

Seismic Refraction Survey of Tar Sands Deposits in Ijebu East of Ogun State Southwestern Nigeria

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Abstract: The interest in unconventional oil resources such as tar sands and oil shale is known as great economic importance by the governments and industries have encouraged researches in the development of these resources. Vast tar sands resources have not been adequately explored and exploited by the Nigeria Government except for accumulation of oil, natural gas and other minerals but bitumen has proven to be of great value. This motivated this study to map the tar sands deposit at Imeri in Ijebu-Imushin within the Ijebu-East Local government area in Ogun State using seismic refraction survey. A seismic refraction survey at Imeri, Ijebu-Imushin of Ijebu-east carried out using ABEM seismograph Terraloc Mark 6 Version 2.22. Thirteen (13) traverse were taken along five profiles in which both forward and backward shooting were measured to cover a spread of 72m in each of the traverse. Pickwin software was adopted to analyze the results obtained in order to give information on first arrival time and velocity of the first and second layers. A model of the earth structure was achieved by the used of ploterrafa (refraction) software and interpretation to determine the thickness of the first layer from the processed data based on the known geology of the area. The velocities of the first layers of five profiles ranges from (0.75-1.30)km/s and the second layers velocities ranges were from (1.31-2.51)km/s. The presence of tar sands was observed in traverse 6, 7, 8, 9&12, with velocity values (1.12-1.44)km/s, (1.12-1.86)km/s and (1.10-1.47)km/s respectively. The depth of the first layer of the above profile ranges from (5.00-7.10)m. traverses 1-5, 10,11 and 13 shows the presence of clayed sand, sand, sand stone clay and sand with water saturation respectively was observed. The information provided by the analysis and interpretation of the first arrival time and velocities of the first and second layers concise with geologic trends of the rock type in the study area. It was observed that the velocities of the first and second layers were related to the velocities of different earth materials and their depth to the surface.

Keywords: ABEM seismograph Terraloc Mark 6 Version 2.22, first arrival time, Pickwin, ploterrafa (refraction) software.

I. Introduction

Tar sands (also referred to as oil sands) are a combination of clay, sand water and bitumen, a heavy black viscous oil. Tar sands can be mined and processed to extract the oil – rich bitumen, which is then refined into oil. The bitumen in tar sands cannot be pumped from the ground in its natural state; instead tar sand deposits are mined, usually strip mining or open pit techniques, or the oil is extracted by underground heating with additional upgrading. Odunaike *et al.*, (2009).

These are grains of sand or, in some cases, porous carbonate rocks that are intimately mixed with a very heavy, asphalt-like crude oil called *bitumen*. The bitumen is much too viscous to be recovered by traditional petroleum recovery techniques. Tar sands contain about 10-15% bitumen, the remainder being sand or other inorganic materials. (committee on oil and tar sand, 2008).

Tar sands are mined and processed to generate oil similar to oil pumped from conventional oil wells, but extracting oil from tar sands is more complex than conventional oil recovery. Oil sands recovery processes include extraction and separation system to separate the bitumen from the clay, sand and water that make up the tar sands. Bitumen also requires additional upgrading before it can be refined. Because it is so viscous (thick), it also requires dilution with lighter hydrocarbons to make it transportable by pipelines. Kambiz (2010)

The estimated world – wide resources of tar sands are about three times the known petroleum reserves. The world's largest deposit of tar sands is near Athabasca, in Alberta.

Bitumen was first discovered in Nigerian in 1990 in a belt stretching from east of Ijebu Ode (Ogun State) through Okitipupa (Ondo State), Benin (Edo State) and then in Lagos State. A series of drilling programmes between 1907 and 1914 by the defunct Nigerian Bitumen Corporation (NBC), following the trend of the outcrop belt from north-east of Lekki Lagoon in Ogun State to the south east in Odon State. Nigeria's

reserves of oil sands are estimated to be 30 to 40 billion barrels of heavy oil in place with future potential recovery of $3,654 \times 10^6$ billion barrels (Adegoke et al., 1991).

