OCCURRENCE OF GAS CHARGED SEDIMENTS AND POCK MARKS IN "EMOBS" FIELDS OFFSHORE WESTERN NIGER DELTA: IMPLICATIONS ON SUBSEA FACILITIES

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ABSTRACT

Increased, oil and gas exploration and exploitation activities in the Niger Delta region of Nigeria have led to a detailed investigation of sedimentary processes of the sea floor in 'emobs' fields for the installation and safety of subsea facilities. The acquisition, processing and interpretation of high resolution Side scan sonar and subbottom profiler data reveals the existence of gas charged sediments and the existence of genetically related depressions and surrounding rings of sand called pock marks which vary between 3m-10m in diameter on the sea floor. The gas charged sediments occur between the seafloor and strong seismostratigraphic layer (lithified layer).The gas charged sediments thickness ranges from 20m-25m between the seabed and lithified layer. The areas of the 'emobs' fields that have gas charged sediments and pock marks, are liable to endanger the installation and safety of subsea facilities especially. 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 investigations of the inner shelf environment of Western Niger Delta offshore (Gulf of Guinea). Generally, analyses of the occurrence and distribution of gas charged sediments show fluid venting areas as potential sites for pockmarks occurrence. In 'emobs' fields, there is heavy existence of oil and gas. Gas which is more mobile tend to sort for routes of escape through the sediments thereby exciting the sediments. Whenever there is weakness on 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 explorationists because they are often direct indicators of the existence of petroleum systems (Chuku,et al. 2015).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 'emobs' 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 emobs field and their implications on subsea facilities installation and safety in the western Niger Delta Nigeria.
The objectives include:

1. To Determine sea bed bathymetry
2. Determine shallow subsurface profile
3. To Identify the existing sea floor features and subsea facilities
4. To determine the commom and peculiar sedimentary processes in the fields.

STUDY AREA/LOCATION

Figure 1: **Location Map of the Study Location 15km offshore Western Niger Delta Nigeria (Modified after Chuku et. al, 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 4⁰00'N and 6⁰00'N and longitudes 3⁰00'E and 9⁰00'E. 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

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 kilometers 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 receiver(DGPS).The backscatter of the surface sediments (side scan sonar) enabled the distinction of the sea floor pockmarks. 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.

SEAFLOOR TARGET MEASUREMENT

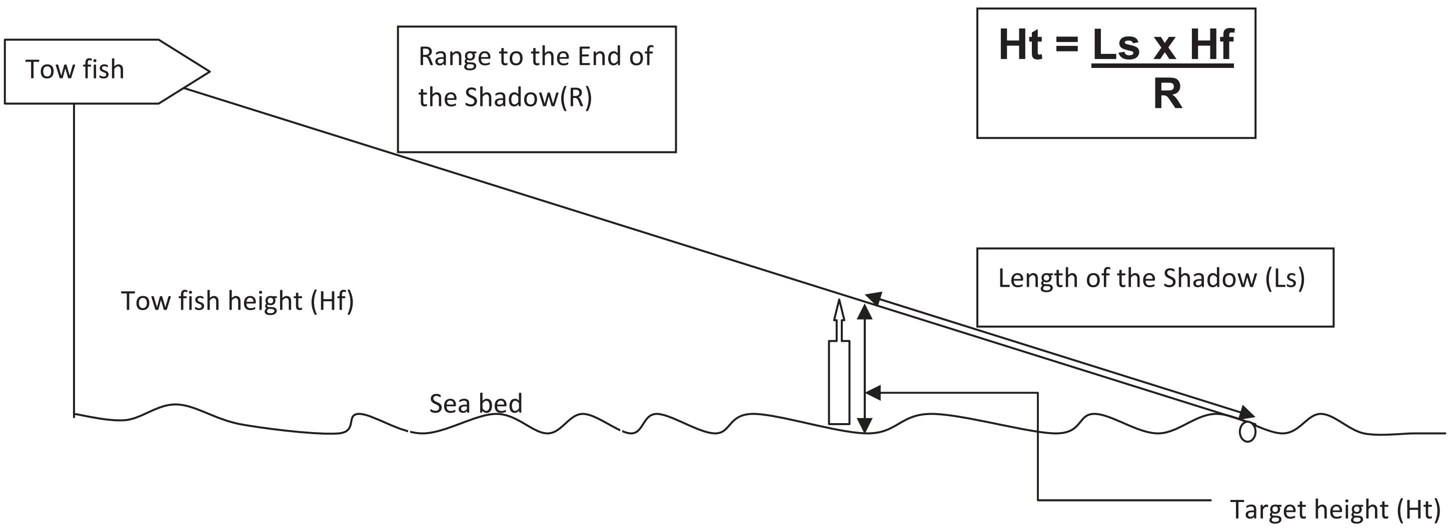

Figure 2: Target height measurements above sea bed (adapted from Chuku et. al, 2015).

