استخدام طريقة حفر الآبار في التصحيحات الإستاتيكية الناتجة عن الكثبان الرملية في حوض مرزق

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مستخلص:

تتركز هذه الدراسة حول المشاكل الستاتيكية للخطوط السيزمية ذات البعدين وهذه الخطوط 05-207-210 والخط 05- 200 – 210 حيث تم اختيار هذين الخطين من بين مجموعة من الخطوط التي تقطع الكثبان الرملية في الامتياز(210) في حوض مرزق الو اقع في الجنوب الغربي من ليبيا التي تظهر فيها الكثبان الرملية.

وقد كان طول هذه الخطوط (26.5) كيلو متراً حيث تمت معالجة هذه الخطوط في شركة شمال أفريقيا للاستكشاف الجيوفيزيائي في مركز المعالجة بطر ابلـــس .

وقد تم استخدام طريقة حفر الآبار في الحسابات الاستاتيكية ومقارنتها من حيث السرعة وسماكة الطبقات السطحية وتطبيقها علي المقاطع السيزمية .

وقد أظهرت النتائج ان هده الطريقة غير كافية لحل هذه المشاكل وذلك من حيث صعوبة الحفر والتغير في التكوين للآبار علي الكثبان الرملية .

Computing field Statics Corrections by uphole method due to sand dunes in NC 210 western Libya, Murzuq Basin

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Abstract

Murzuk Basin, located in southwestern Libya, is an intra-cratonic sag basin characterized by a simple structure and stratigraphy. The northeastern part of the basin is mostly covered by a linear sand dunes of Quaternary deposits. These sand dunes cause practical difficulties for the acquisition of seismic data. This study aims to focus on the static problems, caused by sand dunes to improve the quality of seismic data. Two seismic lines were carefully selected to conduct this study. In this study method was used to estimate field statics. Two dimensional seismic lines of 26.550 km in total length that crossed over the sand dunes have been completely reprocessed at North African Geophysical Exploration Company in Tripoli.The conventional field static method, uphole information has been used to interpolate the near surface model velocity and thickness between the upholes, and the results are applied to the seismic data. The static correction by field statics method is not enough to give the information about the subsurface structure because the uphole information on sand dunes not enough. Drilling on sand dunes is very difficult, the lithology changes between the upholes.

Keywords: static method, structure, thickness and upholemethod.

1. Introduction

The North African platform has multiple intracratonic basins, including the Murzuq Basin, which has a surface area of more than 350,000 km^2. The current basin geometry has little in common with the much larger North African sedimentary basin that existed during the early Paleozoic. Instead, the present-day boundaries of the basin are defined by tectonic uplifts, each of which was the result of multiple phases of production. Some generation of fault movement are recognized in the basin, but the resultant degree of deformation is relatively minor. The basin contains a sedimentary fill that reaches a maximum thickness of about 4000m in the basin epi-center which comprises a predominantly marine Paleozoic section and a continental (Aziz, 2000).The approach hydrocarbon play in the basin consists of a per-glacial sandstone reservoir of Ordovician age sourced and sealed by overlying Silurian shale. This play has proved very successful and accounts for approximately 1500 million barrels of recoverable oil discovered to date. Oil generation may have taken place during the Cretaceous time, but further work is required to better define the timing of oil charge(Abdelmoula, 2017). Subsequent regional uplift and erosion have resulted in cooling of the source rocks. This is no longer generated oil over large parts of the basin to the present day (Davidson,etal 2000).

This scheme is organized by several sections such as the location of study area, the project background of the Murzuq Basin, previous work on static corrections due to sand dunes, and the geology of the study area covers the theory and conventional method of estimating field statics, including uphole survey and their interpretations. The method used to obtain a near surface velocity and depth model where designed in, covers the steps that are used in 2D seismic data processing, and procedure used to get the final brute stack sections, and contains discussion and conclusions of all results recommendations were suggested.

1.1. Geology of the Area

Seismic exploration activities in the area of study have been carried out since 1960 and the most recent survey was acquired in the year 2000. For the older surveys, weight drop and dynamite were mainly used as the sources for generating seismic waves, while in more recent surveys Vibroseis has most commonly been used, in our seismic lines survey. In the Murzuq basin, more than 60 exploratory wells have been drilled, resulting in the discovery of more than 15 hydrocarbon pools. Most of the oil is produced from Memouniat sandstone reservoirs of Late Ordovician age sourced by Tanezzuftshales of Early Silurian age (Echikh and Sola, 2000).

The present day structural frame work of Murzuq basin was the result of a cumulative effects of tectonic movements during the Palaeozoic Mesozoic and Cenozoic ages.

As a consequence there are a wide variety of structural styles, fault pattern and trap types. Regional lineaments are probably related to late Precambrian Pan-African fault systems, which largely controlled the early Palaeozoic structural and depositional evolution of this basin. The Murzuk Basin area contains a large intracratonic basin covering an area of over 350 000 km^2. It is bounded to the north by the Gargaf Uplift, to the west by the Tihemboka Arch and to the east by the Tibesti Uplift. To the south, it extends into Niger and is there known as the Djado Basin. The sedimentary section in the central part of the basin has a thickness of 3500 m, comprised mostly of Palaeozoic and Mesozoic rocks. Cretaceous sediments from an escarpment in the northern and eastern parts, while the central parts is covered by the dunes of the Murzuq Sand Sea (Echikh, and Sola, 2000).

The Silurian source rock remains within the oil generation window only in a limited area of the basin centre. The basin including the Tiririne High separating the Al Awaynat and Awbari troughs and the Traghan High The present-day Murzuq Basin did not develop until the Mesozoic. Prior to that, the Paleozoic basin comprised a series of NW-SE directed highs and lows (Goudarzi, 1967). Overall, fault density and structural complexity increase from the southern, more stable parts of the basin, towards the north-eastern and north-western portions. The most complicated and intensively faulted areas are generally located over the Tiririne and Traghan highs (Echikh and Sola, 2004).

