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EVALUATION OF UPHOLE SEISMIC REFRACTION DATA FROM SELECTED SPOTS IN THE CHAD BASIN OF NIGERIA

Ezike E.C., Odoh O.P[1]
Onyeabor F.C[2]
[1,2] Department of Geology and Mining, Enugu State University of Sciences and Technology, Enugu, Nigeria

Abstract
The up-hole refraction survey was carried out in Chad Basin field, to evaluate the weathering thickness and the velocity of the low velocity layer (LVL). Twenty five up-hole locations were made and the time intercept technique to the seismic refraction curve was employed. In other to obtain the weathering information and velocity variation with depth of the near surface layer, (25) up-hole spread shots in grid of 5km x 4.8kilometres were made. The information obtained was used to calculate the refraction statics, which can be used to eliminate the effect of low velocity layers at a regional level in a prospect. The dominant lithology encountered are; sand, clay, and silt. The weathering thickness was found to vary from 4.2-14.88m with velocity from 224-580msec^{-1}. A sub weathering layer was also observed in some locations. The velocity of the consolidated layer ranges from 1015 to 2450m sec^{-1} with a mean velocity of 2031.84m sec^{-1}. The average time used to travel to weathered and consolidated layers are 0.237744 and 0.01458 seconds respectively. The research showed that the elevation and weathering correction (static) was eliminated at a depth of 4.23m.
Keywords: Uphole, Chad Basin, refraction, Velocity and weathering

Introduction
The move for the Federal Government to build up the nations proven oil reserve through exploitation new field for oil and gas production, there is need to apply good near' surface structural models to bypass the erratic features and minimized the effect of the weathering layer in Chad Basin of Nigeria. In mono-field north western Nigeria Delta, Enikanselu (2008) studied the seismic refraction and uphole survey analysis of weathering layer characteristics. Igboekwe and Ohaegbuchi (2011) investigated into the weathering layer using uphole methods of seismic refraction. Oil has been discovered by Coloco in Mesozoic continental formation in the Chad Republic while the efforts on the Nigeria end are yet to prove successful. Avbavbo et.,al (1986) gave some insight on depositional and structural styles in Chad Basin.

Kwaya, et al., (2013) evaluated the depth to Basement Complex and Celozoic unconformity from seismic profiles and boreholes in the Nigeria sector of the Chad Basin, thereby estimated the depth to the unconformity which will help to determine the thickness of Chad Formation. Umoetok, et al., (2018) investigated near-surface seismic characteristics in Bornu-Chad Basin, thereby calculated the low-velocity-layer depth, velocity structure and lithology of the near surface layers. The aim of the study is to evaluate the weathering thickness, the time used to traverse the weathered and consolidated layer and the velocity of the low velocity layer which will guide to compute weathering statics corrections during the processing of the reflection seismic data.

LOCATION AND GEOLOGY OF THE STUDY AREA
Chad Basin is the largest intracratonic Basin in north-central African that was influenced by Cretaceous and Tertiary rifting. The province covers an area of approximately, 1,145,000 square kilometers and includes part of Algeria, Cameroon, Chad, Niger and Nigeria. It falls between Latitudes 11^{0}N and 14^{0}N

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and longitudes 9⁰E and 14⁰E.The study area covers some towns in Bornu State they are: Suleman, Cross-kawa, Baga and Tunpu.

