ibe et al.,1989). It is bounded in the south by the Gulf of Guinea and in the North by older (Cretaceous) tectonic elements which include the Anambra Basin, Abakiliki uplift and the Afikpo syncline. To the East and West respectively, the Niger Delta is bounded by the Cameroon volcanic line and Dahomey Basin. The study area is a pockmark field as well as gas charged sediments located within the Gulf of Guinea on the continental margin offshore Nigeria. This continental margin is undergoing slow deformation by gravity tectonism that initiated in response to both, rapid seaward progradation and loading huge amount of sediment (Damuth, 1994).

MATERIALS AND METHODS

The data acquisition, processing, interpretation and charting help the understanding of the geological state of the sea floor (Figs 2 & 3).Side scan sonar, subbottom profiler and echo sounder track lines (24) and sea bed samples were collected in the study area in cruises. Approximately 27 linear kilometres of side scan sonar and echo sunder data were surveyed using Geo acoustics SSS 941 Tow fish and EA 400 single beam hydrographic echo sounder.The accurate positioning of the side-scan sonar, subbottom profiler and echo sounder track lines were accomplished by means of a Kongsberg sea path 330 receivers (DGPS).The backscatter of the surface sediments (side scan sonar) enabled the distinction of the sea floor pockmarks (Rao, 2001). Water depths measured form echo sounders were used to determine the bathymetric classification and location of the study area within the inner shelf environment of the Niger Delta. Bed forms captured from the sea bed scan were matched with the topographical features to deduce the processes shaping the sea floor environment of the study area. The sub bottom profiler enabled the determination of the gas charged sediments.

SEAFLOOR TARGET MEASUREMENT

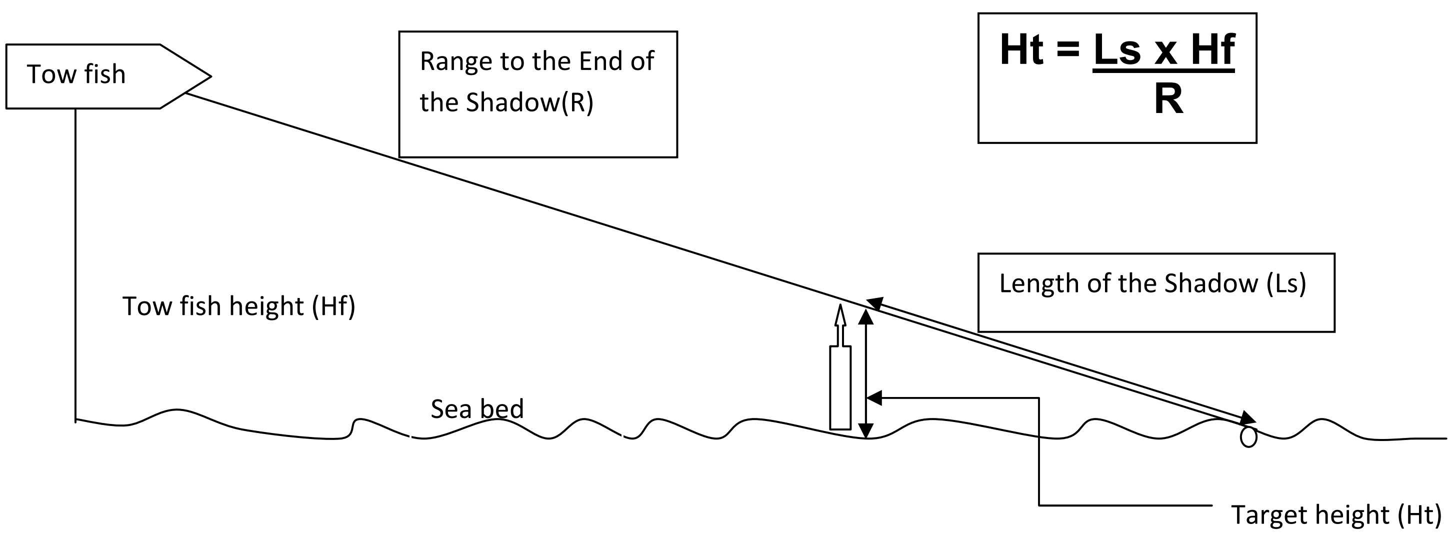

Figure 2: Target height measurements above sea bed (Adapted from Chuku and Ibe, 2015).

Figure 3: Methodology Work flow chart.