The area of study is located in the northeastern part of Murzuq Basin in (Concession NC210),southwesternLibya as showing in Figures (1) and (2) The area is covered with sand dunes reaching approximately around 100 m high and 1 to 2 km wide(Ushah, 2004).These sand dunes cause practical difficulties for the acquisition of seismic reflection data.For this work,two dimensional (2D) seismic lines (NC210-207-05 and NC210-200-05) were selected from several seismic lines.They crosses many sand dunes (Figure 3). Seismic lineNC210-207-05 extend from northwest to southeast and mainly covered by sand, generally the terrain is rough,and the surface elevation is around 460m to 585m.There are 1412 receiver points and 1411 shot points designed, the source and receiver interval is12.5m.Table (1) represent the Azimuth of this seismic lineNC210-207-05.

Table 1: Azimuth of Seismic line NC210-207-05.

Line Name	Stationno.	Easting	Northing	Bending	Azimuth	Distance(km)
NC210-207-05	1000-2411	665172.960- 670091.561	3067294.340- 3050356.549	0°00'00.0 0"	163°48'25.64"	17.6375

Seismic line NC210-200-05 extends from east to west, and covered by sand dunes. The terrain is generally rough and the surfaceelevation is around 498mto524m. There are 714 receiver points and 713shot points designed, receiver points No.1000to 1713, shot points No.1000.5to1712.5, total 8.9125km in length,the source and receiver interval is 12.5m.Table (2) represent the azimuth of this seismic line NC210-200-05.

Table2: Azimuthof Seismic line NC210-200-05.

Line Name	Station no.	Easting	Northing	Bending	Azimuth	Distance(km)
NC210-200-05	1000-1713	662038.000- 670194.062	3061409.000- 3065002.230	0°00'00.00"	66°13'25.16"	8.9125

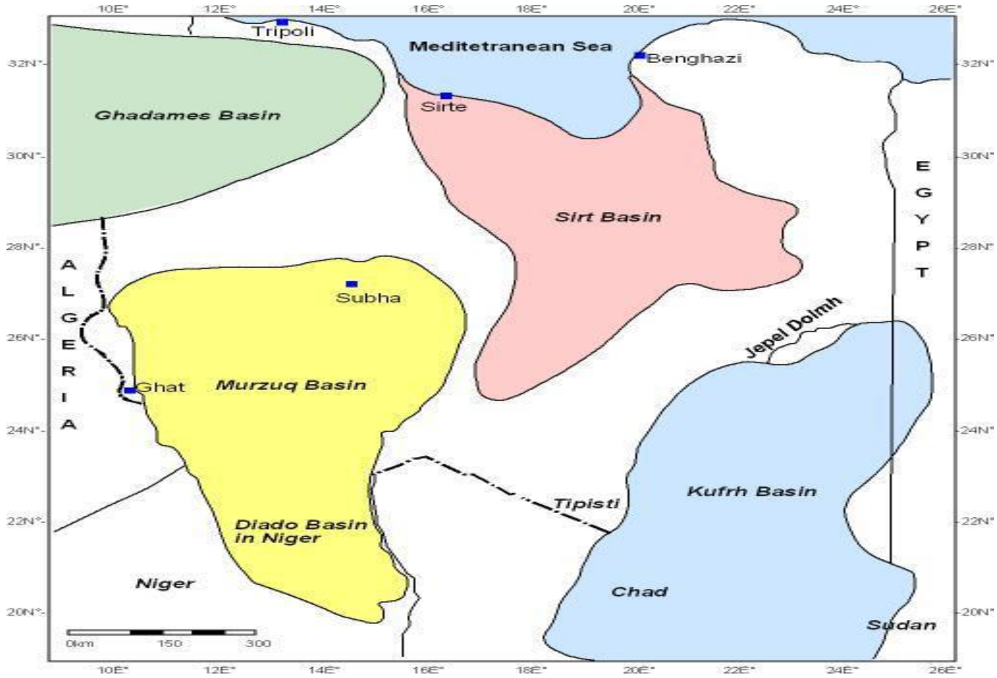


Figure 1: Sedimentary basins of Libya showing the location of Murzuq basin in Southwest of Libya (Ushah, 2004).

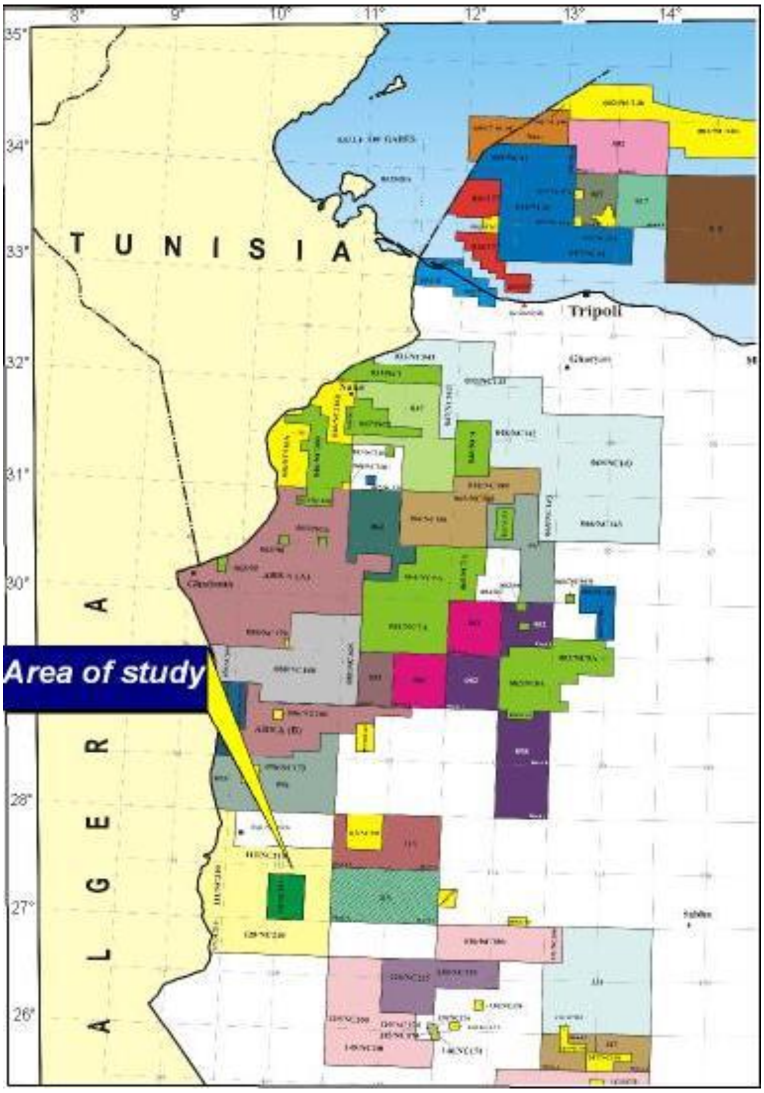


Figure2: Generalized location map of Concessions in western part of Libya showing the study area in Concession NC210 (NOC, 2009 internal report).