The by-product of the bitumen can be useful domestically; pitch a by-product of bitumen can be used as a smokeless, domestic charcoal/coal briquette. It is also a useful material for petroleum and allied industries. Nigeria is known to have enormous reserves of oil sands within a belt that cut across Ogun, Ondo and Edo states, covering a distance of approximately 10 km. Oduniake et al., (2010).

Today's oil price is good news for heavy oil developers. But the past year has also brought new economic realities in the two biggest heavy oil resource countries. It increased scrutiny of environmental issues surrounding unconventional oil development.

The inclination is to call these challenges "non-technical". But all the challenges that heavy oil development faces will ultimately be dealt with through the development of new technology. The country to look at all possible sources, including its significant heavy oil deposits to the economy of the concern country. Ministry of mines and steel development (MMSD) 2010.

II. Materials And Methods

The survey involved the understudying of the geology, topography and general selling of the, follow by seismic refraction measurements and interpretation of the acquired data by geophysical software using pickwin and ploterafa software.

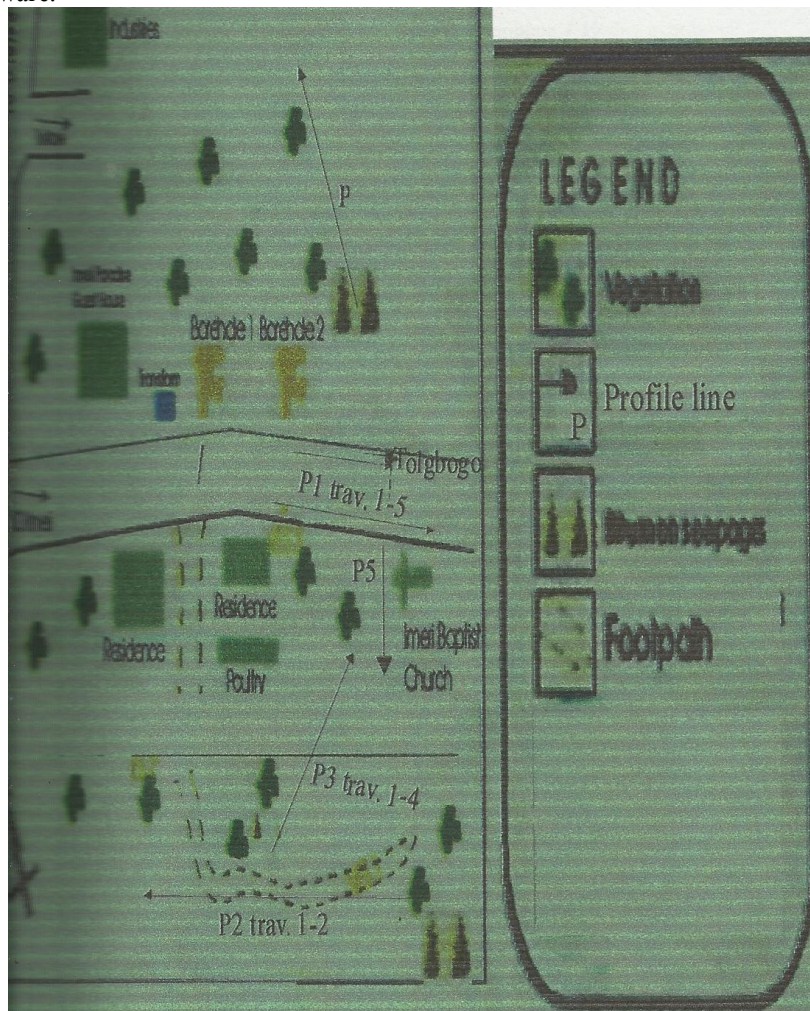


Figure 1 Base map of the study area

FIELD PROCEDURE

A total of five seismic refraction profiles were run, in which 13 traverse were cut both forward and backward shooting were carried out along each traverse over a lateral distance of 75 meters. Sufficient information on the direct wave and reasonable converse of the reflection was obtained.