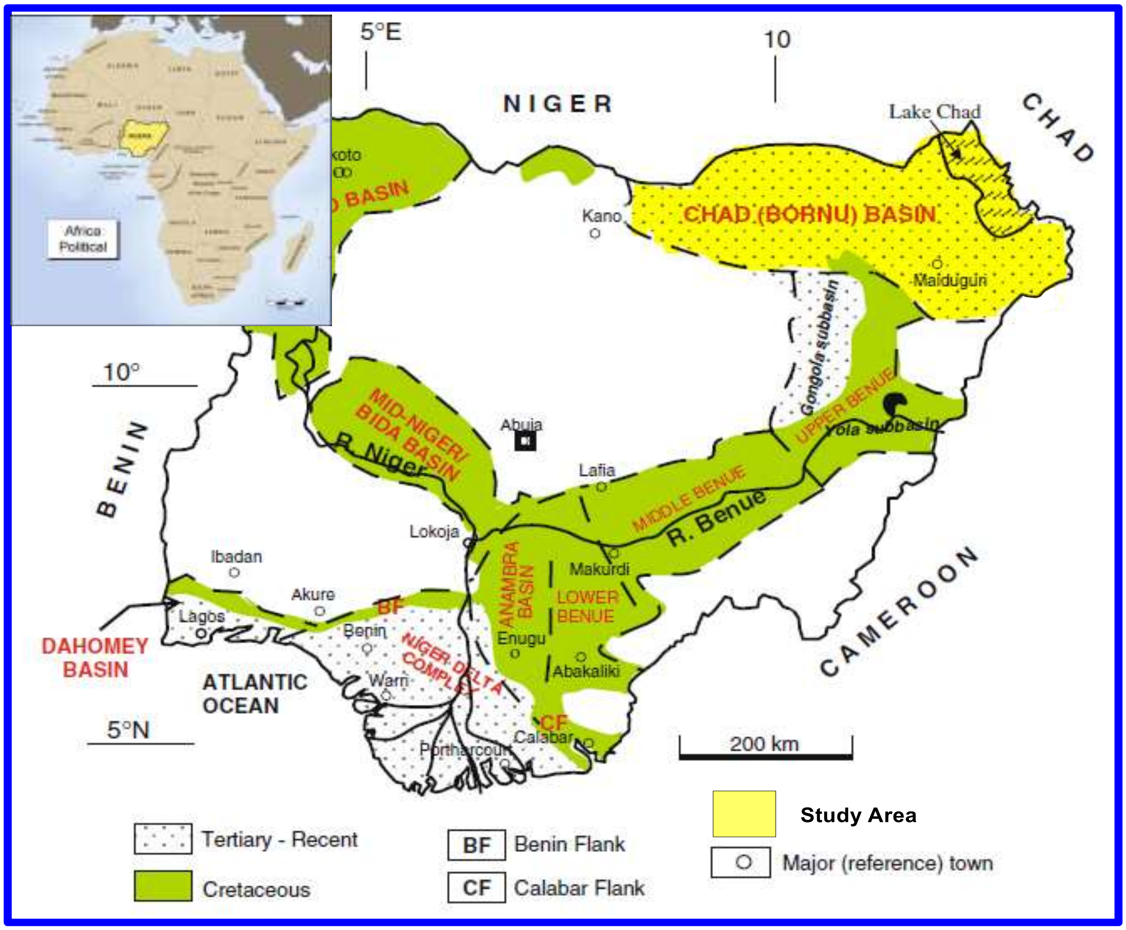

Fig. 1: Map of Nigeria showing the location of Chad (Bornu) Basin, inset is a map of Africa showing the location of Nigeria. (Source: modified from Obaje, 2008).

GEOLOGY OF THE STUDY AREA

The main lithologic units underlain the area is siltstone, sandstone and clay of Chad Formation.

The Clay Unit

This unit dominates the lower southern part of the study area. It extensively covers the entire town of Baga. The clay in this unit is soft and sticky, showing a light grey colour, very poorly consolidated with traces of sands and quartz pebbles. This clay is a swelling type and is suitable for pottery works.

The Sandstone Unit

This unit is prevalent at the central portion of the study area advancing towards the northwestern part .This sandstone can be seen in the Suleman village. The sandstone is whitish, poorly sorted and fine

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grained. The grains are sub angular to angular. The sandstone contains quartz pebble and minor intercalation of silt.

The Siltstone Unit

This unit is seen to be predominant on the surface at the northeastern section of the study area, within the Vicinity of Cross-Kawa town and also partly into Tunpu town. The siltstone is brownish and contains some minor intercalations of Ironstone, Grits and Laterites. Generally , base on borehole data in Chad Basin there are six formations that made up the Basin ; Bima Sandstone, Gongila Formation, Fika Shale, Gombe Formation, Keri-Keri Formation and Chad Formation.