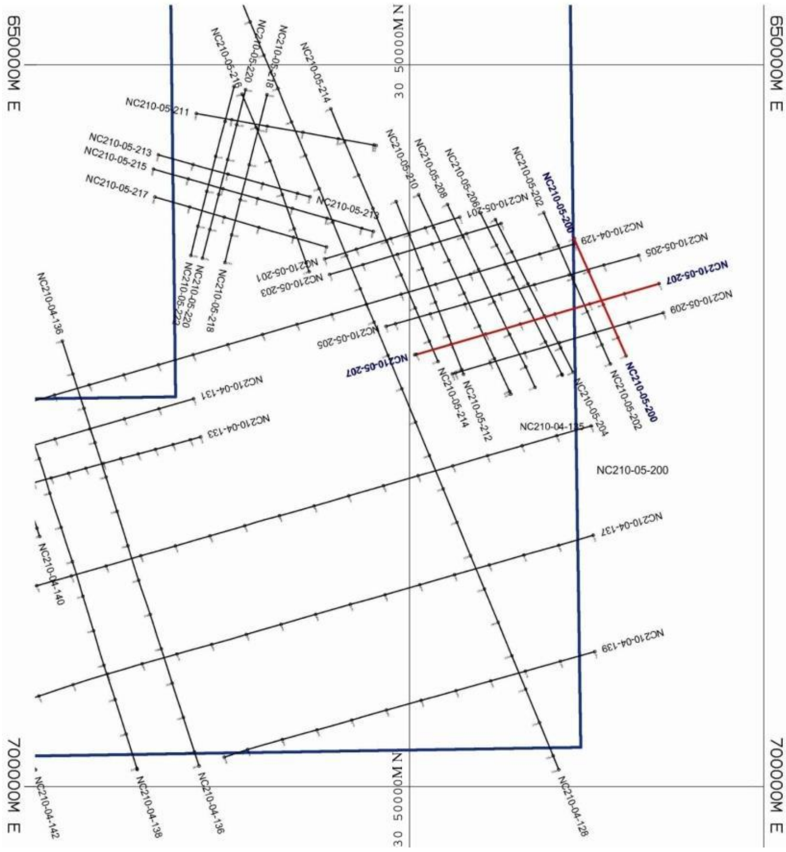


Figure 3: location map shows some of the seismic lines in Concession NC210.
(NOC, 2009 internal report).

2. Previous Work on Static Corrections due to Sand Dunes

There is a huge amount of published work on static corrections, which has been comprehensively reviewed in a textbook by Cox (1999). For a convenient overview, the reader is referred to a series of three papers by Marsden (1993a,b,c).Static corrections can be defined as the time shifts applied to compensate for different travel times of seismic waves through the earth near surface layer, between a horizontal or smooth datum and the ground surface.Robinson and Al-Husseini (1982) addressed the static problem due to sand dunes and described one approach to it is solution. -90m. The reflected waves are delayed in time by up to 150ms at the crests of their data were from Rub AL-Khali, Saudi Arabia, where the dunes are about 1 km wide with a vertical relief of 60dunes. It is often difficult to position uphole-drilling rigs near the tops of dunes,and it is awkward to drill in soft sand. Therefore Robinson and AL-Husseini (1982) generated a cross plot of travel time against the elevation of the dune surface.

3. Method of study:

3.1. Uphole Surveys

Uphole survey is used in land seismic survey to estimate the information about the near surface layer. Uphole survey designed to evaluate the thicknesses and velocity of the near surface layer in the borehole. In an exploration area with lowrelief structural targets, the main assumption used in conventional static correction is that ray paths are vertical in the near surface (in case of low velocity layer).
The field static data were computed by uphole survey method are applied to the seismic data, this method of computing the field static is referred to the conventional method in this work.
The two dimensional (2D) seismic lines NC210-207-05 and NC210-200-05,have been processed byNAGECO processing centre in Tripoli. The computation and application ofconventional method on seismic lines have been tested and presented in this work.

3.2. Static CorrectionTheory

The main important data processing step is the static correction calculations,the static correction can make a lot of difference on the section,especially in areas of rough terrain and areas where near surface velocity is highly variable.
The purpose of the static correction is to remove the effects of the near surface caused by changes in elevation and for near surfacelateral change in velocity.

3.3. Datum Static Correction Method

We can compute the elevation and weathering travel time,if we know information about near surface layer, Figure (5) describes the near surface profile with the location of a source, or receiver, at point (A)

onthe surface, the elevation of weathering corrections can be computed as following:
the elevation travel time is given byequation (2.1):

$t_{EA} = (E_A - Z_A - E_D)/V_r$(2.1),

where $E_D$is the elevation of datum,

Z_A is the thickness of the weathering layer,

E_A is the elevation of the source or receiver at point (A),

V_W is the velocity of the weathering layer,

V_r is the velocity of the sub weathering layer, or replacement velocity,

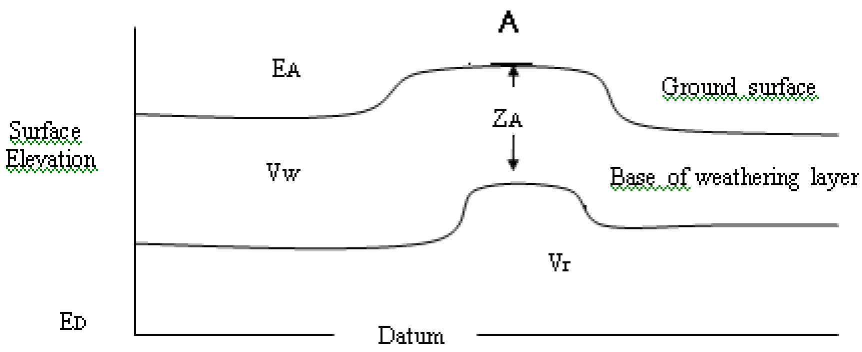
the symbol Z_A in equation (2.1) refers to the total thickness of the weathering layer. If there is more than one weathering layer, the weathering travel time is the sum of individual layer travel times, each of which is computed from its thickness and velocity.

t_{WA} weathering travel time, is given by equation (2.2):

$t_{WA} = Z_A/V_W$(2.2), for one layer,

the total datum static correction t_A, is equal to the sum of the weathering and elevation travel times, the negative sign of static correction means that the source and receivers are above the datum: time $t_A$is given by equation (2.3):

$t_A = -(t_{WA} +$



$t_{EA})$(2.3),

Figure 5: Computation of datumstaticcorrection withthe source or receiver at the surface.

