SEISMIC CROSS SPREAD TECHNIQUE OF GEOPHYSICAL PROSPECTING AND IMPACTS OF PERMIT PROBLEMS IN SOME PARTS OF AFRICAN REGIONS

DR. MADU ANTHONY JOSEPH CHINENYEZE
Department of Geology, College of Physical and Applied Sciences, Michael Okpara University of Agriculture Umudike (MOUAU), Abia State, Nigeria.

Introduction

The principle of straight and wavy lines maintained in cross spread technique from the origin or start of seismic lines to the end of the lines enhances transportation or traffic within the spread. The uninterrupted movement and easy roll along of recording swaths are absent in the brick-wall method of seismic data acquisition, as the discrete segments of source lines terminate between receiver lines. The cross spread technique is based on orthogonal geometry and is suitable to acquire wide-azimuth data. Each intersection of a source line and a receiver line forms the center of a cross-spread. The dense sampling of the sources along the source line and of the receivers along the receiver line creates a dense single-fold areal coverage. The wide spread accesses created by seismic lines in the technique opens the doors to third party disturbances to production recording.

In Niger Republic the calcareous materials and argilaceous sediments at some parts of Dibeilla-Fana- Joauro oil field areas are of sigificance. In addition, the litho-logs from the dugout water wells, revealed alternating sequences of shale sediments, siltstone, and limestone. This appears to be in agreement with the transgressive and regression facies of argillaceous and fauna sands and sandy limestone, with overlapping and overstepping relationship, of the age Paleocene to Eocene which followed Upper Cretaceous (Maestrichtian) [1]. The limestone and siltstones constituted the aquicludes at various locations. At the prolongation of dry season, the water wells dried up, as a result of limited size of the reservoirs. Such was misinterpreted by the locals that the seismic heavy trucks and vibrators or VIBROSEIS machines shook the limestone sediments to collapse the walls of water wells, thus block-off the water supply.

Cross spread technique of seismic prospecting is the configuration based on consistent orthogonal pattern of both receiver lines and source lines[2]. At locations where infrastructural facilities such as oil well heads or underground pipelines interfere with the seismic lines, offset lines are designed around consecutive obstacles. The angle of excursion of the skirting from the

original line must not be beyond 26° to 34° [3]. Around such intersection of lines with infrastructure a technical skirting designed about the structure would maintain separation distances between the structure and the infill offset source lines in terms of multiples of the receiver line spacing or source line spacing. Densification of the shot points is designed to cover the scope of near-offset shots and near-mid offsets shots in order to build up subsurface coverage that will compensate for the gap created by the omission of source points within the area of infrastructural obstacles. Communities located within obstacle-areas might reject traversing of seismic lines across their sacred bushes and the solution will be to plan compensation source line offsets, which are designed as skirting around the obstacle zone. But this might leave minor "coverage-lows" due to deficiency or loss of near-mid offset subsurface CDP's or bins or coverage[4]. Seismic exploration in recent decades worldwide, has been faced with many and variable challenges. One of the major challenges is the occurrence of permit problems by host communities or their members to the free-flow of seismic data acquisition. The severity of the challenges varied with geographical location/ relative urban proximity, vegetation condition, significant mineral or geologic deposits or features, geomorphologic disadvantages in terms of road degradation due to plying of many heavy trucks on local earth roads, demand for youths' employment, and geo-political disagreements of non-acceptance of youths from one community in adjacent communities, spread of false information of negative impact of the exploration on certain aspect of the host community life, claim of contamination of groundwater by the dynamite explosives used in shooting operation, erroneous claim of pollution of air by company's fleet of vehicles and heavy generators, and generators. By implication, any of these factors can trigger off problems of interruption to exploration activity when permit procedures were violated, when signed-memorandum of understanding (MOU) was violated by the seismic operator or contractor, when operational activities adversely impacted on the host communities and touching their source of livelihood sometimes of their creeks and rivers. Indicators of grievances include, blocking of access routes to seismic lines, disconnections of active-Receiver-line-cables and geophones to boxes/station units, theft of equipment, vandalizing of equipment, excavation and theft of buried 12V motor batteries and power boxes, especially in the extensive receiver spread of Sudan. On the other hand, the situation was different and more serious in Ethiopia due to stiff opposition of the Ogaden basin youths in the Somalian Region to the Ethiopian Federal Government efforts towards oil exploration. Attacks were occasionally meted out against petroleum exploration projects and road construction projects in the region from 2007 to recent years. Some African petroleum producing nations have certain groups of violent youths noted for opposition and fighting against exploration activities within the country's hydrocarbon laden region.