In – Line seismic refraction technique was carried out by placing 24 Geophones with a spacing of 3m from each other (fig 1)

The geophones were positioned by pushing a spike screwed to the casing firmly into the ground. The geophone were then connected through the seismic cable to ABEM seismograph.

The seismograph was connected to the battery to power it for its operation and sensor wire connected to the seismograph. The sensor was attached to the hammer in the correct direction to take the sound received from the hammer. The metal plate was placed 3m off the first geophone's. seismic wave was generated by impact from hitting a 6 pound sledgehammer on a metal plate.

Record was pressed on the seismograph and as the hammer was hit on the metal plate. The purpose is to improve the pulse hitting the ground directly to provide more seismic energy.

A series of 2 to 4 were initiated for spread, one or more beyond the ends (3m off the first geophones). These additional shot points allow dipping interfaces, change in overburden materials, and intermediate layers to be identified shot points increase the accuracy of the depth of bed rock interpretation. The geophone signal which is electric current produced by ground vibration was transmitted to the recording system (seismography) by means of seismic cable.

After the plate has been struck, stop was pressed on the seismograph and the data collected was recorded. The hammer was hit more than once to take average of the first arrival travel time and the file was saved with a name that relates to the geophone position. The geophone was then moved and a new file was opened; this was repeated until data was collected for the whole survey. Milson (2003)

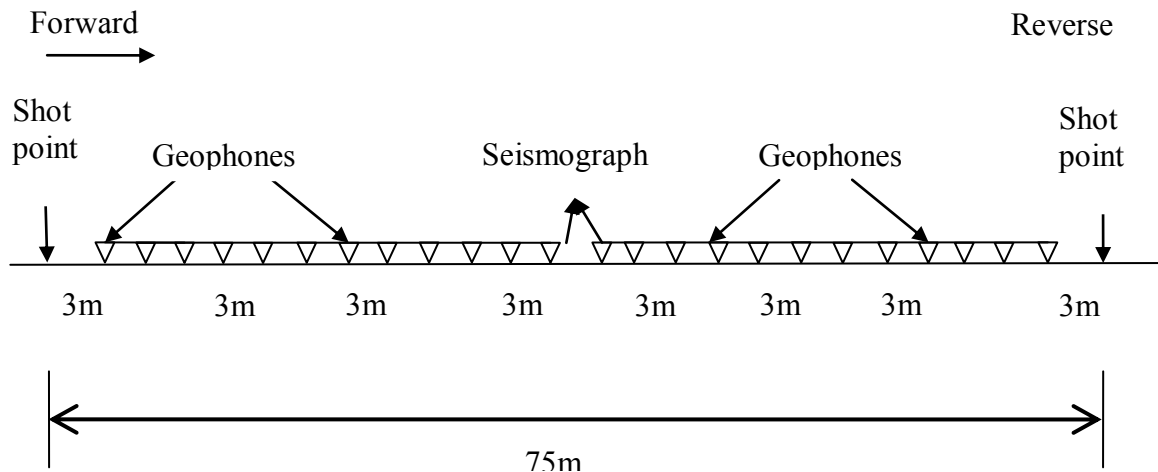
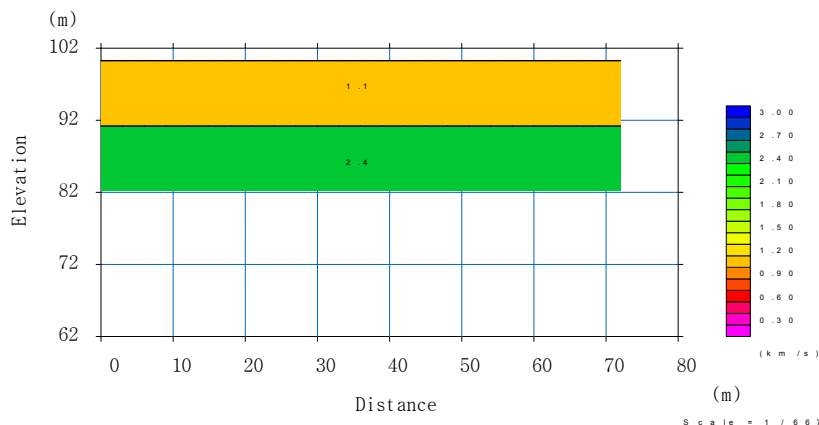