Figure 3: Methodology Work flow chart

See appendix:

RESULTS AND INTERPRETATION

SUB BOTTOM PROFILE DATA

The seismic record of the survey area suggests the presence of the lithified sediments at approximately 20.0m to 25.0m below the sea bed. The prominent seismic stratigraphic interface that separates the lithified sediments from the overlying sea bed sediments was found to shoal towards north east of the survey corridor. Between the sea bed and lithified sediment is the sediments as shown in the figures below:

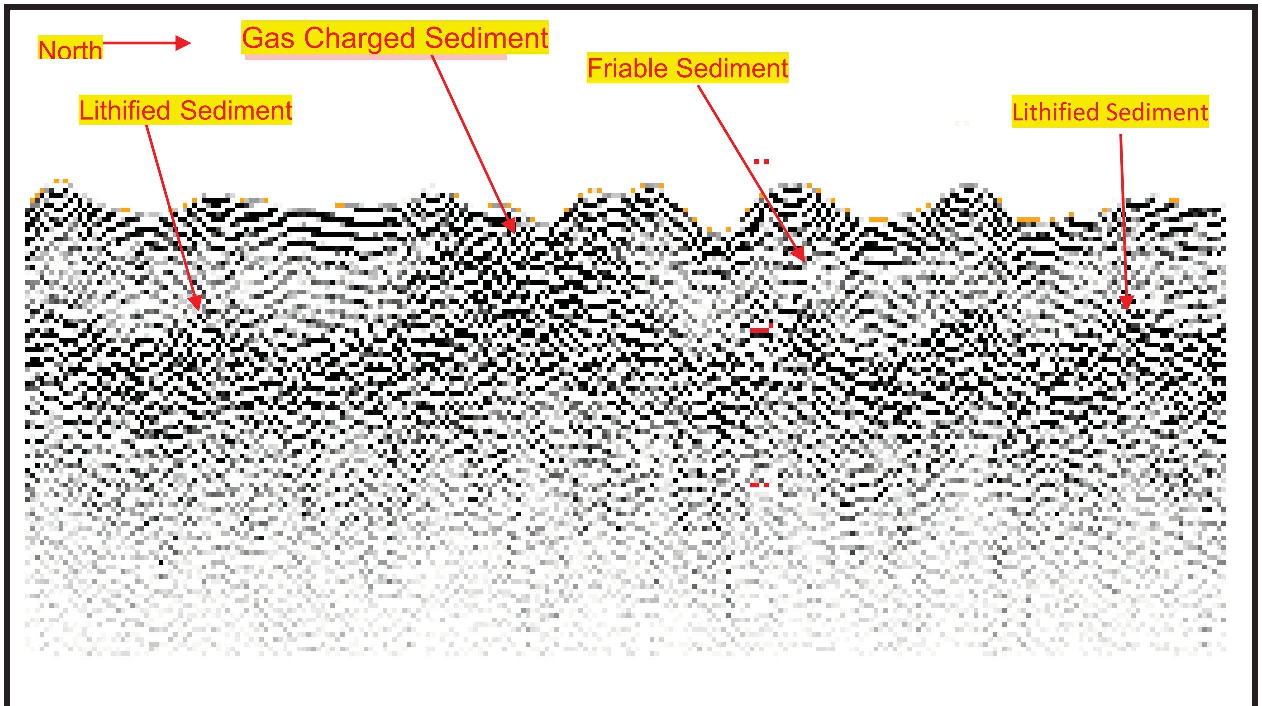

Figure 4: SBP Data extract indicating Gas charged sediments.

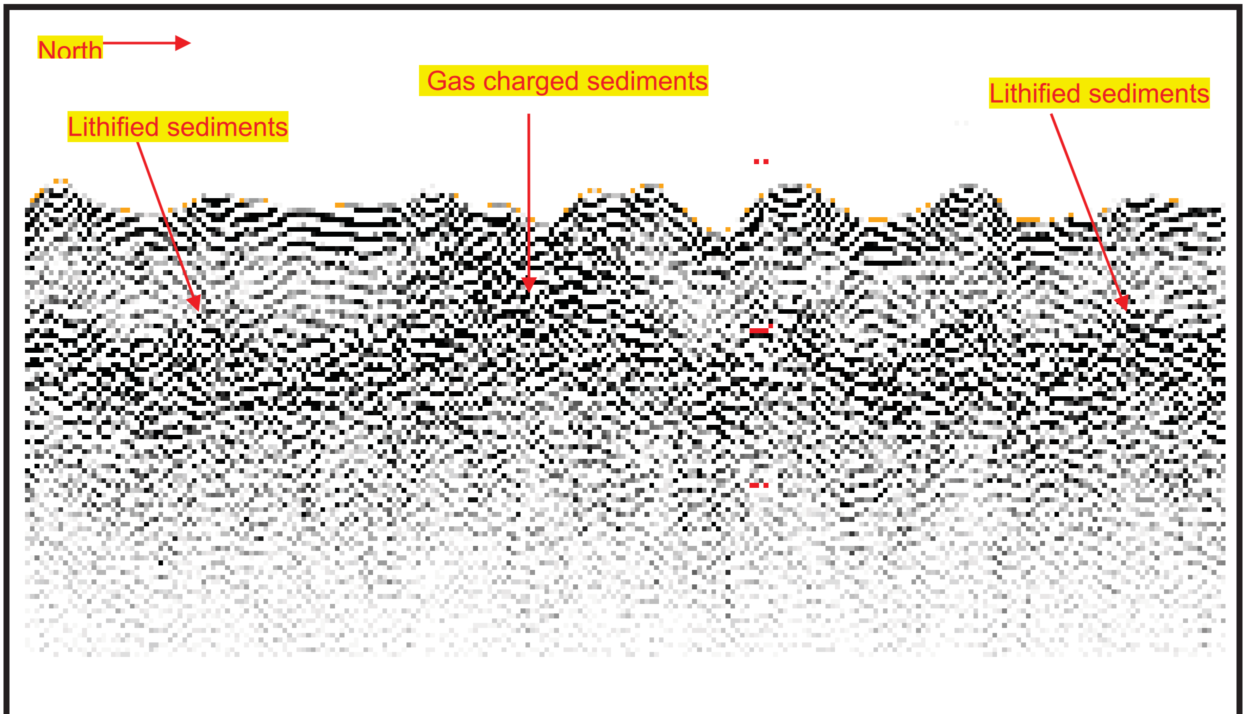

Figure 5: SBP Data extract indicating occurrence of gas charged zone below seabed.