3.4. Data Acquisition

Fourupholes have been drilled at selected locations along line NC210-207-05,and one uphole along line NC210-200-05. These upholesprovide direct measurements of the velocities and thicknesses of the weathering and sub weathering layers. The depth for these upholesabout 30m – 70m.

The source at surface used in this survey is the hammer and plate. The source is located 3m away from the top of the borehole, and receivers in the borehole as illustrated in Figure (6). The cable containing hydrophones, to be lowered into the borehole. The shooting at interval different depths and travel times of direct waves are estimated from uphole records (Figure 7).

borehole source surface

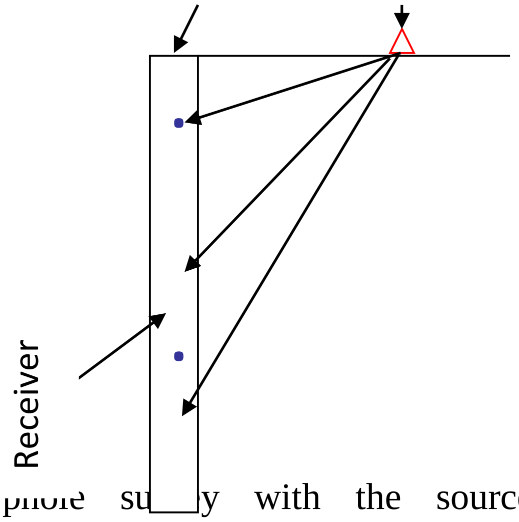


Figure 6:Uphole survey with the source at the surface andhydrophones in the boreholefrom (Cox,1999) .

Record channel (1-36).

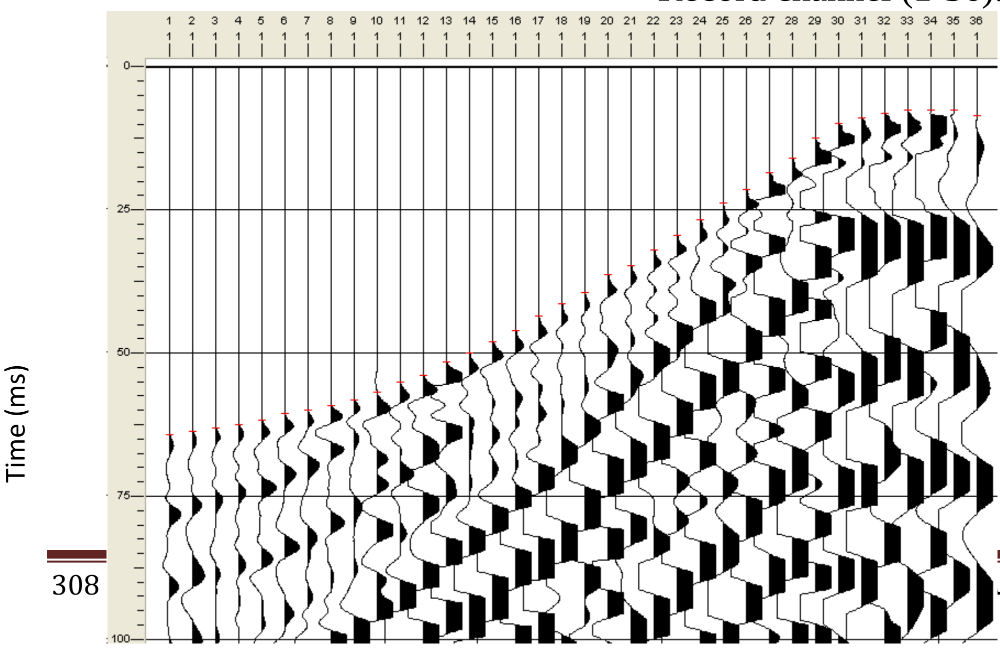
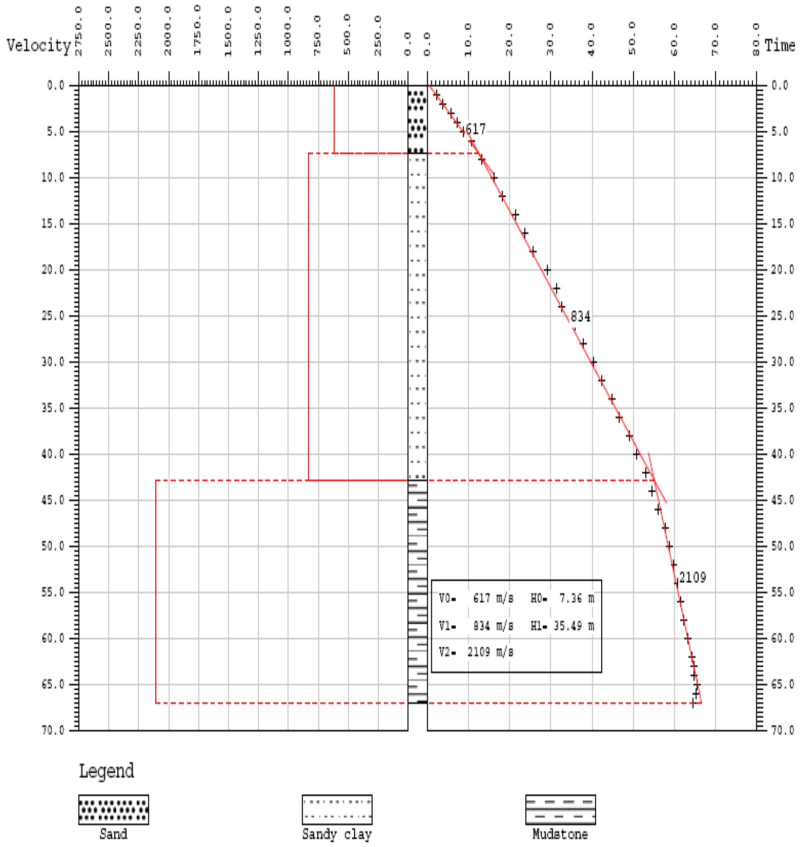


Figure 7:A field record of data from an uphole survey for seismic line NC210-207-05, Station (1128.5).