See Appendix A: Pictorial methodology and Appendix B: Materials

RESULTS AND INTERPRETATION

SUB BOTTOM PROFILE DATA OF GAS CHARGED SEDIMENTS

The seismic record of the survey area suggests the presence of the lithified sediments (strong seismostratigraphic layer) at approximately 20.0m to 25.0m below the sea bed. The gas charged sediments are found between the sea floor and the lithified layer. The gas charged sediments thickness ranges between 15m-20m. Between the sea bed and lithified sediment is the sediments as shown in the figures: 4, 5, 6 & 7 below:

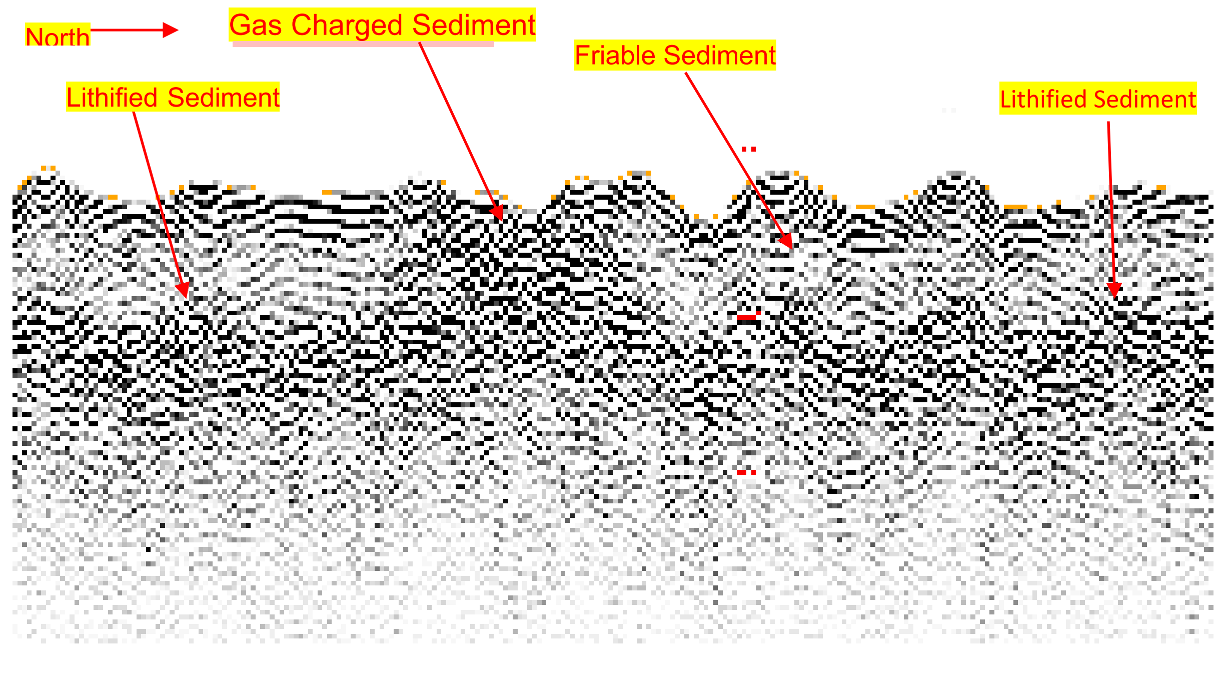

Figure 4: Sub bottom profiler Data extract indicating Gas charged sediments.