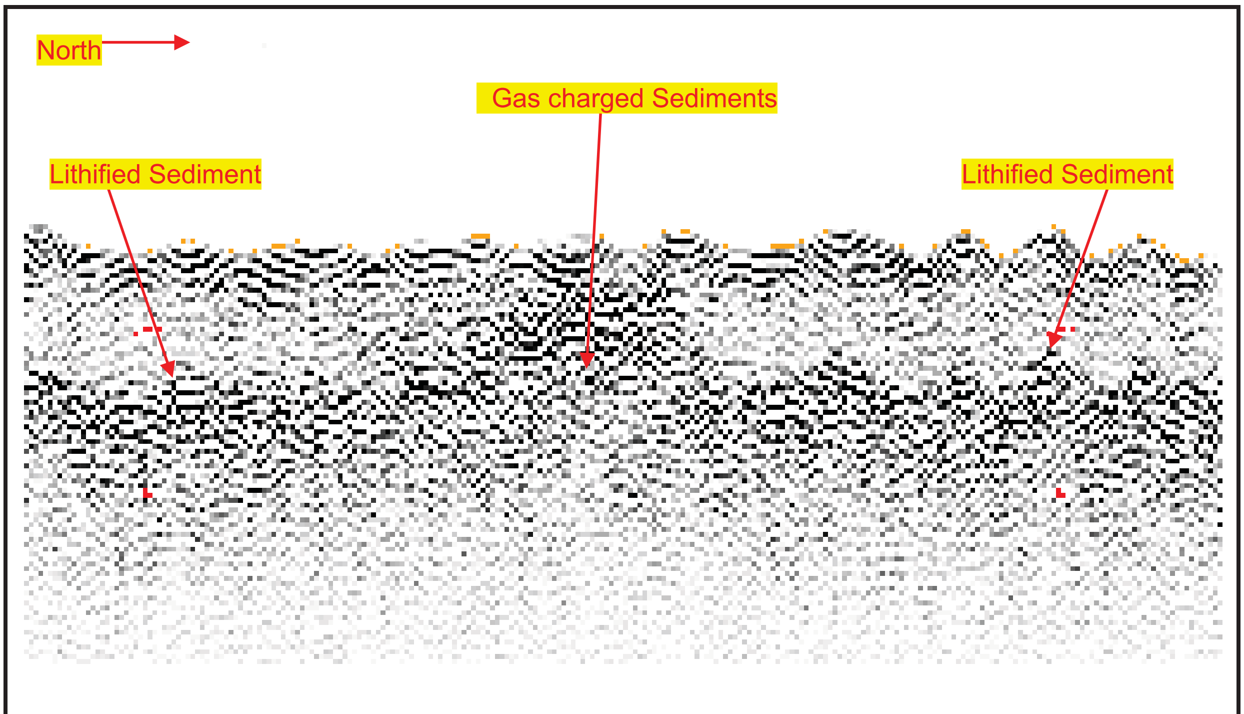

Figure 6: SBP Data extract indicating occurrence of gas charged zone below sea floor.

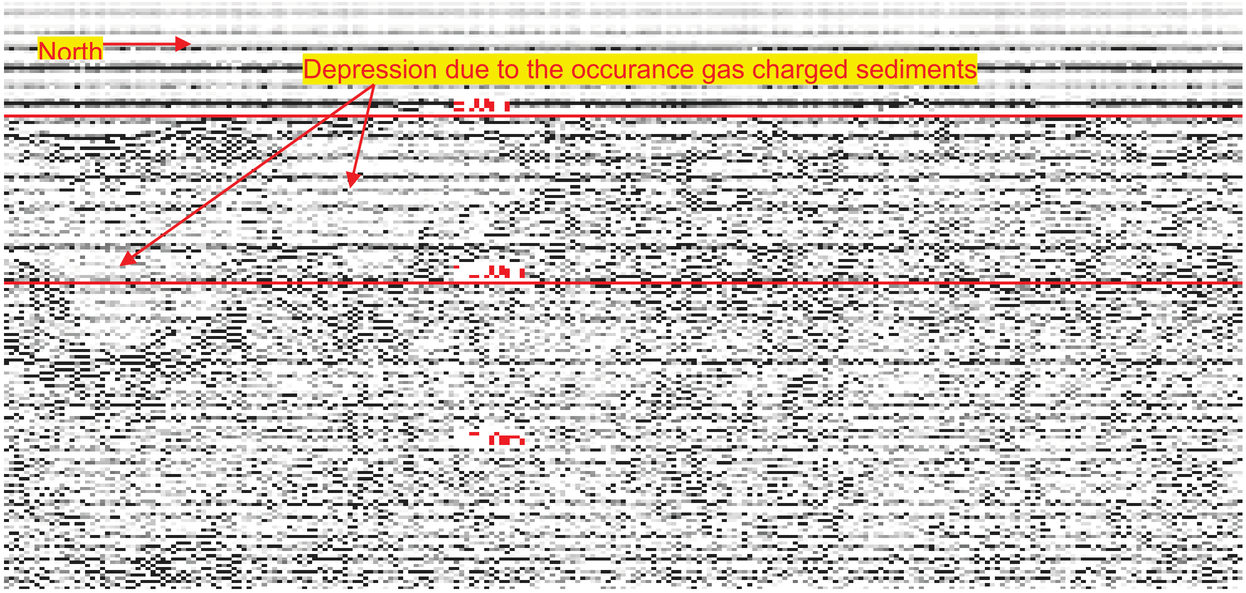

Figure 7: SBP Data extract indicating sea floor depression.

