IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 9, Issue 12 Ver. I (Dec. 2015), PP 13-15
www.iosrjournals.org

Hydrogeological Application of Refraction Seismics

Agha S.O.
Department of Industrial Physics, Ebonyi State University, Abakaliki

Abstract: *The principles and procedures for seismic refraction surveying have been applied in the study of the hydrogeology of Afikpo-a sedimentary basin in south-Eastern, Nigeria. The instrument used is a seismograph and its accessories. Compressional seismic waves were used for single line profiling of the area. The result obtained showed that the first, second and third layers of the study area have average velocities of 298m/s, 671m/s and 1554m/s respectively. The result indicates that the zone of saturation in the area is the third layer and its probable lithology is sandstone.*

Key words: *Hydrogeology, sedimentary, saturation, lithology.*

I. Introduction

Geophysics is the study of the earth using physical measurements made on its surface (Kearey and Brooks, 1991). In order to study the earth's subsurface, a lot of geological and geophysical techniques such as seismic, electrical, gravity, magnetic, electromagnetic and radioactivity measurements of the earth's surface are involved. Of all these, the seismic technique appears to be the most commonly employed perhaps because of its use in the exploration of oil and gas. There are two methods of the seismic technique viz reflection and refraction seismic.

Refraction seismic is employed much less intensively than reflection in oil exploration. This is probably attributable to the greater amounts of dynamite required, the larger scale of the field operations and the lower precision in the structural in formation obtainable from the method. (Dobrin,1976). The method of seismic refraction however is widely applied in both engineering geology and hydrogeology. The hydrogeological application of the method is nevertheless the object of this study. By implication, the study aims at determining the water bearing beds underneath the earth in Afikpo using the seismic refraction method. The study area(Afikpo) is located within the southern Benue trough and has a total landmass of about 47km^2.

Anyigor and Agha (2015) carried out a seismic refraction survey on the observation of intrusions in Afikpo. The result they obtained showed that three layers of the subsurface were delineated by the seismic waves used in the survey.The topmost or first layer had a thickness of 6.7m and was interpreted to be made up of sandy clay. The second layer which was interpreted to be sand with gravel had average thickness of 12.9m while the third layer whose thickness was undetermined but whose average velocity was 4530m/s was suspected to be a layer of intrusions. Selemo(1999) carried out a research on the aeromagnetic study of the basement relief of Afikpo. His objective was to study critically the basement relief with a view of understanding properly the intrabasement and suprabasement anomalies that may be responsible for the geological structures in the area.

II. Geology of Study Area

The study area lies close to the southern margin of the Benue – Abakaliki trough. The north-western sector, the Abba Omega-Afikpo axis (which is located close to the Abakaliki anticlinorium is affected by folding-thereby casuing the beds in Afikpo to dip mostly southeasterly by about 30^0-40^0. The regional strike of the Ezeaku formation which underlies the Nkporo shale formation in the area is northeasterly. The Ezeaku formation consists of parallel-to-strike sandstone ridges rising over a low featureless plain of shales and siltstones. Limestone is very minor and occurs as narrow bands in few places. The sandstones are cross- bedded near the top and ripple- laminated near the base. The shales enclosing the sandstone lenses are rarely exposed. The Nkporo shale formation is rich in ammonites. It is overlain by marine Imo shale. (Kogbe, 1976).

III. Instrumentation and Methods

Instrumentation: A portable signal enhancement seismograph was the major equipment used. It is powered by an in-built 12v accumulator with an operating time of about 30hrs. Some other components involved in the instrumentation for the refraction work include aluminum striking plate and a 9kg sledge hammer, which together make up the seismic source.10Hz electromagnetic type P-wave geophones were the detectors used.

Method: For refraction survey on a small scale such as this (determining the lithology and thickness/ depth of water-being bed(s), values of travel times for records up to an offset of 50m is sufficient. The maximum offset in this research however was 60m. The energy required to traverse the shot-detector range came from the sledge hammer/metal source. Single line profiling was adopted with a shot-detector array consisting of about 12

geophones in series. The metal plate was buried to a depth of about 5cm. This was to ensure deeper penetration of seismic energy when the plate is struck with the sledge hammer and for better coupling. Offset distances, X(m) and corresponding travel times,T(ms) were recorded.