Study Area

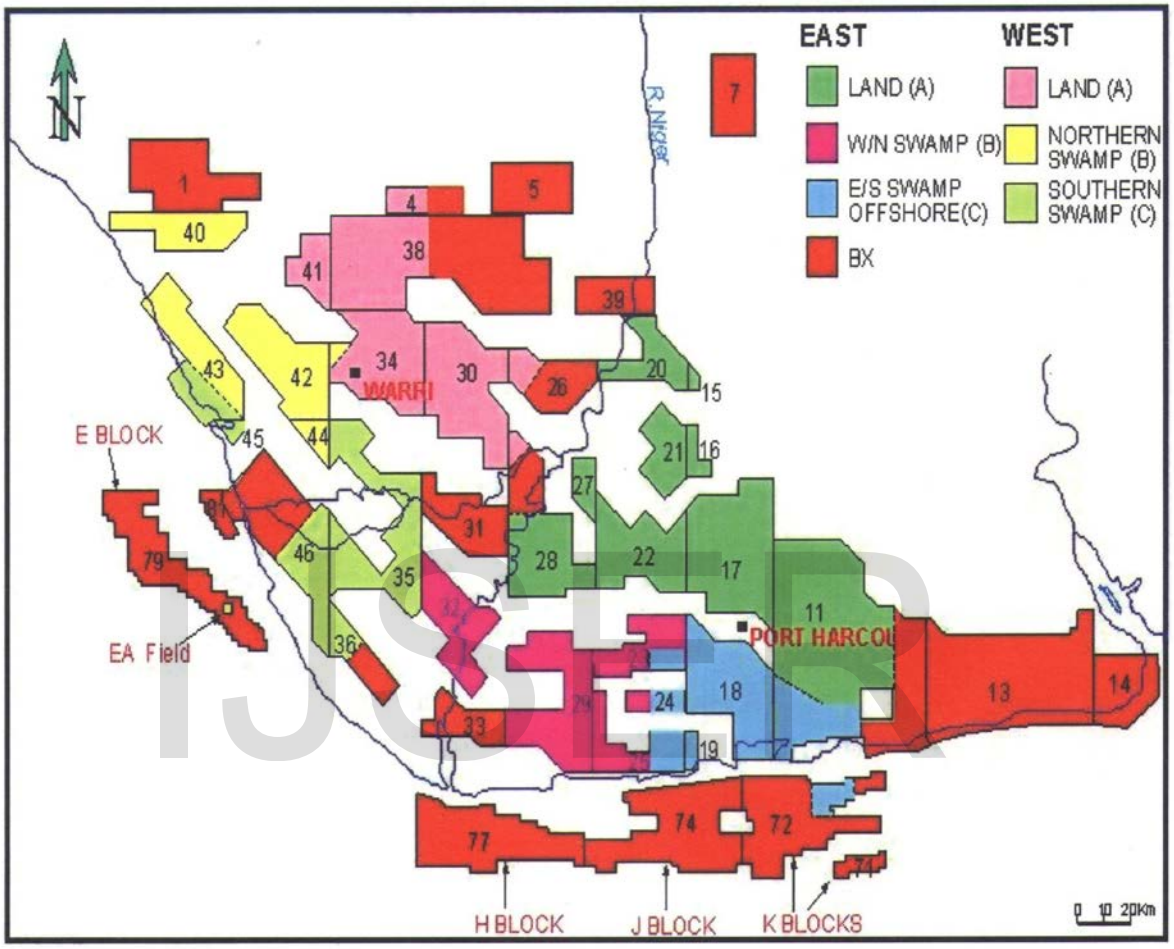
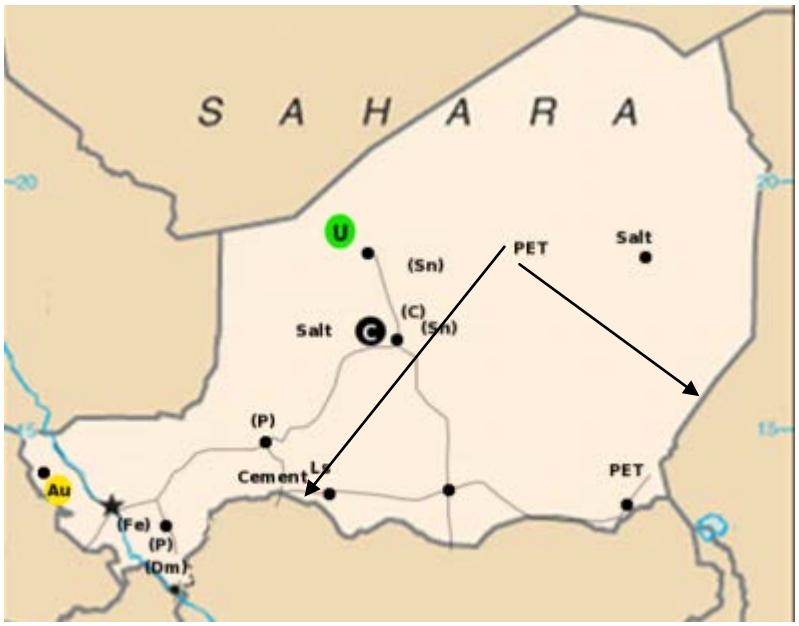