POCKMARKS

Many Pockmarks of varied diameters were observed within the surveyed corridor. Some of these pockmarks are found very near to the as-found Export Line. The pockmarks pose threats to the mechanical integrity of the subsea facilities, since they are actually shallow gas vents. The table below provides the position details of these pockmarks: Also, the figures 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)	Remarks
	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	

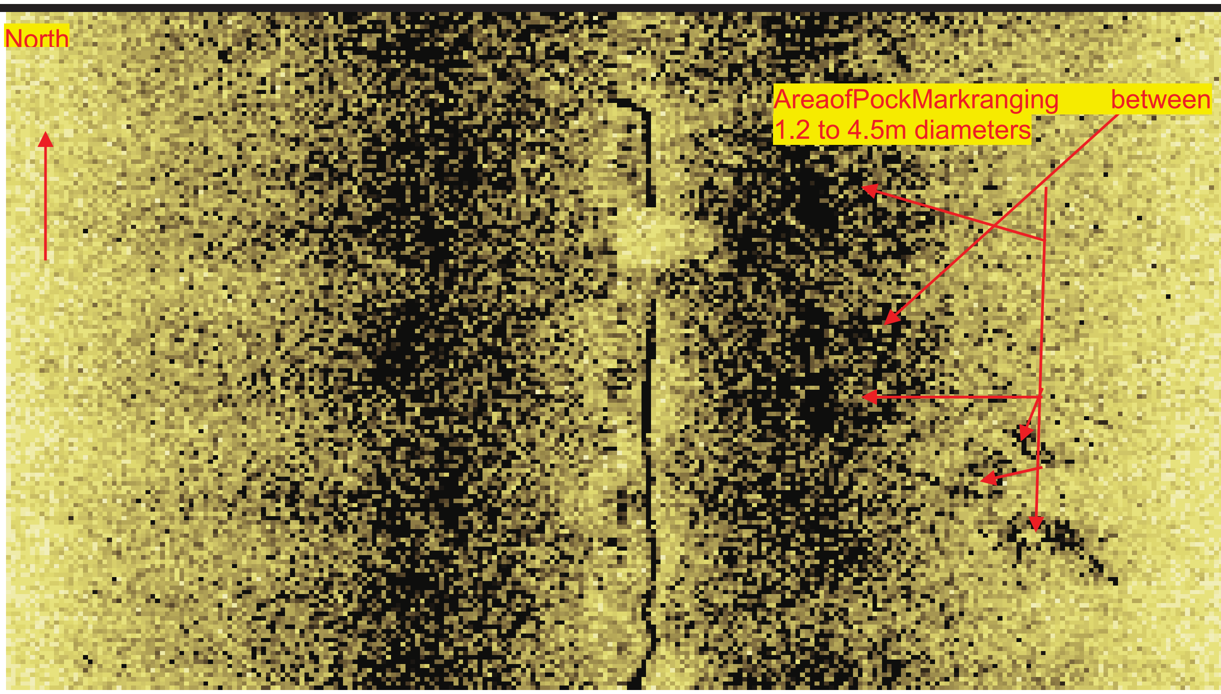

Figure 8: SSS Data extract showing Area of Pockmarks within the vicinity.