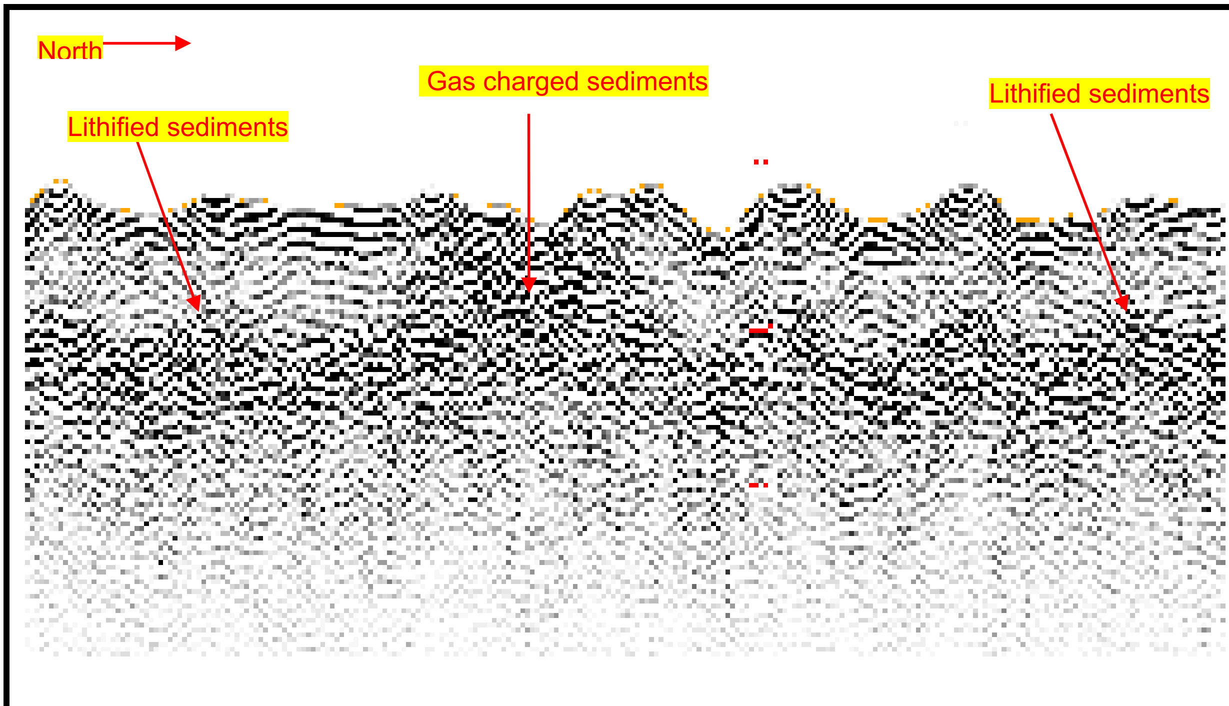

Figure 5: Sub bottom profiler Data extract indicating occurrence of gas

charged zone below seabed.

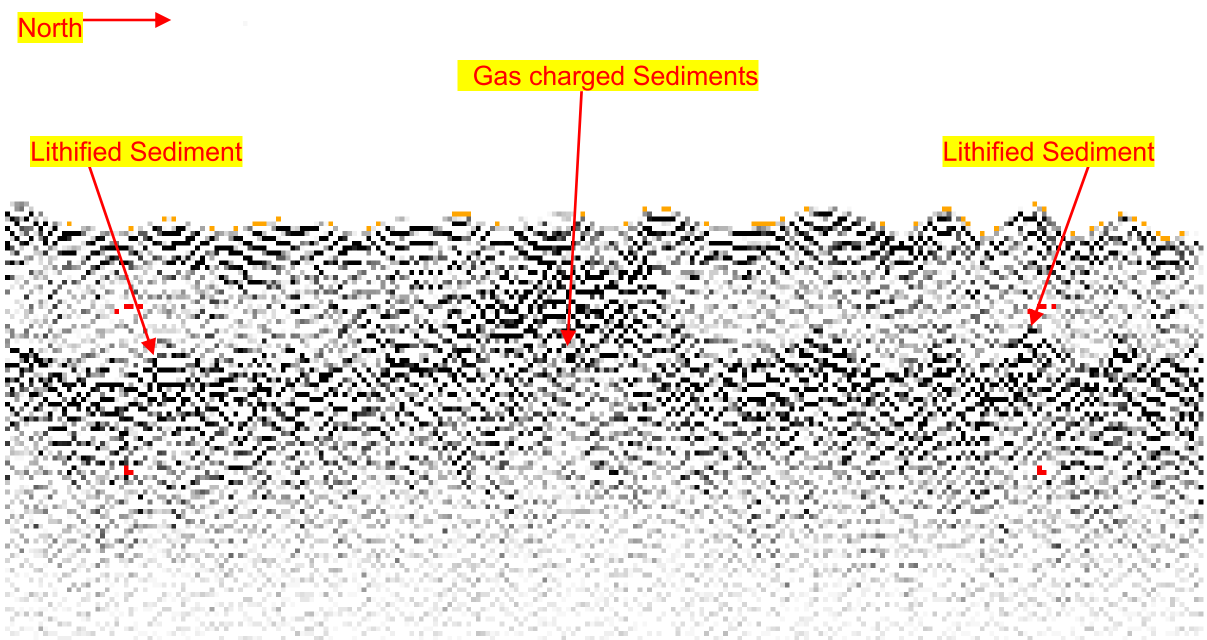

Figure 6: Sub bottom profiler Data extract indicating occurrence of gas charged zone below sea floor.