4. Interpretation ofUphole Data

A vertical uphole time is plotted against depth, the times from the source to the receiver were



measured and adjusted with a geometric correction to generate vertical times. The adjusted and corrected times are then plotted on a time-depth display in Figures (8, 9and 10), and straight lines are fitted to the plotted points. Interval velocity for each layer can be estimated from the slopes of these lines, and intersection points of these lines give the thickness of each interface, the differences between interface depths give the thickness of each layer, the most convention for depths is to be plotted vertically and times horizontally. The results of the interpretation of the upholes are shown in tables (3), and for seismic line NC210-207-05. One uphole is located on seismic line NC210-200-05, this uphole is interpreted and summarized in Table (4).

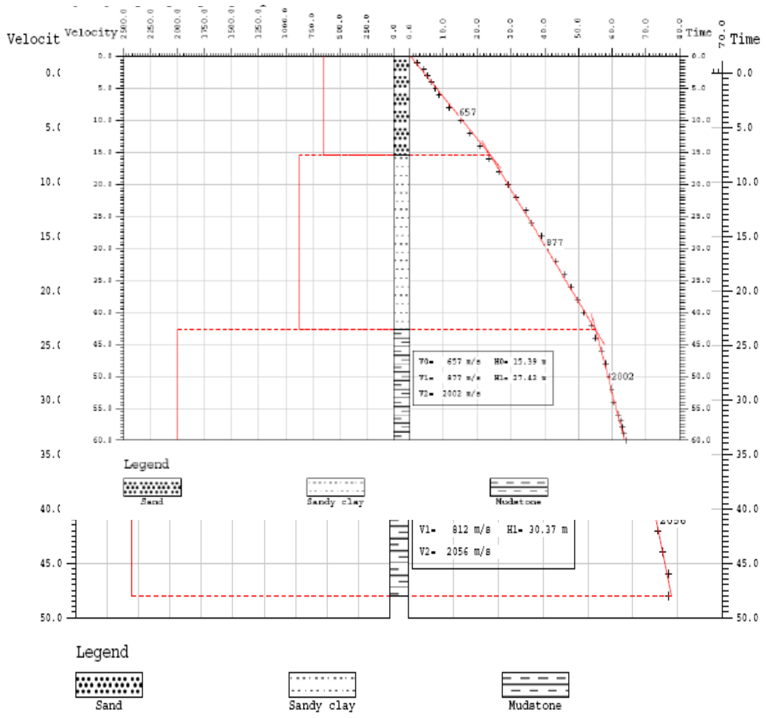


Figure 8: Interpretation of uphole on seismic line NC210-207-05, station (1128.5).

Figure9: Interpretation of uphole on seismic line NC210-207-05, station (1332.5).

Figure 10: Interpretation of uphole on seismic line NC210-200-05, station (1188.5).

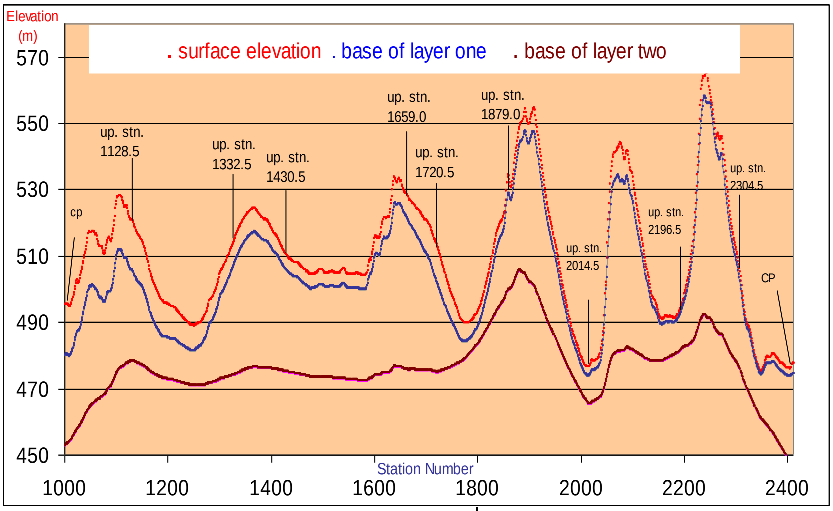
Table 3:Datum static correction (weathering and elevationcorrections) at the upholes along seismic lineNC210-207-05.

Variables	UpholeStn. 1128.5	UpholeStn. 1332.5
EA - surface elevation	521.1 m	517.0 m
Ed - Datum elevation	500 m	500 m
Z1 - Thickness of layer 1	15.39 m	7.36 m
Z2 - Thickness of layer 2	27.42 m	35.49 m
EA – (Z1+ Z2) - Ed	-21.71 m	-25.85 m
Vw1 - Weathering velocity of layer 1	657 m/s	617 m/s

Vw2 - Weathering velocity of layer 2	877 m/s	834 m/s
Vr - Replacement velocity Vc- Velocity correction	2002 m/s 2450 m/s	2109 m/s 2450 m/s
Weathering Correction Z1 / VW1 Z2 / VW2	23.42 ms 31.26 ms	11.9 ms 42.5 ms
Elevation Correction = { EA - (Z1+ Z2) - Ed } / Vc	-8.86 ms	-10.55 ms
Datum Correction = - (Weathering Correction + Elevation Correction)	-45.8 ms	-43.9 ms

Table 4: Datum static correction (weathering and elevationcorrections) at the uphole along seismic line NC210-200-05.