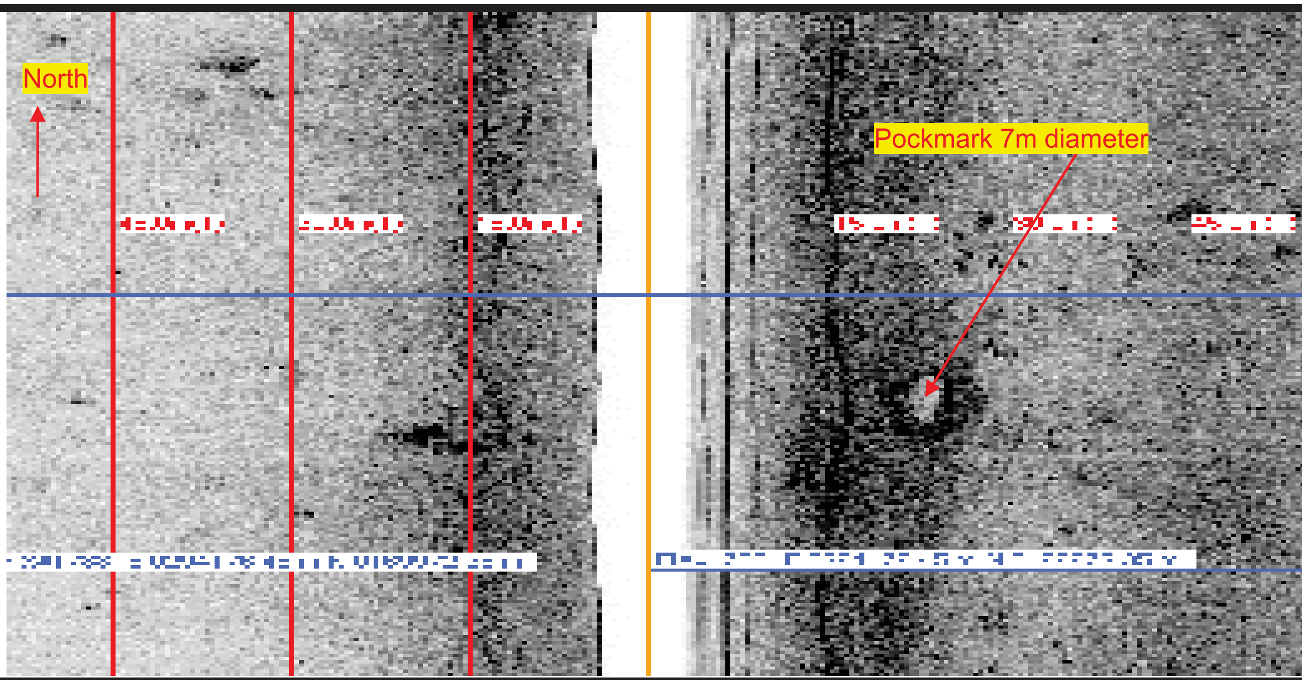

Figure 9: SSS Data extract showing Pockmarks on seafloor of study area.

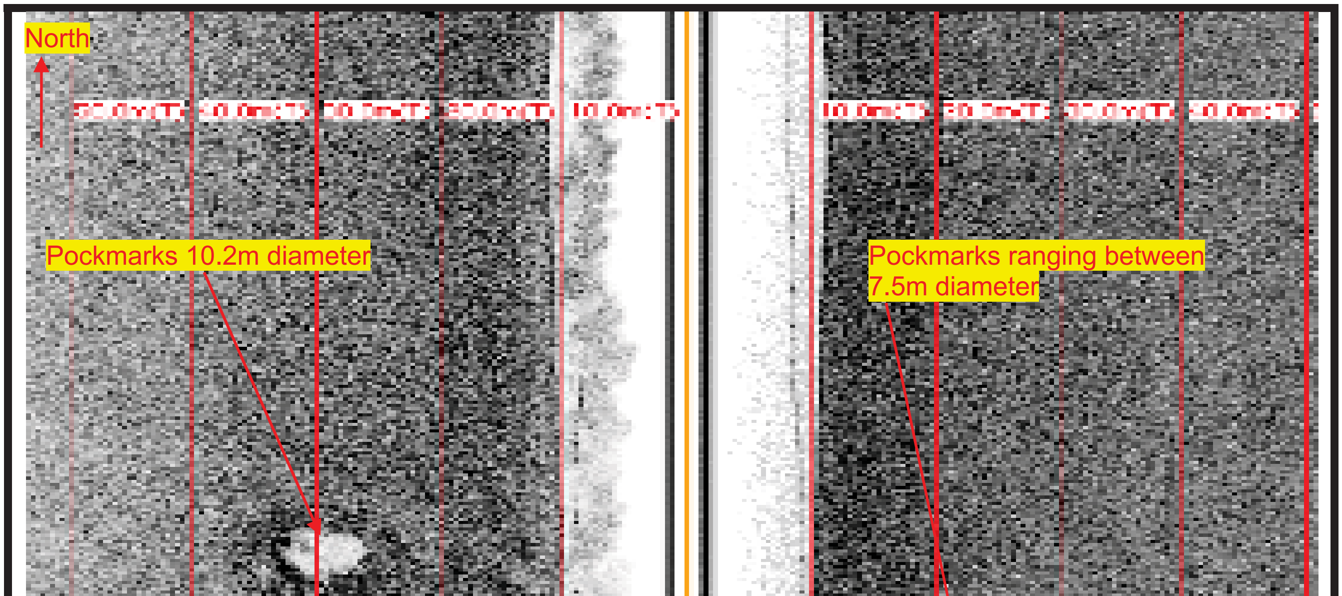

Figure 10: SSS Data extract showing Pockmarks on seafloor of

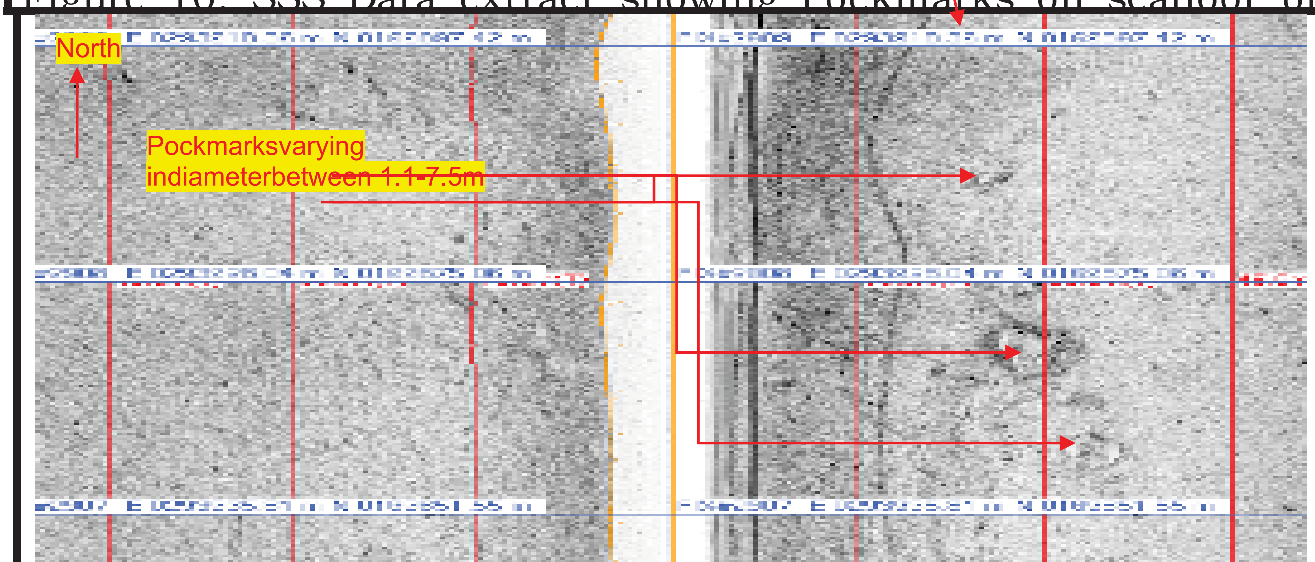

Figure 11: SSS Data extract showing Pockmarks on seafloor of study area study area ....