Figure 1a: Map of Niger Delta showing various OML and OPL Blocks where Seismic has been acquired.

The Niger delta contributed majorly to the study sites in Nigeria, with the portion of the Chad Basin, and parts of Niger Republic (figure 1). Other regions include Ethiopia, and Sudan in East Africa.



Known and exploited Mineral resources of Niger, data derived from US Geological Survey. Colored circles represent current mining centers. Unexploited but proved resources in parentheses. * Gold: Au * Coal: C * Diamond: Dm * Iron ore: Fe * Phosphate: P * Tin: Sn *** Limestone: Ls; * Petroleum, crude: Pet.**

Figure 1b: Niger Republic has a Sector (bounded by two arrows) of calcareous deposits and outcrops (In agreement with Hospers, 1965). Presence of Petroleum (PET) and Limestone (Ls) deposits within the identified sector of Oil field, Jaouro.

Methodology

During physical supervision of seismic operations, activities were captured and some constraints were encountered. Planned inspection visits to seismic lines in the fields were conducted and visits to field camps and Community Affairs and Permit Department of seismic crews were consistently monitored to check on the impact of permit problems on the production of various seismic projects. Operations' vehicles were allocated for monitoring both in East Africa and in West Africa especially for the purpose of timely intervention and resolution of community permit problems, road blockages, or seizure of seismic equipment or even severe cases of youths' seizure of explosives (dynamite/detonators) in the crave for employment or repair of damaged roads. More vehicles were used for line monitoring in Recording operations in Ethiopia and Sudan due to larger surface area coverage of active spread.

The dimension of spread involving 16 Receiver Lines (Figure-2) Active spread of (9km x 300m x 15RL Intervals = 40.5Km^2.