Variables	Uphole Stn.1188.5
EA - surface elevation	510.7 m
Ed - Datum elevation	500 m
Z1 - Thickness of layer 1	5.79 m
Z2 - Thickness of layer 2	30.37 m
EA - (Z1+ Z2) - Ed	-25.46 m
Vw1 - Weathering velocity of layer 1	375 m/s
Vw2 - Weathering velocity of layer 2	812 m/s
Vr - Replacement velocity Vc - Velocity correction	2056 m/s 2450 m/s
Weathering Correction Z1 / VW1	15.44 ms



Z2 / VW2	37.4 ms
Elevation Correction = { EA - (Z1+ Z2) - Ed } / Vc	- 10.39 ms
Datum Correction = - (Weathering Correction + Elevation Correction)	- 42.4 ms

5. Near Surface Model

A two layer model was used for calculated uphole static correction, for seismic lines NC210-207-05 and NC210-200-05, in concession NC210, interpretation of some upholes was adjusted to be fit the model,Figure (11), information from drilled upholes along these two lines, and intersection points with the other lines there arenineupholesbetween the seismic lines, and the control points (cp) chosen is used to calculate the static correction as shown in table (5).

Figure 11: Two layers thickness model for source seismic lines NC210-207-05.

Table 5: Control list for line NC21-207-05, contains the information obtained from
upholes, control points (cp).

Type of points	Station No.	Northing	Easting	Elevation (m)	Thick(m) Layer 1	Thick(m) Layer 2	Vw1 (m/s)	Vw2 (m/s)	Vsw (m/s)
cp	1000.5	3067290	665181	495.3	480.1	452.9	481	784	2064
uphole	1128.5	3065754	665627	520.8	505.7	478.4	480	784	2064
uphole	1332.5	3063304	666339	516.8	509.7	474.5	440	867	2142
uphole	1430.5	3062127	666680	509.8	505.3	475	472	775	2035
uphole	1659.5	3059379	667478	528.8	522	475.8	655	875	2003
uphole	1720.5	3058647	667691	512.8	501.5	474.9	616	834	2108
uphole	1879.5	3056741	668244	548.8	543.5	505.7	451	862	2280
uphole	2014.5	3055118	668716	476.6	473.9	465.3	625	1677	2262
uphole	2196.5	3052931	669351	496.8	495.3	482.3	398	1016	2444
uphole	2304.5	3051636	669726	507.3	504.4	476.6	340	793	2067
cp	2410.5	3050362	670096.3	477.4	474.3	446.9	340	792	2065

where cp is the control points,
Vw1 is the weathering velocity of layer 1,
Vw2 is the weathering velocity of layer 2,
Vsw is the velocity of the sub weathering layer, or replacement Velocity.

6. Final Brute Stack Sections

After applied processing steps on these two seismic lines, we appliedstatic corrections on brute stack section, also we can see the different results of brute stack with static corrections, seismic lines NC210-207-05 (17.6 km, total length) and NC210-200-05 (8.9 km, total length) and split spread shot gathers, respectively with 12.5 m, source and receiver spacing (along most of the lines). Each shot gather consisted of 400 traces with 200 fold cover. Figure (12) illustrates brute stack section of seismic line NC210-207-05 with no static correction applied. Figure (13) represents brute stack section of seismic line NC210-207-05 after applying uphole static.
Figure (14) shows the brute stack section of seismic line NC210-200-05 without any static correction applied. Figure (15) represents brute stack section of seismic line NC210-200-05 after applying uphole static.