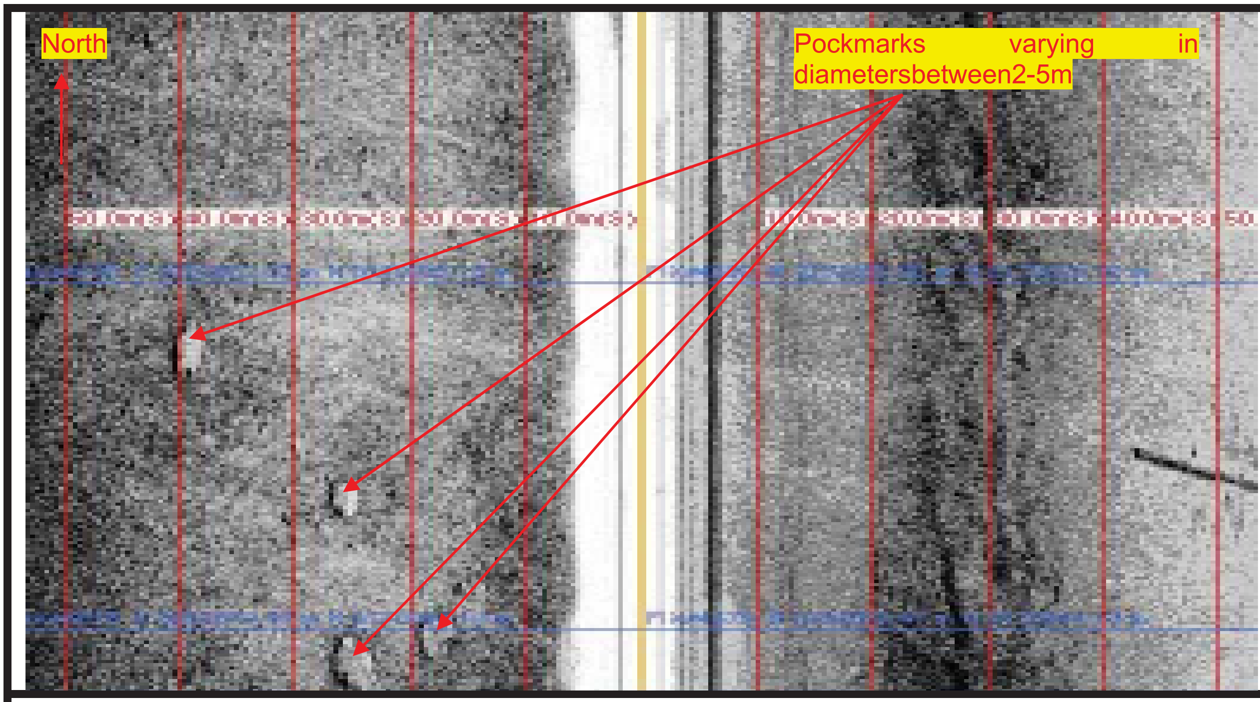

Figure 12: SSS Data extract showing Pockmarks on seafloor of study area

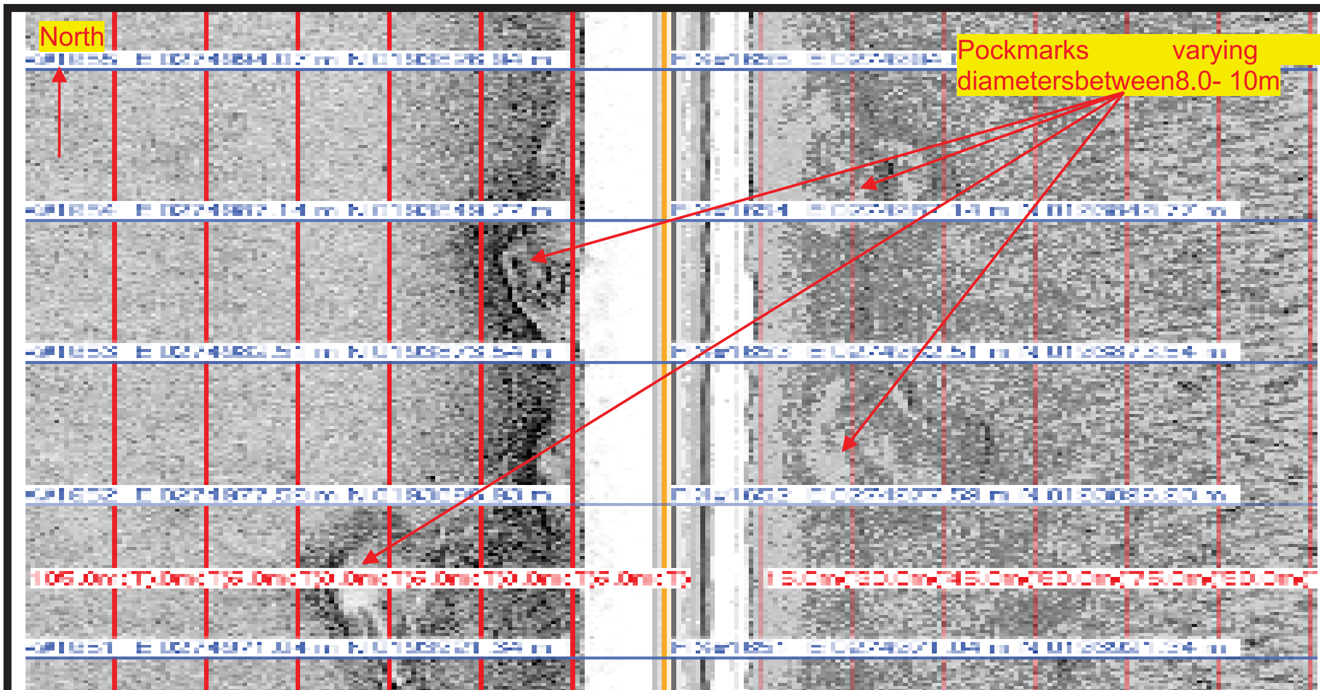