In the field layout diagram shown below, the Receiver lines which run North-South and the Source Lines that run East-West provide multi-access to the arid desert.

I). CROSS SPREAD RECEIVER LINES, TRENDING NORTH-SOUTH

II). CROSS SPREAD SOURCE LINES, TRENDING CONTINUOUS EAST-WEST

The impact of heavy vehicles in Niger Republic, upper latitudes of West Africa, and the desert terrain of Ethiopia and Sudan were associated with copious “Dust-pollution” constituting thick brown clouds of dust that soared from the ground level to the sky. This situation along many parts of earth-roads in the active spread areas stirred up conflicts with other road users and host settlements. Sometimes, the brown clouds served as indicators of seismic vehicle locations within the cross spread continuous lines, which is contrary to Brick wall geometry where vehicle speed restriction is in place because of Source Line SL’s end-of-line bushes.

16 Receiver Lines in Simultaneous Active Spread

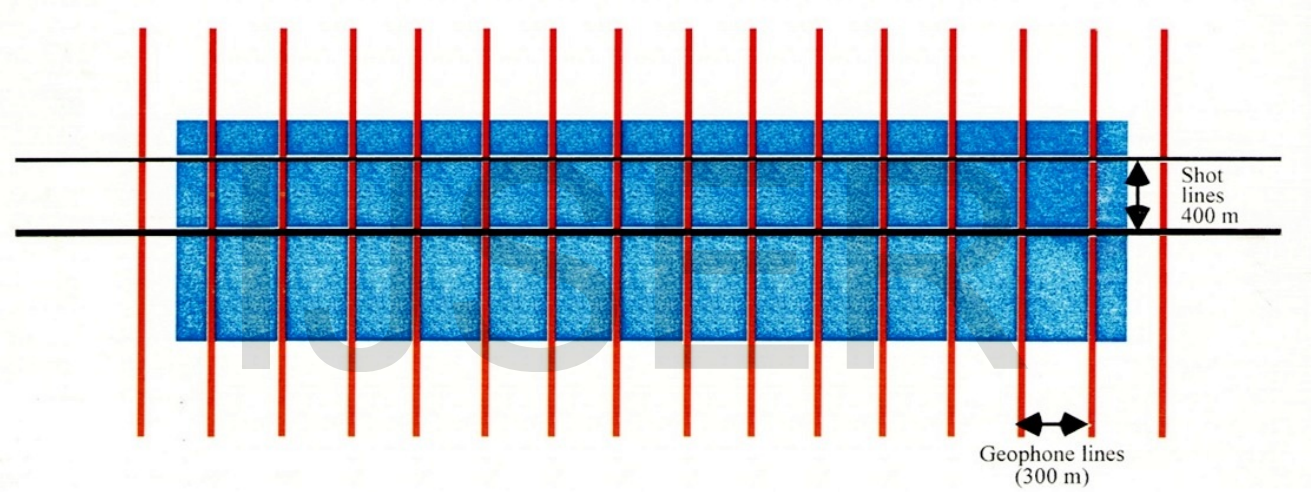


FIGURE:2 Cross Spread field configuration in **Sudan** 3-D Seismic Acquisition.

The percentage data in the Results in Table 1 was computed based on the number of permit cases reported during seismic acquisition. Cases were tracked in the crew’s Radio-books as well as Permit-men’s “field notebooks”. The cumulative field reports were evaluated.

Results and Analysis of Data:

Table-1 shows the various Permit Problems of Nigeria (West Africa region). The Permit problems were recorded as incidents occurred and were resolved. The continuity and

interconnection of the seismic lines in cross spread technique enhanced trafficking of more trucks, thus, yielding more consequences than brick-wall configuration or other techniques.

The Sudan seismic operations created multi-access to the remote areas of active spread, due to large extent of 16 Receiver Lines per unit active spread involved in the cross spread acquisition geometry (figure 2). There were disturbances to seismic lines by locals who ventured into remote portions of active spread for excavation and theft of buried 12V batteries. For the Ethiopian permit episode, see Appendix 1.