MATERIAL AND METHOD

Usually, up-hole is placed at seismic line intersections in correspondence to a state, with additional holes spaced along line at intervals related to lateral velocity variations. Before starting operations, cables are checked for leakage and continuity, transducer, efficiency, correct distance between take-outs and shooting or energy sources efficiency and proper timing as described in record system and QC procedures. Tests were carried out on the recording system to verify the time break; the main recording parameter such as sample rate-filters etc and the channel gain application at every location.

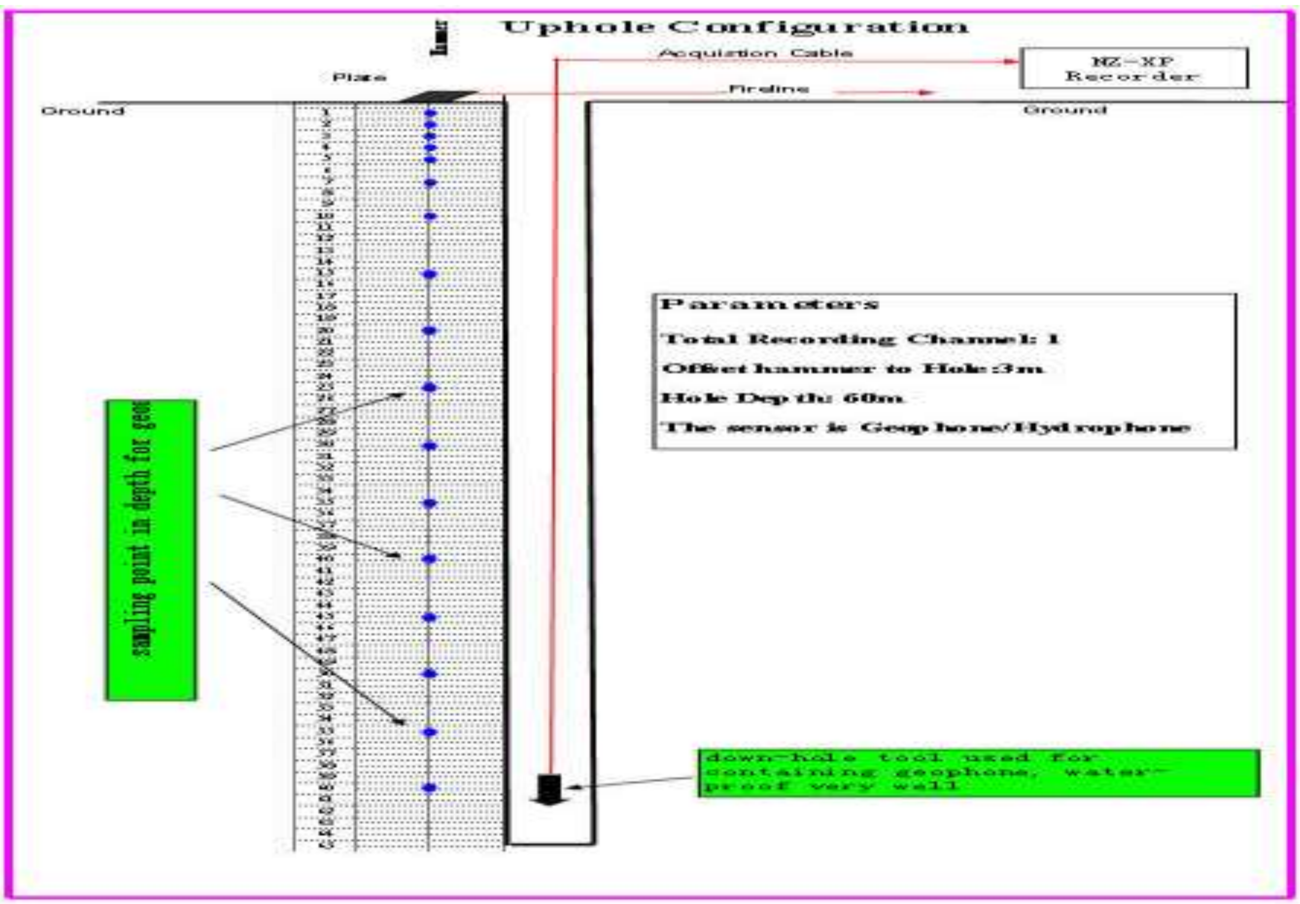

Fig 2 Up – Hole Configuration

Up-hole data was acquired using a single trace GEOMETRIC STRATAVISOR NZXP portable digital recorder the refraction spread consisted of a single SM4, 10H geophones positioned as shown in (fig 2) the Harness diagram uphole recoding was carried out in the areas using water tankers, out of drill rig. The points were drilled to a depth of recording in most cases. The technique used was the down-hole receiver (i.e. up-hole survey) method with a surface energy source; this method allows for higher reliability of measurement and multiple records taken at multiple depths as the tool is pulled up gradually for the entire survey. A cylindrical weight of 5kg was attached to the bottom of the cable with a rope to prevent lost or damage to the cable in case of hole collapse and also to allow the operator to know when cable reaches the bottom of the hole. Measurement were taken when the cables were eased out to the bottom of the hole, further measurement in the real cases are carried out by pulling up the cable and maintaining a coverage of at a single succeeding position to the former. A hammer was used as the energy source and placed about 3 meter always from hole to obtain the first breaks. This guaranteed that the first breaks were vertical. The recording sample rate is 500µsec. A total of twenty five upholes were recorded.