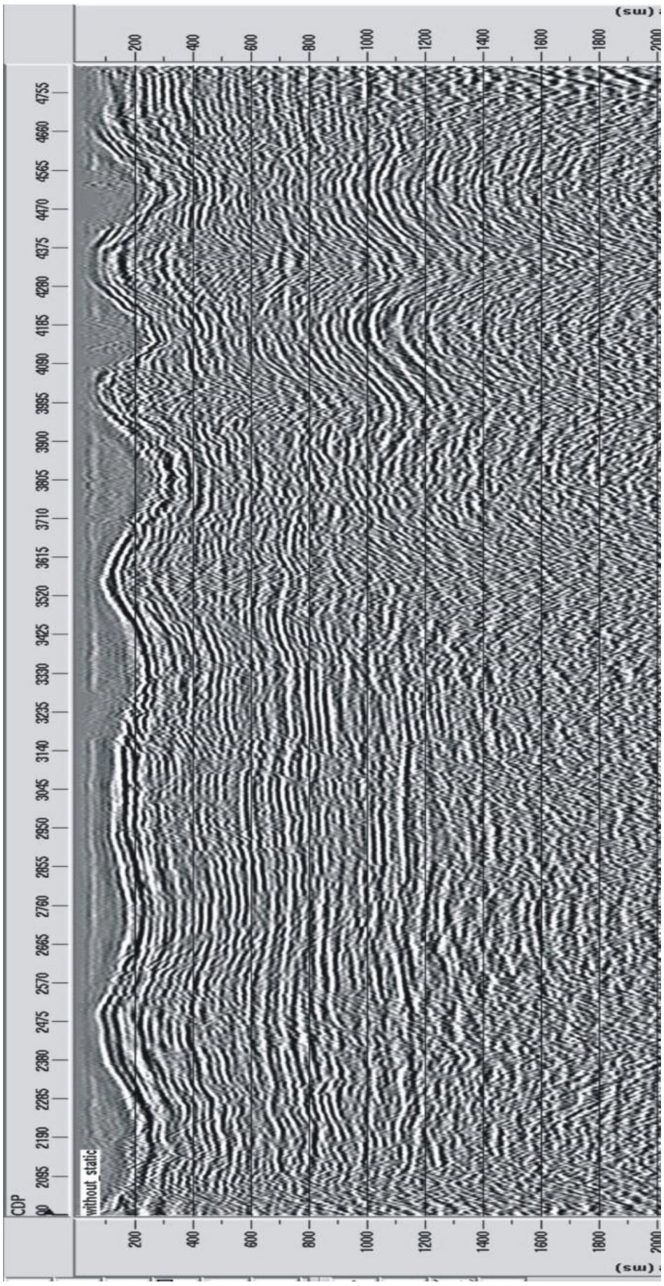
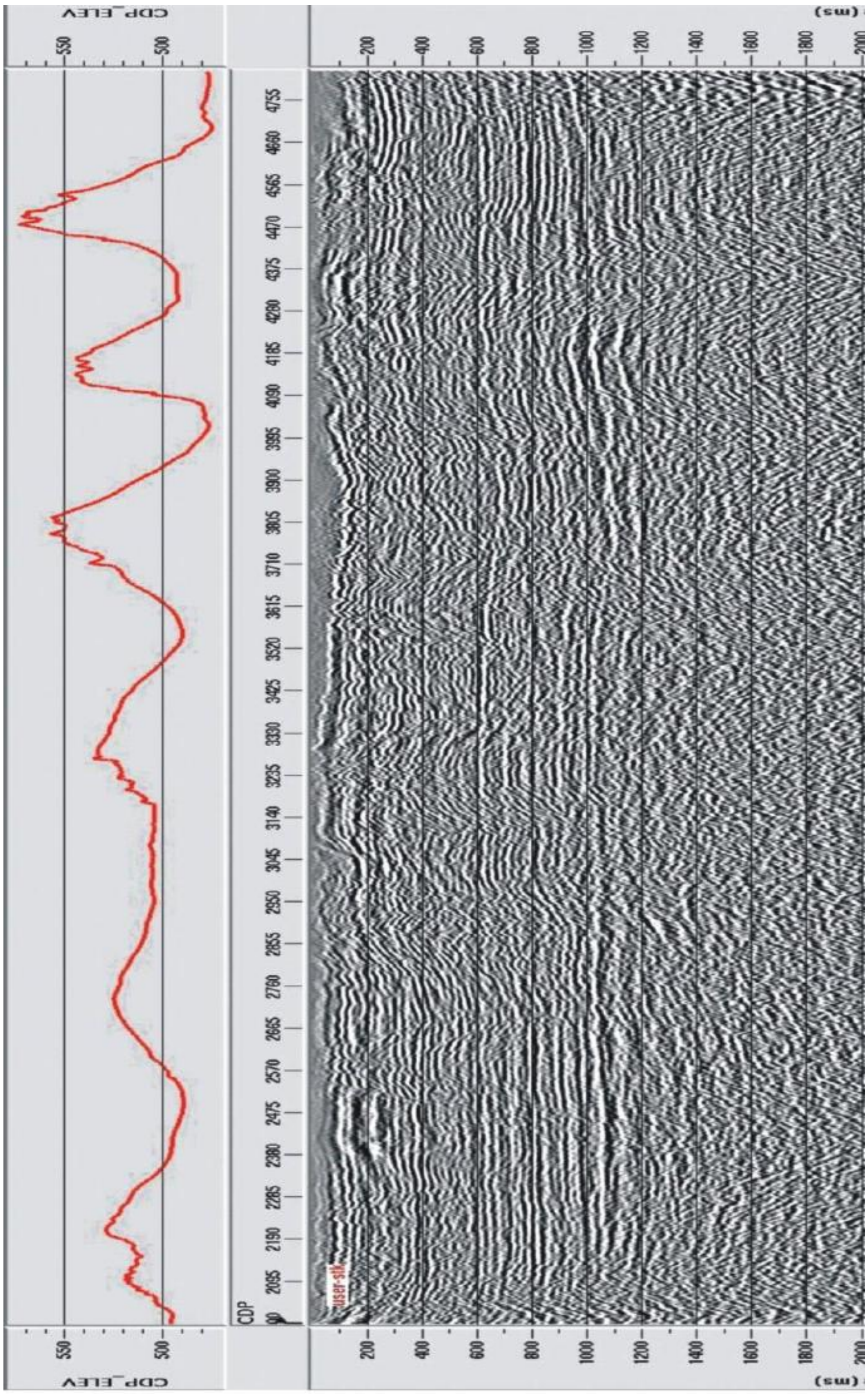