In Niger delta, whenever seismic lines traversed community's sacred or forbidden bushes it attracted the grievance of the host community. Host communities signed permit to traverse their sacred bush through elders' procedural permission. The immediate consequence is usually blockage of roads to seismic lines, seizure, and vandalizing of recording line equipment, (figure 3), including geophones, power boxes and 12V batteries.

In the Niger delta of Nigeria, indicators of grievances are made up of blocking of access routes to seismic lines for survey crews, drilling crews, and recording crews, to jeopardize recording production. Permit problems indices also included vandalizing of recording line equipment, disconnections of Active spreads of Receiver Lines, cables and geophones links to boxes, and theft of line equipment. In two months of seismic investigation in the Niger Delta, there was a loss of 63hrs chargeable downtime due to permit problems (Figure 3).

The hydra-headed problem of Boko Haram insurgence[5] in the NE of Nigeria, led to the termination of the seismic exploration ventures in the Chad Basin since over a year. The 3-D seismic acquisition programmes in the Chad Basin were put on indefinite suspension due to security problems in the areas. The flat topography and openness of the terrain in the Chad Basin area provided easy access to the Boko-Haram to attack and burn down operations trucks and jeopardized further seismic surveys in the basin.

TABLE-1 **PERMIT PROBLEMS IMPACTING ON SEISMIC PRODUCTION NIGER DELTA NIGERIA, NOT AS FATA L AS IN EAST AFRICA.**

Date (NOV-DEC)	Permit Downtime Claimed (Hrs)	Remarks
25/11/10	4:00	Seizure of line equipmt, delayed payment of stipend
27/11/10	3:03	Elders' demand for pay of stipend, - material seizure
28/11/10	6:24	" "
29/11/10	0:59	Demand for equipmt protection (guards)
30/11/10	2:37	
5/12/2010	5:22	Disturbance to Shooters, compensation for trespassing/dececrating sacred bush
7/12/2010	5:18	
8/12/2010	10:00	Vandalizing of line equipmt / blockage of Rd- due to delay in payment of wages
9/12/2010	6:26	
12/12/2010	3:37	
13/12/2010	6:16	" "
14/12/2010	5:39	" "
31/12/2010	3:29	Disturbance to Recorders to register grievance, demanding for more employment
TOTAL:	**63:20**	

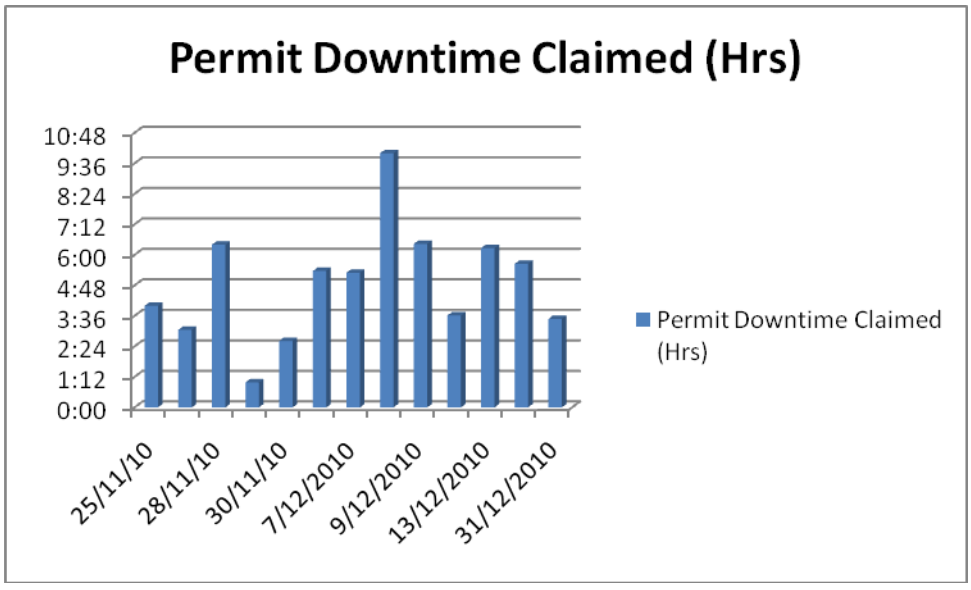


FIGURE 3: Chargeable Downtime (63.30hrs) due to community permit problems.