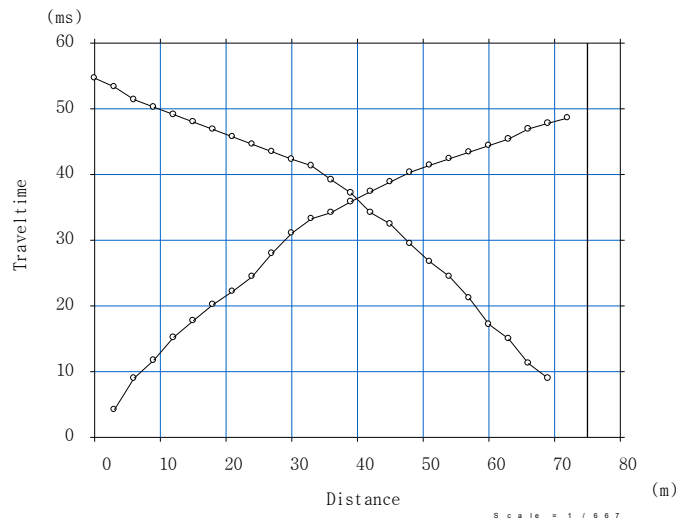
Fig 2 The arrangement of seismograph and geophone on the field.

III. Result

The measurement of arrival time thickness and the velocity of each year layer for the thirteen traverse from five profiles were presented in Figure 2-14 and Table 1 respectively.



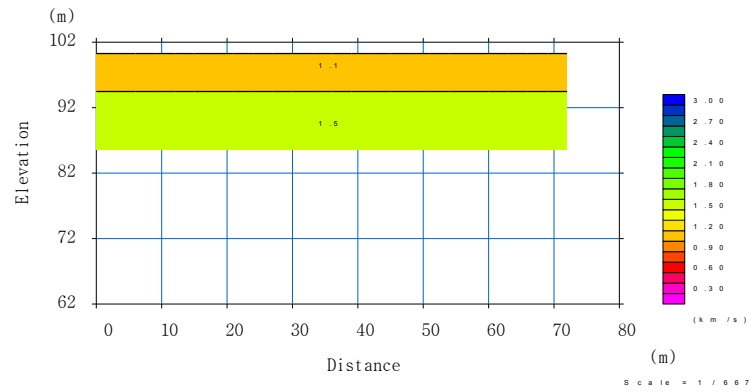
(a)



(b)

Figure 3 a&b: pick first arrival time and model of Traverse1

(a)



(b)