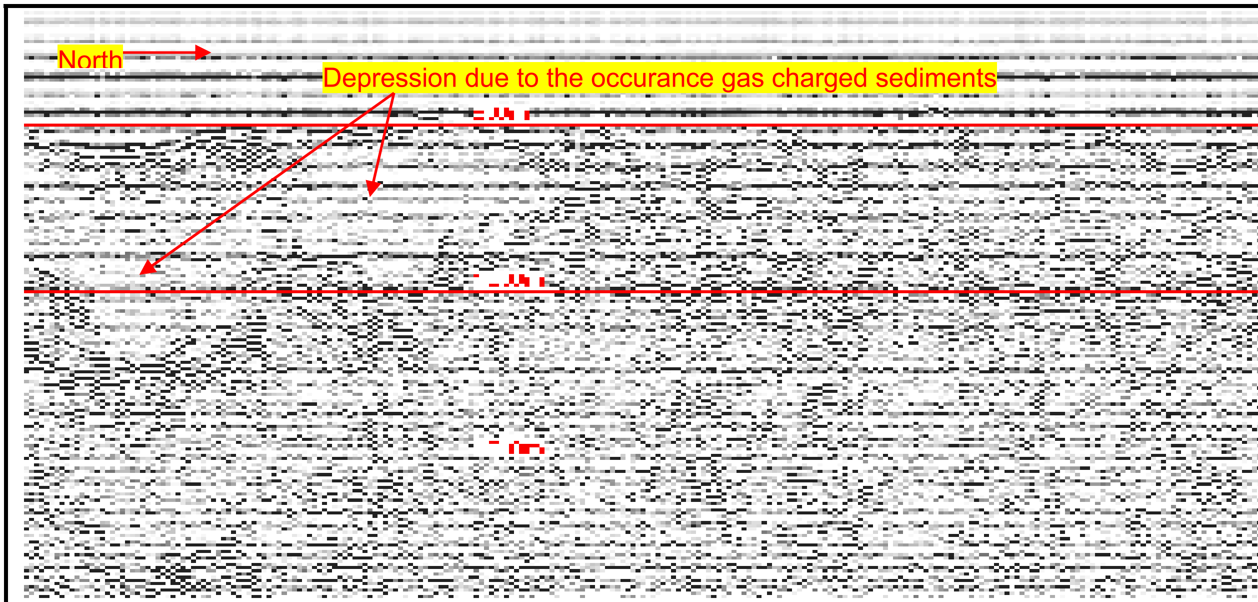

Figure 7: Sub bottom profiler Data extract indicating sea floor depression due to the presence of the gas charged sediment below the sea bed.

Generally, analyses of the occurrence and distribution of gas charged sediments show a precursor to the occurrence of pock marks(Anderson et al.,2008). These are chimneys for fluid venting in the field and are isolated in offshore operations.

POCKMARKS

Many Pockmarks of varying diameters were observed in the study area. The pockmarks pose threats to the mechanical integrity of the subsea facilities and offshore operations, since they are actually shallow gas vents. The table below provides the position details of these pockmarks: Also, the figures 8-14 below show the pock marks on the sea bed:

Table 1: Details of the Pockmarks within the Study area.

Sl. No.	Position of the Pockmark		Diameter (m)
	Easting (m)	Northing (m)	
1	95638.8	173024.1	0.9
2	94842.5	172363.2	5.2
3	94343.9	172034	4.8
4	94283.9	171964.8	7.8
5	94273	171960	3.2
6	93928.3	171700	3.2
7	93376.9	171346.1	5.4

8	92992.8	170931.2	7.0
9	92986.2	170903.6	5.6
10	92986.1	170934.5	4.2
11	92984	170921.7	3.8

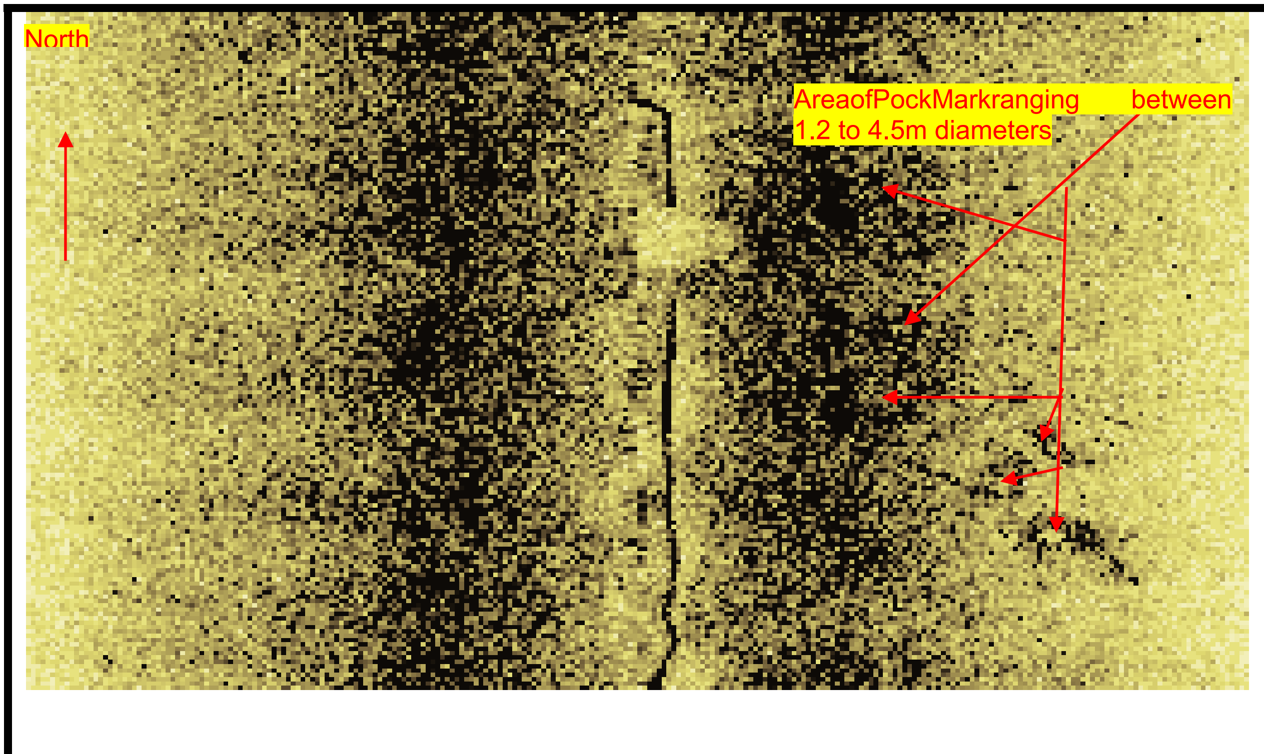

Figure 8: SSS Data extract showing Area of Pockmarks in the field.