Conclusion

The Permit problems were worsened by multiple accesses created by the occurrence of source and receiver lines of orthogonal continuity. The continuity and interconnectivity of the seismic lines in cross spread technique enhanced trafficking of trucks, yielding more limiting consequences than in brick-wall or other techniques with interlocking bushes.

Exploration in Ethiopia requires serious security planning. The multi-fatality incident of Bole, Ogaden Basin in 2007 and that of 2010 respectively terminated the seismic acquisition programmes with more than two years' delay for ratification of all regional permit challenges.

In Nigeria and Niger Republic, community permit grievances were often shown by blockage of roads to seismic lines for survey crews, drilling crews, and recording crews, to jeopardize Recording production. They also embark on disconnections of Active spreads of Receiver Lines, cables and geophones, vandalizing of recording line equipment, and sometimes theft of equipment.

Appendix-1

In Ethiopia East Africa, a multi-fatality attack was launched against a Seismic crew at Bole, on 25th April 2007, between 5:30am and 8:00am by militants of the Ogaden Basin of the nation, and 130 lives (95 personnel and 35 camp-followers) were shot dead. Within two and a half hours of militants' operation a serious mayhem was wrought in destruction of lives and properties. Ethiopian militants besieged oil exploration camp or seismic crew Bole Ogaden Basin of Ethiopia, and killed 66 national staff - Ethiopians, 9 Chinese expatriates, 20 soldiers (Federal troops), (and 35 civilian camp-followers/women and children), and kidnapped 7 Chinese expatriates who were later released weeks after the incident. But God miraculously preserved my life amidst showers of bullets into my air-conditioned cabin.

After the attack, the surviving workforce were busy, from about 9:00am to 5:30pm carrying the dead bodies and loading into Load-Carrier big trucks of the crew and set-off to Jijiga, the Somalia Regional capital of Ethiopia, where we arrived about 9:00pm that night. The 20 diseased soldiers and the dangerously wounded soldiers were specially evacuated by a military helicopter that flew in from the Regional Headquarters Jijiga. It was a day of horror, but the Almighty God protected me from torrential rain of bullets and mines and bombs. The remembrance of the incident any time, re-played the merciful-kindness and faithfulness of God to me, saving me from that mass wastage of lives and exploration-experts. I cannot conceal it.

The client, SW Energy Limited was an Ethiopian indigenous oil company, which contracted the survey to a Chinese seismic operator, ZPEB. The hostile attitude and interruptions in meetings by certain of the locals or Ogaden-native workers suggested that the exploration crew was not welcomed by the host communities, though permitted and guarded by Ethiopian Federal Forces.
The Ethiopian Federal Government and her Somalian Region Local Government gave approvals to the client and contractor for the execution of the seismic exploration, but the youths and local activists were in opposition, who constituted Guerrilla warfare groups and dwelt in the forest region of the Ogaden Basin. They fought against all Government-sponsored exploration activities in the Ogaden Basin while Federal Forces existed as on-site security.

At the early rain in April, the Ethiopia's Ogaden Basin terrain became refreshed with parcels and pockets of green shrubs vegetation. The vegetation provided camouflaging hide-out for the attacking gorilla-warfare groups, who were against Federal Government projects and some community leaders. These groups resisted government projects in the Ogaden Basin such as seismic explorations, oil well drilling and road construction projects.

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