Results and Discussion

Table 1: UP-HOLE LOCATION AND THEIR STATISTICS

Serial No.	Location (Sps)	Coordinates		Elevation	First layer report		Second layer report		Time used to traverse the weathered layer	Time used to traverse the consolidated layer
		Easting (E)	Northing (N)	(ft)	Thickness (m)	Velocity (m/s)	Thickness (m)	Velocity (m/s)	Time (sec)	Time (sec)
UPH-01	50242342	326706.1	1432429	944.3	8.01	420		2161	0.01907	
UPH-02	50242442	328001.4	1427600	951.8	4.43	224	5.9	1120	0.01978	0.00527
UPH-03	51202342	331343.9	1433670	949.2	6.24	472		2109	0.01322	
UPH 04	51202442	332636.5	1428839	950.2	8.81	450		2236	0.01958	
UPH 05	52162342	335979.9	1434911	943	6.73	282		2309	0.02387	
UPH 06	52162442	337271.9	1430082	945.3	9.84	495		2450	0.01988	
UPH 07	53122342	340615.3	1436150	955.8	10.20	421		1015	0.02423	
UPH 08	53122442	341909.6	1431325	944.6	7.32	389		2053	0.01882	
UPH 09	54082342	345252.3	1437395	932.8	14.82	554		1726	0.02675	
UPH 10	54082442	346559.3	1432565	940	14.31	415		2087	0.03448	
UPH 11	55042342	349888.1	1438639	945.3	4.23	448		2130	0.00944	
UPH 12	55042442	351181.6	1433809	944.9	4.92	443	11.5	2242	0.00111	0.00513
UPH 13	56002342	354522	1439880	937.4	4.34	511		2309	0.00849	
UPH 14	56002442	355819.5	1435051	938.4	5.35	485		2308	0.01103	
UPH 15	56962342	359159.2	1441125	925.2	4.33	374		1922	0.01158	
UPH 16	56962442	360454.8	1436295	932.1	5.54	580		2309	0.00955	
UPH 17	57922342	363797.7	1442364	920	4.32	267	7.1	1700	0.01618	0.00418
UPH 18	57922442	365091	1437536	932.8	5.81	402		2090	0.01445	
UPH 19	57922532	366257.2	1433193	951.2	5.44	491		2251	0.01108	
UPH 20	58882342	368435	1443609	933.8	6.83	484		2188	0.01411	
UPH 21	58882442	369730.4	1438780	928.5	4.84	372		2004	0.01301	
UPH 22	58882532	370892.6	1434431	918.4	5.42	344		2081	0.01576	
UPH 23	59842342	373071.4	1444850	930.5	5.53	381		2060	0.01451	
UPH 24	59842442	374364.6	1440022	925.2	4.64	529		1909	0.00877	
UPH 25	59842532	375529.3	1435677	924.3	5.33	539		2027	0.00989	