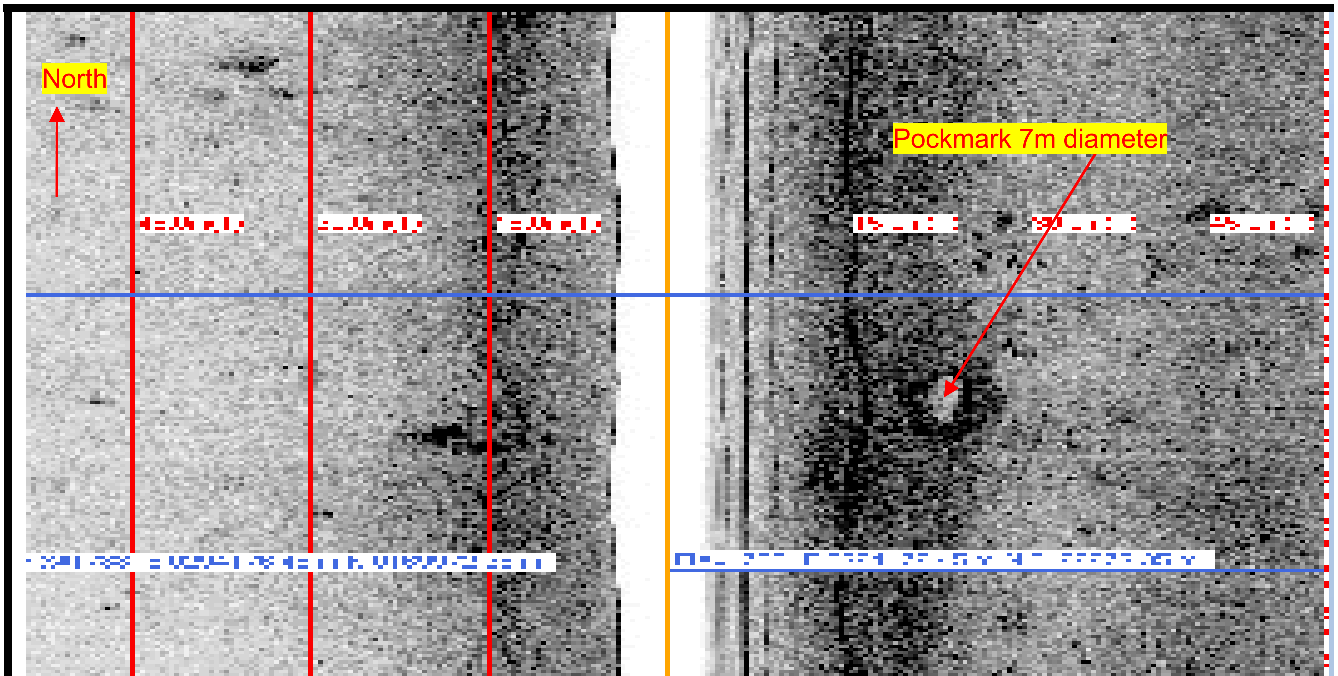

Figure 9: Side scan sonar Data extract showing Pockmarks on seafloor of the field.