IV. Results and Discussion

Results: Refraction curves were generated from the travel time versus offset plots for two locations selected in the study area. The curves are shown in fig.1 and 2.

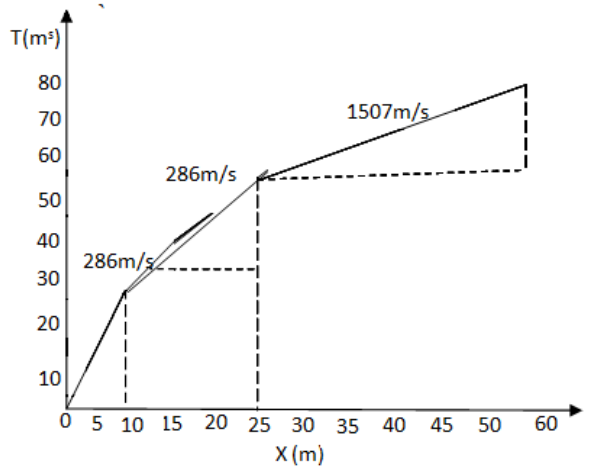

Fig.1. Refraction curve for t-x plot of compressional seismic wave propagation at location 1.

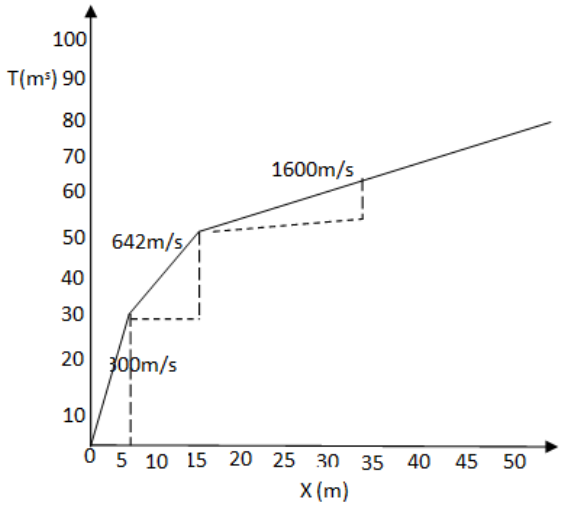

Fig.2. Refraction curve for t-x plot of compressional wave propagation at location 2.

V. Discussion

At the first location, the graph (Fig.1) showed three geoseismic layers with velocities 286m/s, 718m/s and 1507m/s for the first, second and third layers from the surface respectively. These layers were interpreted to be probably loose sand, sandy clay and saturated sand. The thicknesses of the first and second layers were 5.6m, and 3.4m respectively. The thickness of the third layer could not be determined.

At the second location, the t-x curve also showed three geoseismic layers (Fig.2). The velocities of the layers are 300m/s, 624m/s and 1600m/s which when translated into geologic pictures indicates dry sandy soil, sandy clay (dry) and wet sandstone beds. The thickness of the third bed was undetermined.

VI. Conclusion

In the light of the above discussion, we conclude as follows

I. The first three layers of the study area have average compressional wave velocities of 298m/s, 671m/s and 1554m/s accordingly.

II. The average thickness of the first and second layers of the study area are 5.4m and 3.6m respectively.

III. The zone of saturation in the area is the third layer and its probable lithology is sandstone.
III. The the sandstone layer is the aquifer in the study area. The depth to the aquifer was estimated to be 9m.

References

[1]. Anyigor, S. I. and Agha, S. O.(2015): Observation of Intrusions in Seismic Refraction surveys(A Case Study of Afikpo). International Journal of Engineering and Management Sciences. 6(1),19-22.
[2]. Dobrin, M. B. and Savit, C. H.(1988). Introduction to Geophysical Prospecting(4th edition). McGraw-Hill, New York. 120-125.
[3]. Kearey, P. and Brooks, M.(1991). An Introduction to Geophysical Exploation(2nd edition). Blackwell Scientific Publications, London.
[4]. Lowrie, W.(1997). Fundamentals of Geophysics. Cambridge University Press,
[5]. Kogbe, C. A.(1989). Geology of Nigeria. Elizabeth Publishing Company, Lagos. 279-298.U.K. 84-91.
[6]. Selemo, D.(1999). Aeromagnetic Study of the basement relief in Afikpo basin, Nigeria. Unpublished Ph.D thesis, University of Calabar, Nigeria.