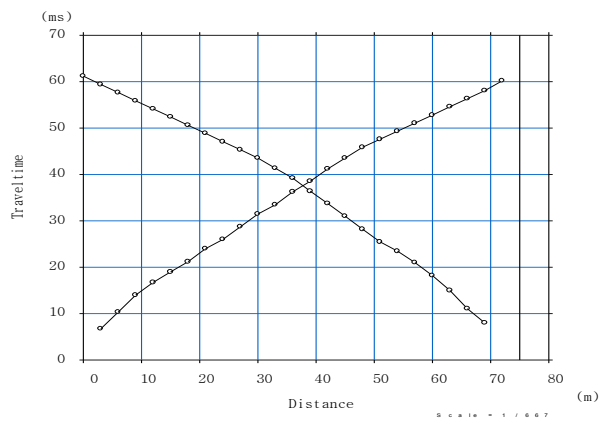
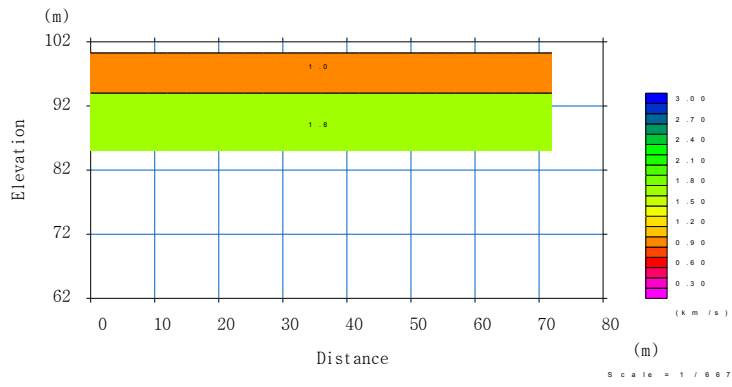
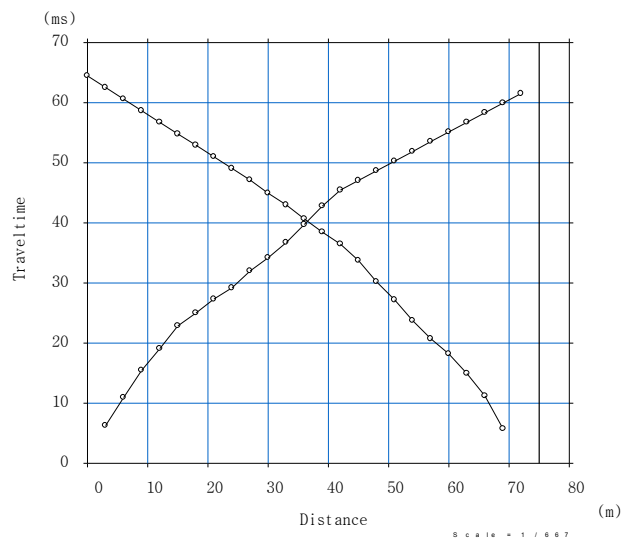


Figure 4 a&b: pick first arrival time and model of Traverse2

(a)



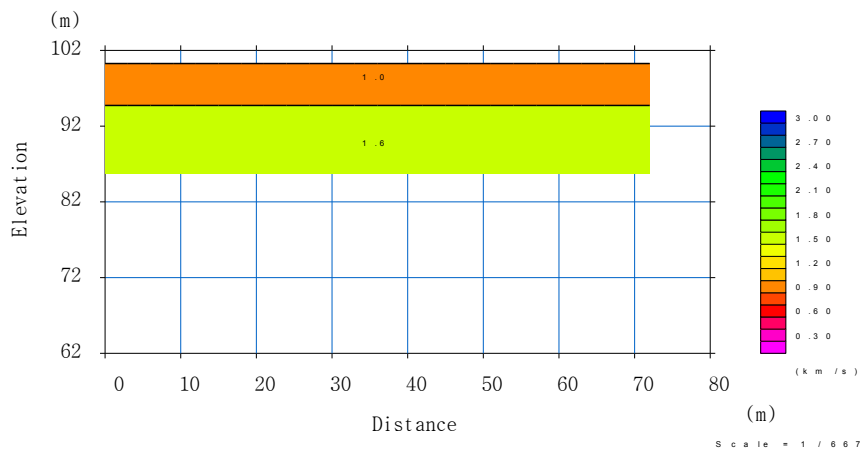
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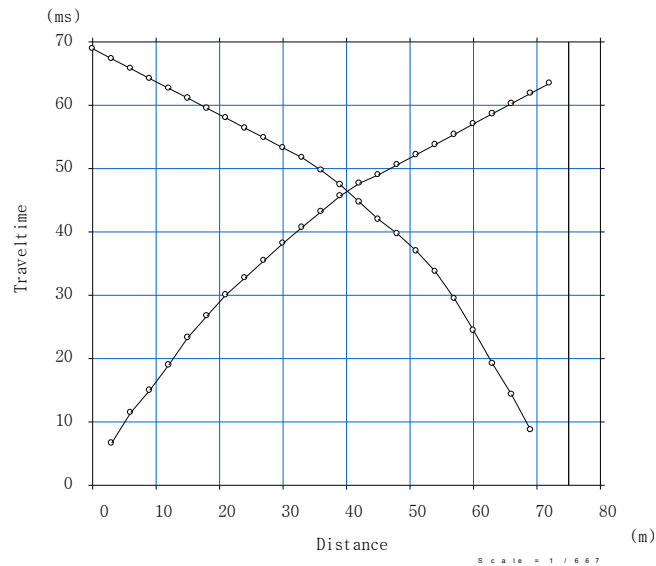