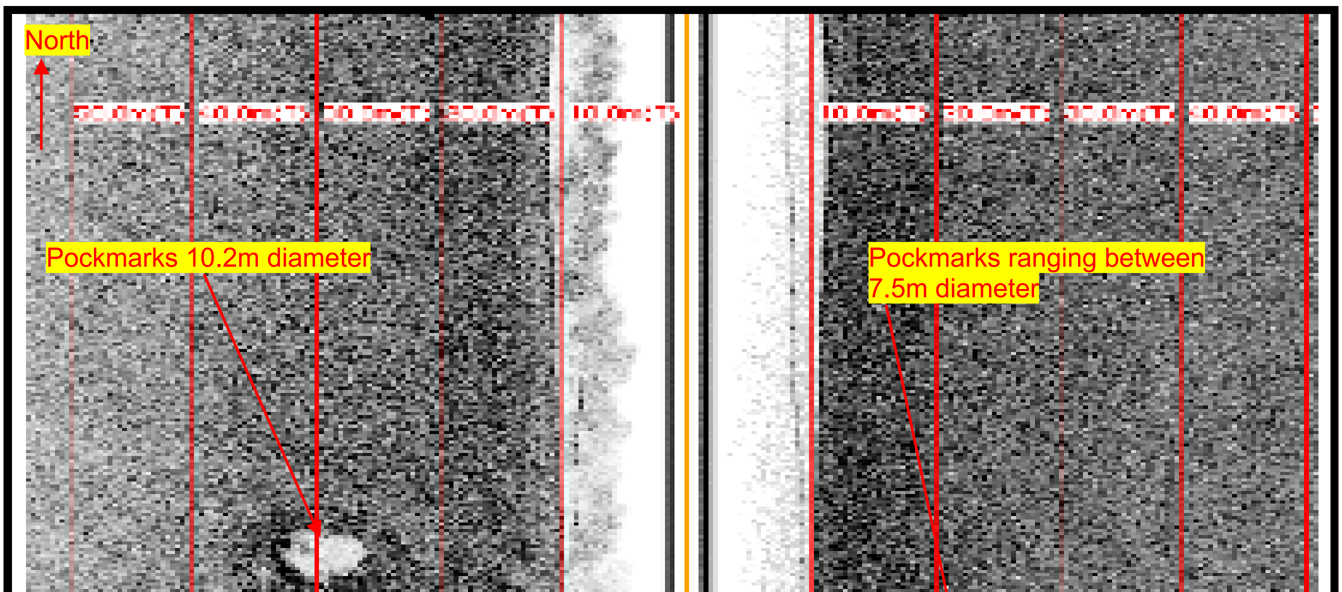

Figure 10: Side scan sonar Data extract showing Pockmarks on

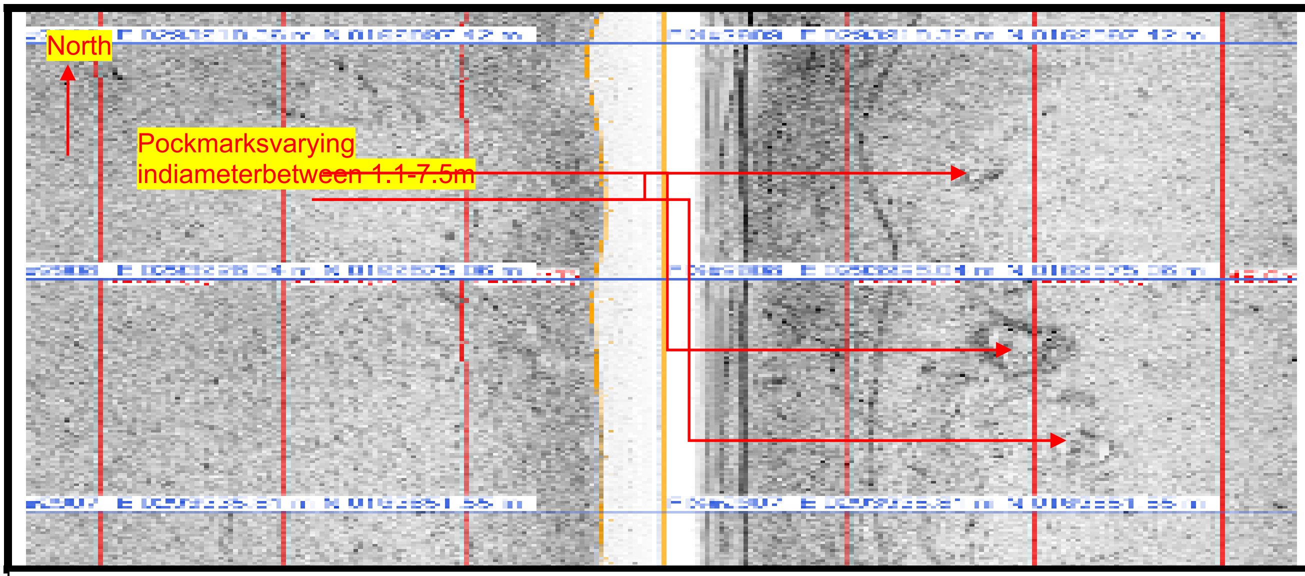

Figure 11: Side scan sonar Data extract showing Pockmarks on seafloor of study area study area.