Figure 13: SSS Data extract showing Pockmarks on seafloor of

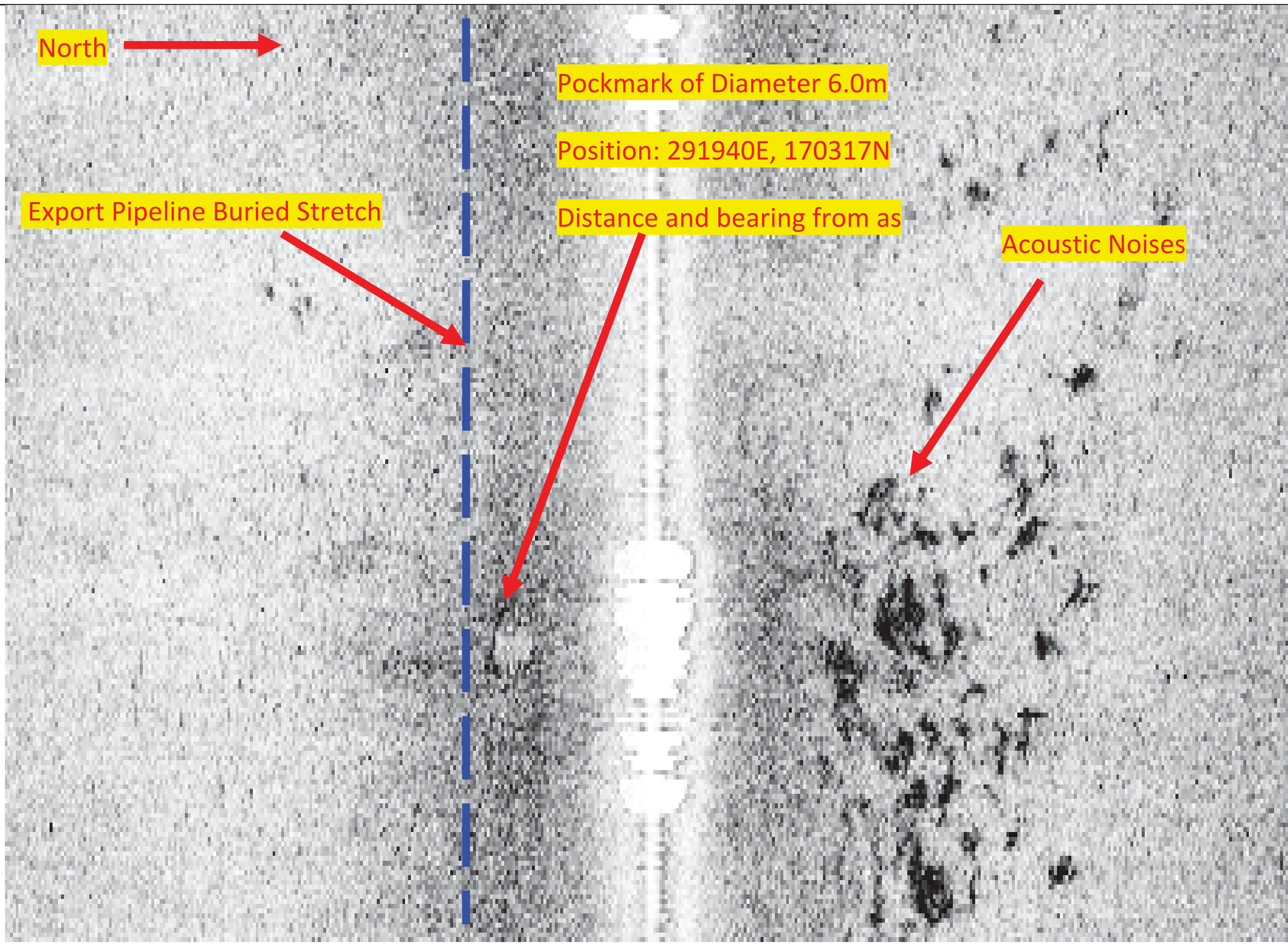

Figure 14: SSS Data Extract showing Scar marks and Pockmarks in E-Field.