Figure 12: the brute stack before any static correction applied for seismic line NC210-207-05.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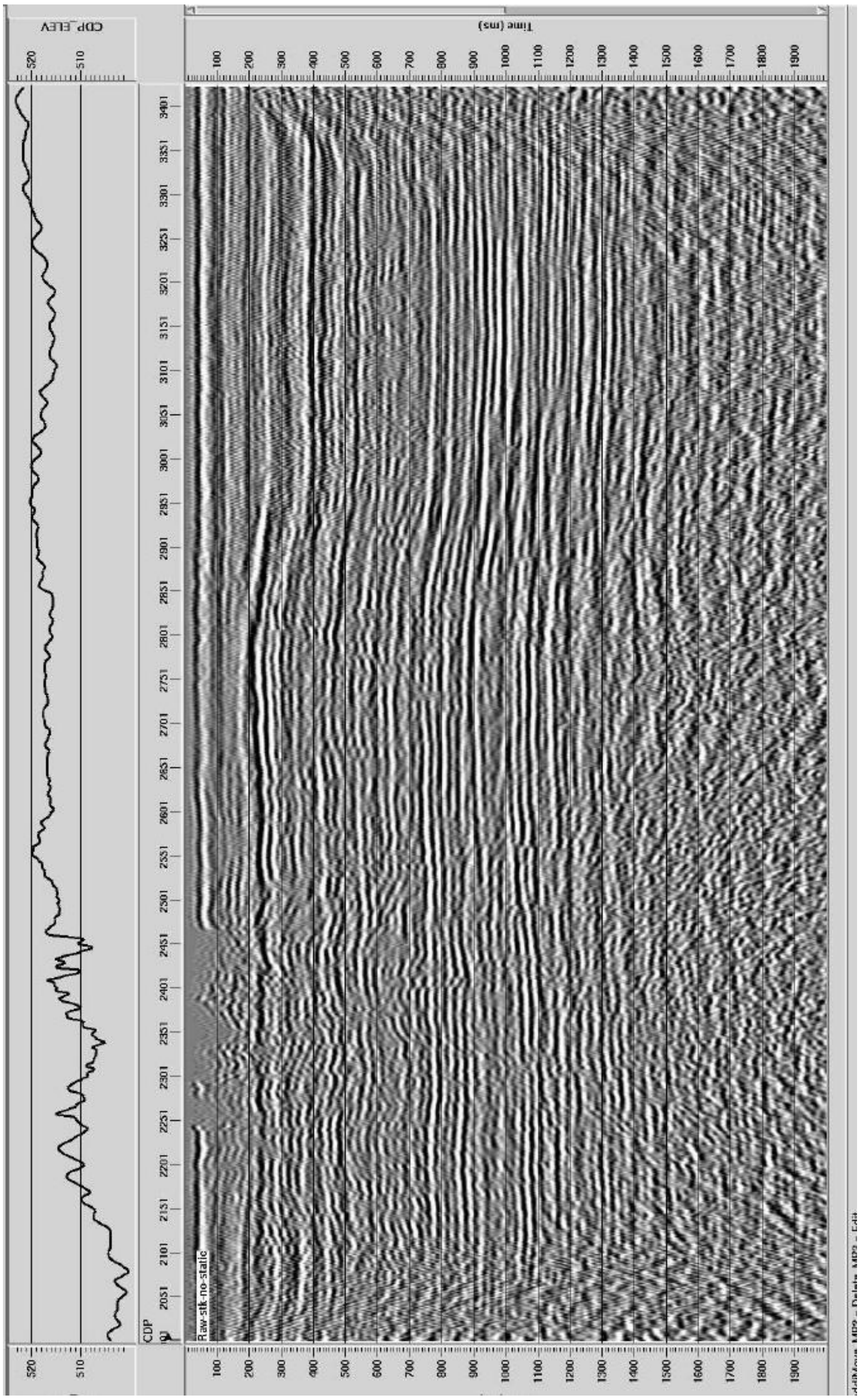
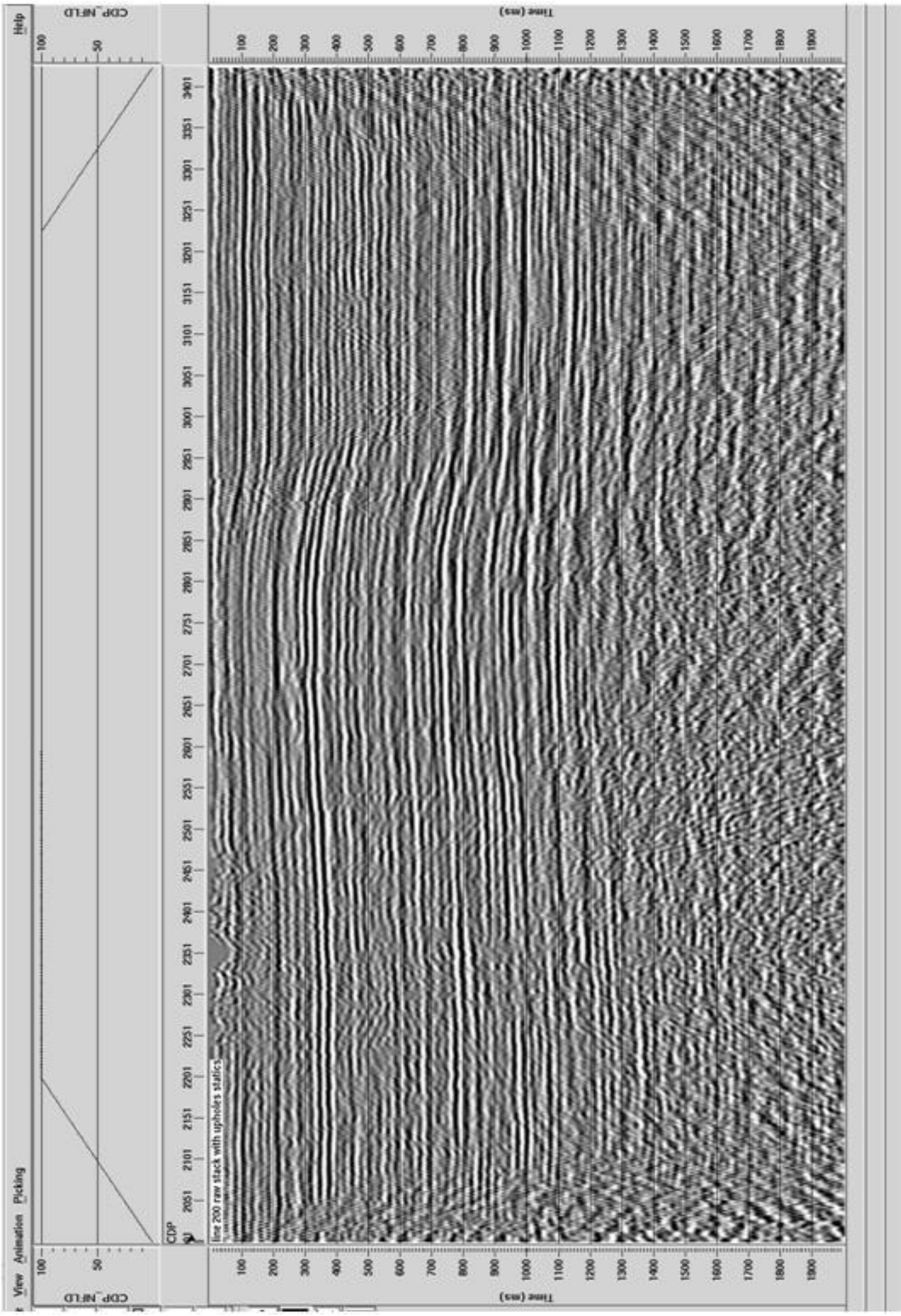


Figure 14: the brute stack without any static correction applied for seismic line NC210-200-05.



7. Conclusions

Themethod wasused to calculate the static correctionand applied on two seismic lines NC210-207-05, and line NC210-200-05,thetwoseismic lines crossed the sand dunes.

The method field staticsusing uphole information about the near surface layer, in the borehole drilled on these two seismic lines.The static correction by field statics method is not enough to give the information about the subsurface structure because the uphole information on sand dunes not enough. Drilling on sand dunes is very difficult, the lithology changes between the upholes. The field statics method is good to use when the lithology does not change between the upholes.

8. Recommendations

The area of study in Atshan arecovered with very high sanddunes,itisdifficult to study by conventional method. To obtainverygood results static correctionfinally the recommendations are summarized asthe following:

- The upholes should be very closed to each other to get good informationand cover thechange in lithology between the upholes.And getting good interpolation between the upholes.
- The depth of the upholes should be drilled to investigate the base ofweathering zone to obtain the accurate information about the thickness and velocity of weatheringand sub-weathering zone.

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