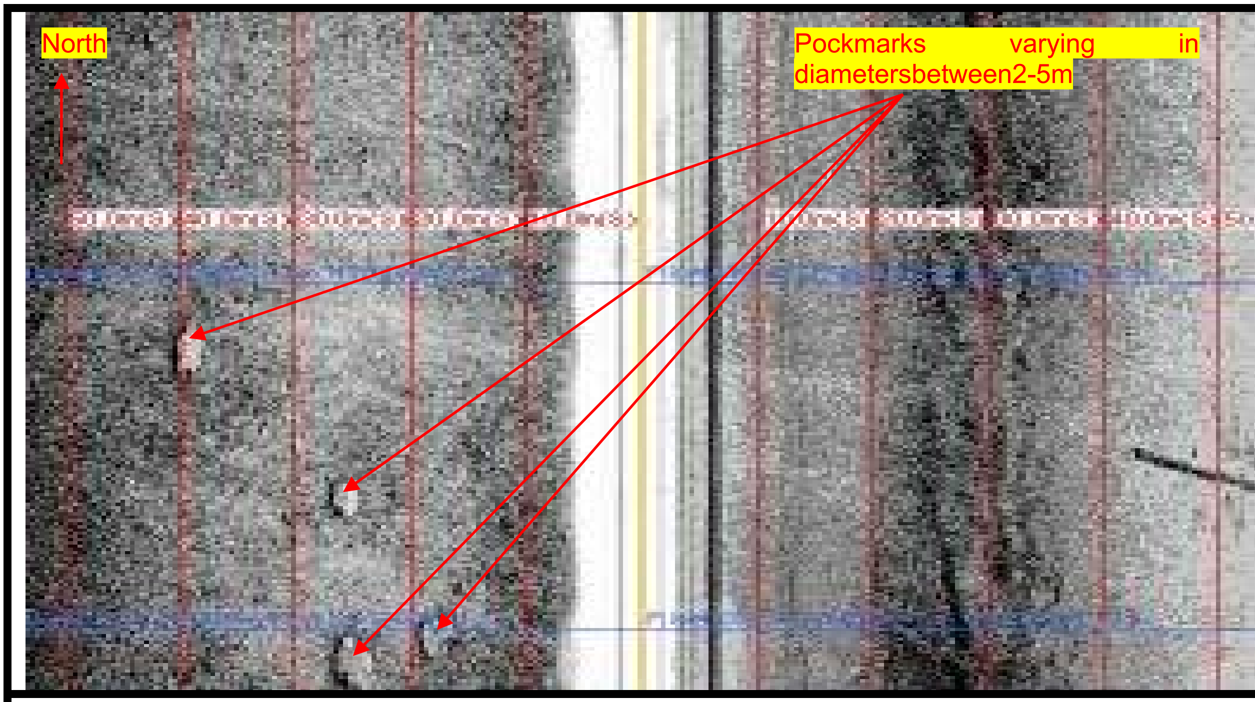

Figure 12: Side scan sonar Data extract showing Pockmarks on seafloor of 'Semob' field