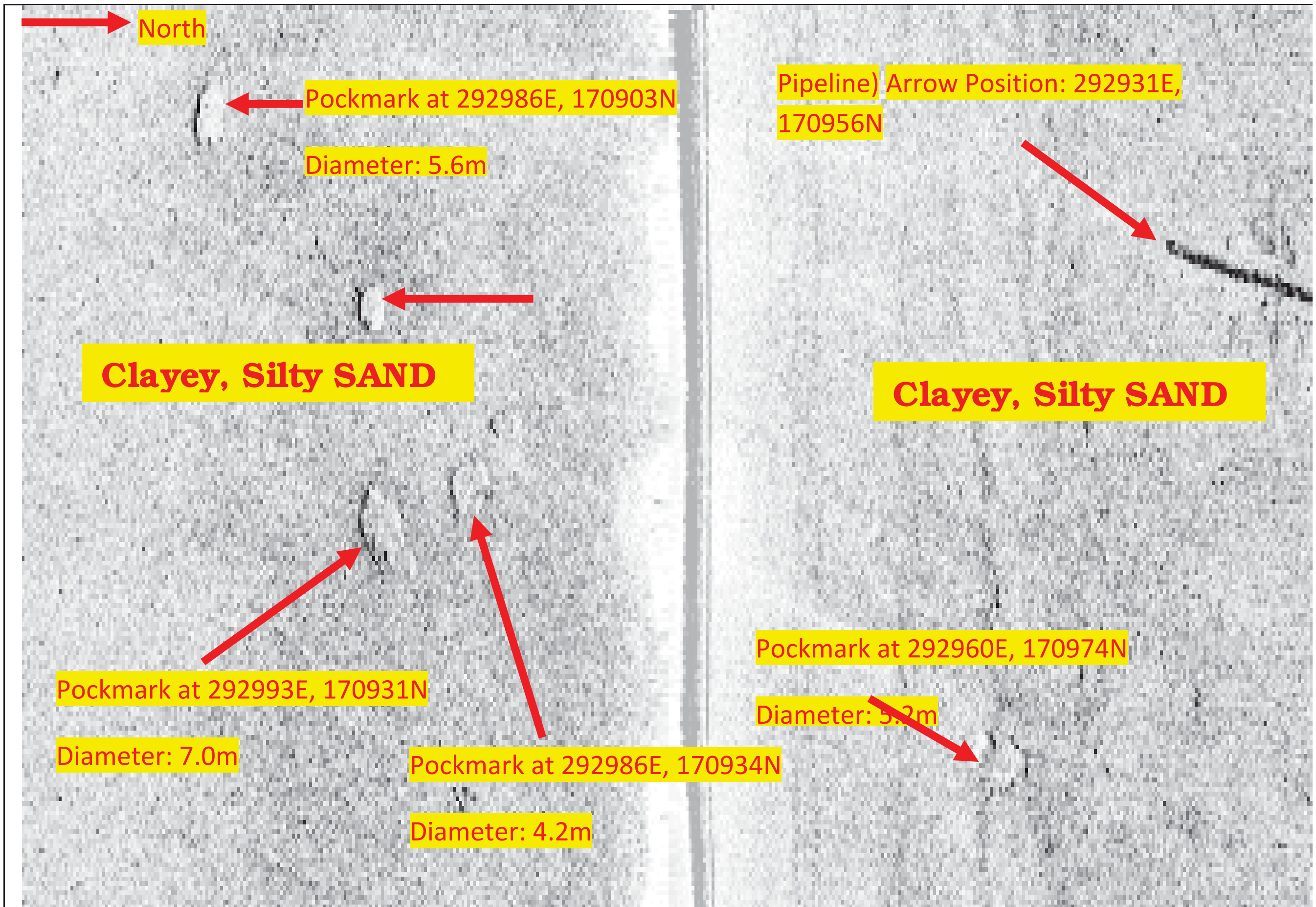

Figure 15: SSS Data Extract showing several pockmarks at 2km Southeast of O-field

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 20m-25m 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 'emobs' 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 pipelay 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.

REFERENCES

Achanya, J.O. (2006). Sea floor sediments offshore Gulf of Guinea (Ed. Middleton,G.V.). Kluwer Academic Publishers,**V** 1(1): 9–24.

Anderson, J.T., Holliday, R. and Kloser, D.G. (2008). Acoustic seabed classification, current practice and future directions. ICES Journal of Marine Science, 65, 1004-1011.

Babangida J.(2015). SeismiImaging of Seabed MorphologyOffshoreNiger Delta. Universal Journal of Geoscience 3(2): 25-70.

Chuku, H.C and Ibe A.C.(2015). Topography and lithofacies of the sea floor in Meren field, offshore Western Niger Delta.IJSIT, 2015, 4 (6), 524 -551.

Damuth, J.E. (1975). Echo character of the western equatorial Atlantic floor and its relationship to the dispersal and distribution of terrigenous sediments. Marine Geology 18, 17–45.

Emery, K.O. (1976). Perspectives of Shelf sedimentology: In marine sediment transport and costal management. 581-591, Published by John Wiley and Sons Incorporated.

Ibe, A. C., Awosika, L. F., Ibe, C. E., Inegbodion, L. E. and Adekanye, J. E. (1989). Hydrographic and Topographic Survey of the Ugborodo, Bendel State Shoreline. A Report for Oluonye and Partners, 24p + map.

Loncke, L., Mascle, J., Parties, F. (2004). Mud volcanoes, gas chimneys, pockmarks and mounds in the Nile deepsea fan (Eastern Mediterranean): geophysical evidences. Marine and Petroleum Geology 21(6), 669-689.

Rao, G.N., (2001). Sedimentation, stratigraphy, and petroleum potential of Krishna-Godavari Basin, East Coast of India. AAPG Bulletin 85, 1623–1643.

Tesmi, J., (2008). Seabed pockmark sand seepages Impact on Geology, Biology and Marine Environment, Graham and Trotman, London. pp 6-20.

APPENDIX

MATERIALS