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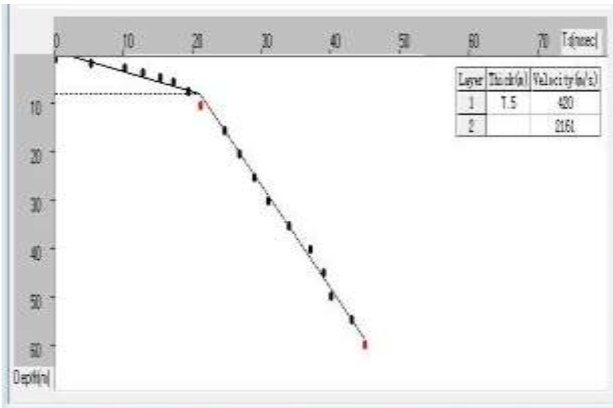
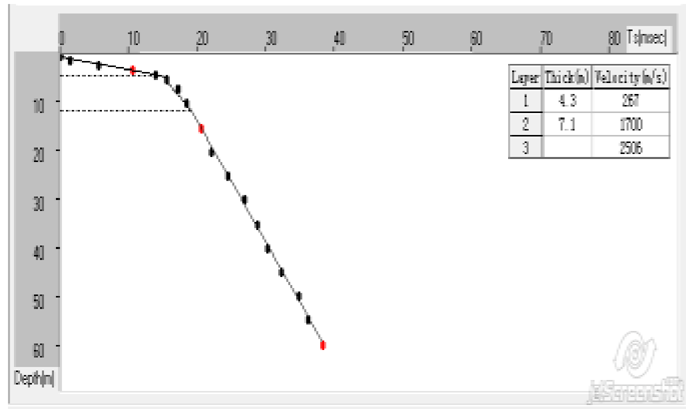
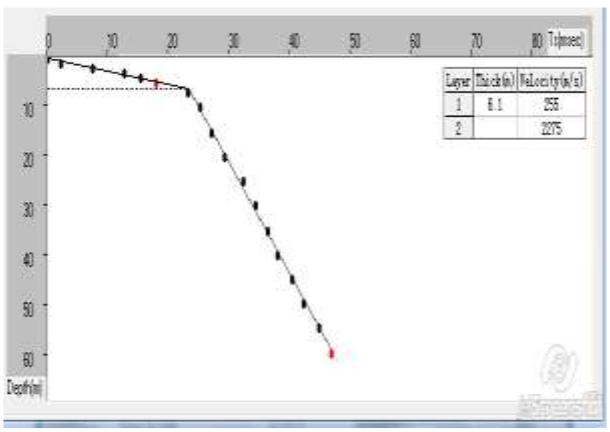
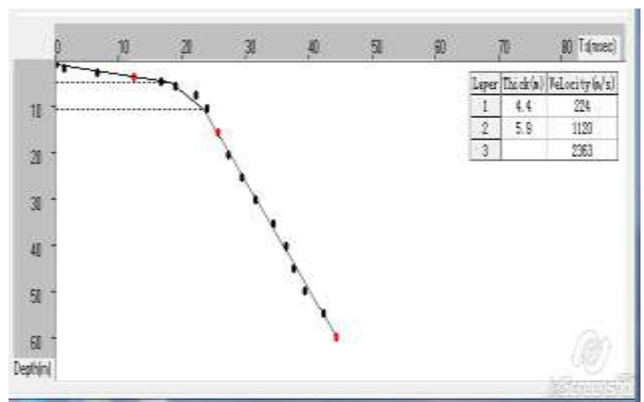
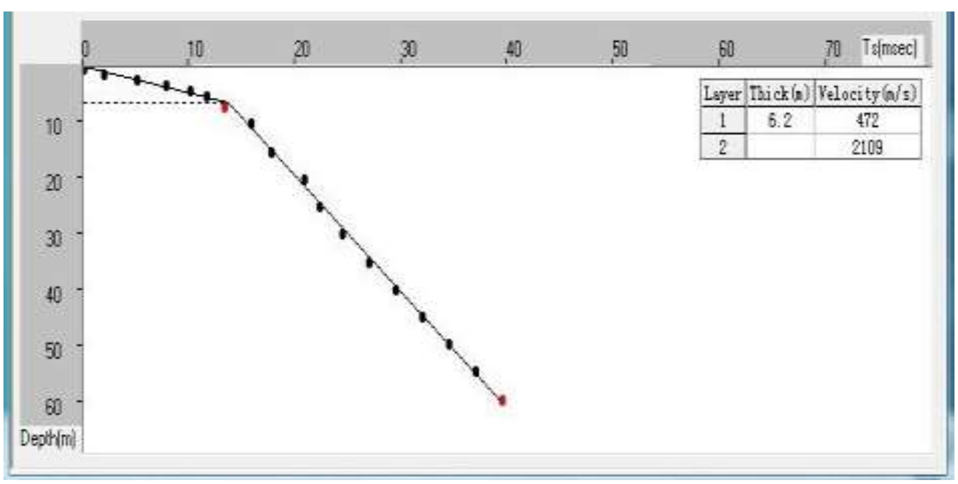
Table 3: **UPHOLE DATA INTERPRETATION OF TRAVERSE TIME VERSE OFFSET (X) CROSSPLOT**