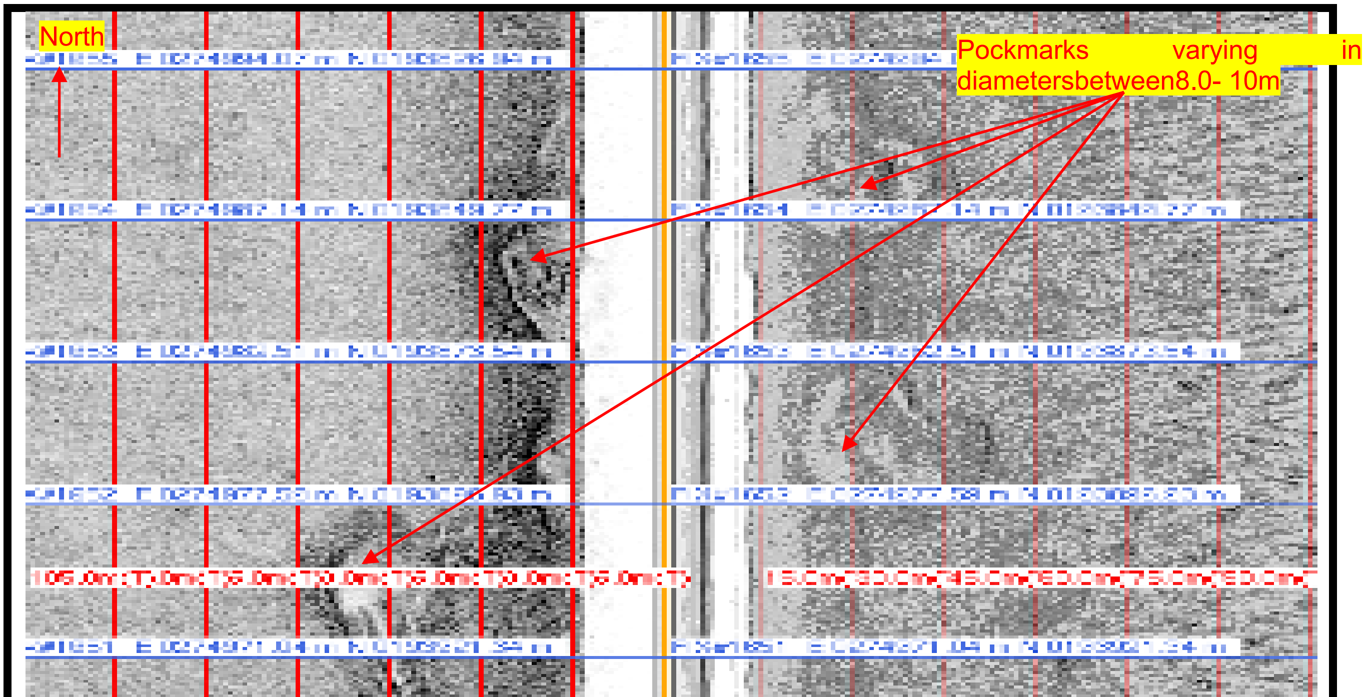

Figure 13: Side scan sonar Data extract showing Pockmarks on

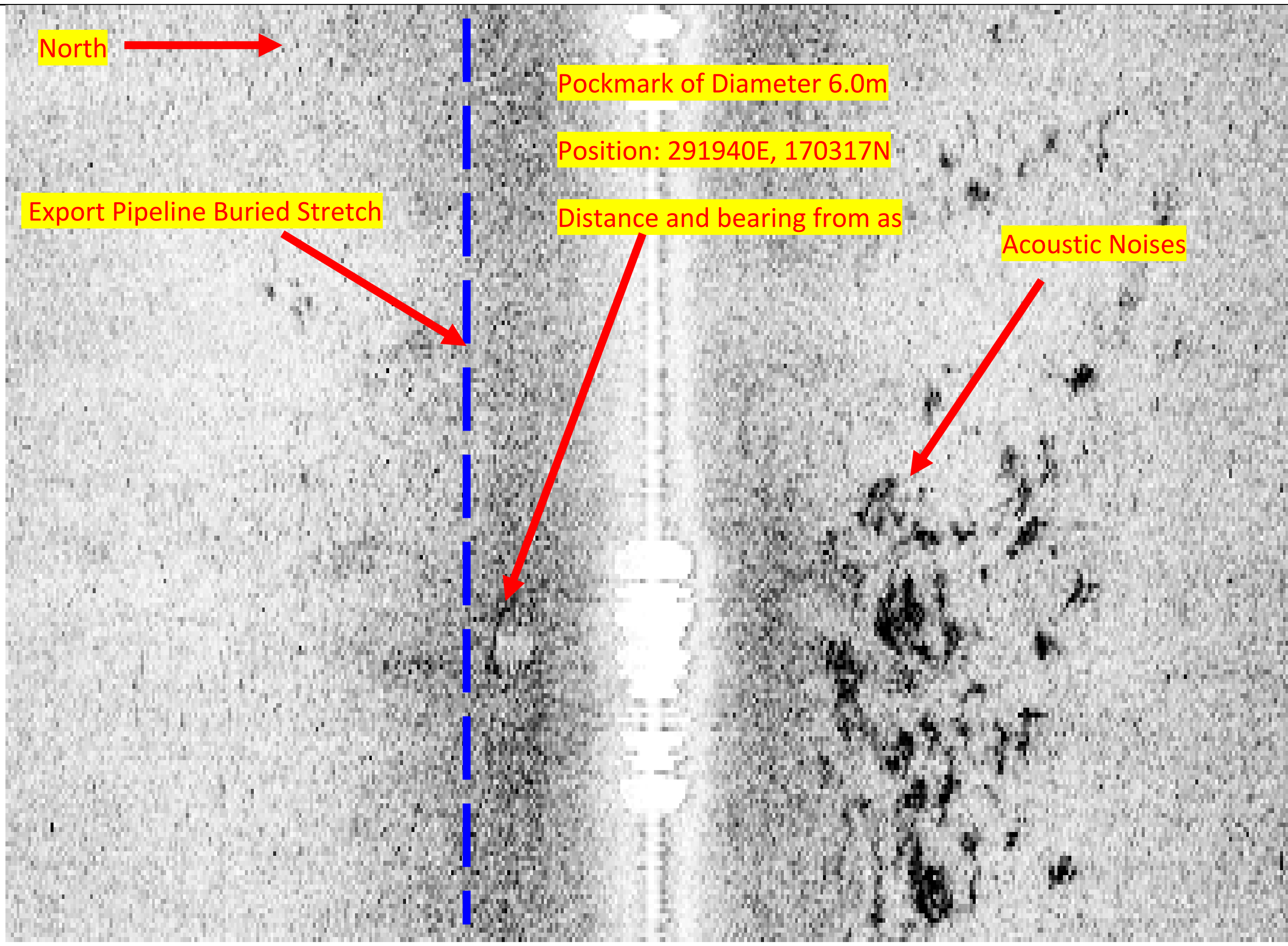

Figure 14: Side scan sonar Data Extract showing Scar marks and Pockmarks in the Field.

CONCLUSION

The prominent seismo- stratigraphic interface refers to the lithified sedimentary sequence within the study area was found 20m below the sea bed. Gas charged sediments about 10m-15m thick occurred between the seabed and the lithified layer. The sea floor scan also shows existence of genetically related depressions and surrounding rings of sand called pock marks which vary between 0.5m-9m in diameter. The areas of the 'semob' fields that have gas charged sediments and pock marks are liable to endanger the installation and safety of subsea facilities. Therefore should be avoided.

RECOMMENDATION

Avoid areas with pock marks/ gas vents within the study area due to great potential for the collapse of subsea facilities, if situated on them.

Areas of shallow gas sediments should be considered during offshore operations since these areas could be unstable during the operations.

Seafloor sedimentary processes study should be carried out at least in every six (6) months, to ascertain the integrity of the subsea installation.

Ethical approval and consent are not applicable

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APPENDIX A

APPENDIX B

MATERIALS