DISCUSSION

From the research carried out in the study area, a total of twenty five uphole data were acquired at various selected station points randomly (table1). From the data acquired their individual graphs of depth against time was plotted (Table:2 to26).The average total depth penetrated by each uphole sounding is about 75m.The results of the soundings revealed two predominant lithostratigraphic layering sequence, where by the younger lithologic unit is the weathered zone and older unit is the consolidated zone. The thickness of the weathered zone ranged from 4.4m to 14.8m while the thickness of the consolidated zone was undefined except for uphole 2, 12 and 17 data, which gave a three layer lithologic sequence. The second layer had thickness of 5.9m, 11.5m and 7.1m respectively. Velocity range for weathered layer was found to be 279.9m-291.3m/s, and its mean velocity is about 285.3m/s, while the velocity range for the consolidated layer is 1015-2450m/s and its mean velocity is about 1732.5m/s. The average time taken to traverse the weathered and consolidated layer is about 0.016 and 0.015 seconds respectively (table 1). The individual time for each layer is shown in table 1 above .Predominantly, the uphole data reveal that the study area is characterized by sands and clay, with minor grits, and ironstone.

Conclusion

The low velocity layer of the earth crush correspond to the topmost layer of the earth's surface which is characterized by the presence of loose, unconsolidated or weathered sedimentary materials or an exfoliated materials of metamorphic or igneous rocks. There is a great disparity in the velocity of the weathering layer (LVL) and that of the underlying consolidated strata and this variation causes error in the arrival time of the reflected/refracted vibrations associated with the small changes in thickness of the weathered layer.

Low velocity layer can be eliminated by correcting for the near statics surface velocity and topographic differences. Differences in arrival time due to difference in the elevation of the geophone will have the effects of positioning a syncline under a hill or an anticline under a valley or a fault under a cliff. It is therefore, required that low velocity layer data acquired during seismic prospecting be corrected to take care of this anomaly. Therefore, this research showed that the elevation and weathering correction (static) was eliminated at a depth of 4.23m.The results can be used to eliminate the effect of low velocity layers at a regional level in seismic processing, planning and assessing risk for engineering structures, and for groundwater exploration.

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