(b)

Figure 5 a&b: pick first arrival time and model of Traverse3

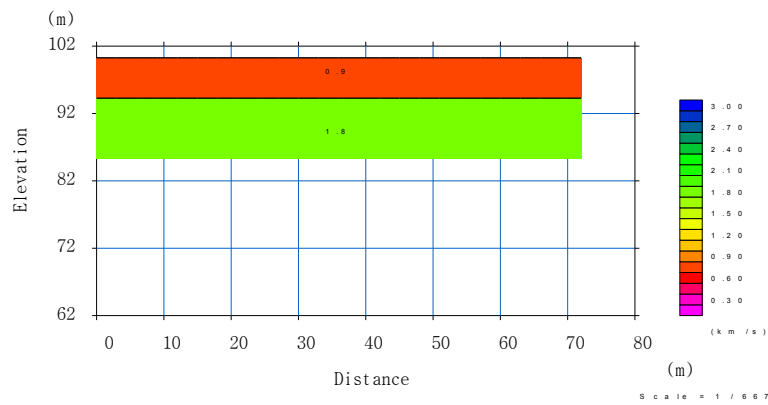
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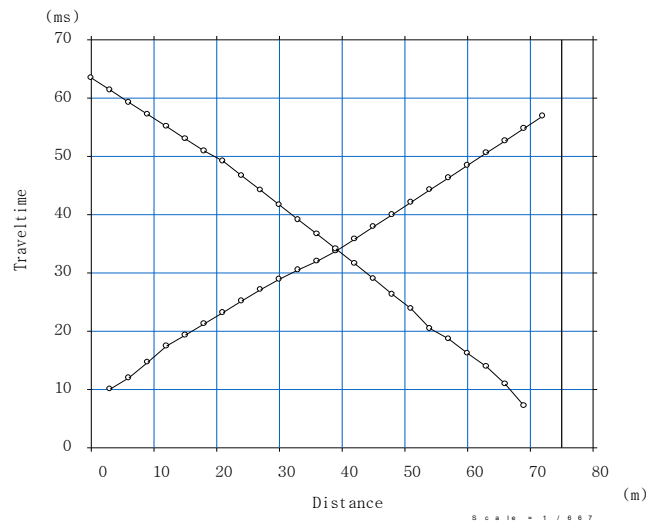


(b)

Figure 6 a&b: pick first arrival time and model of Traverse4

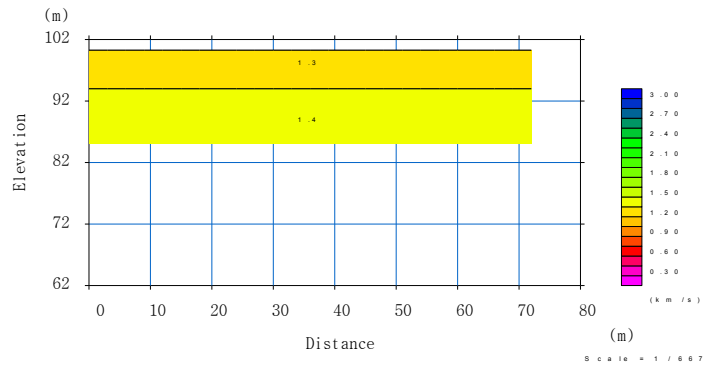


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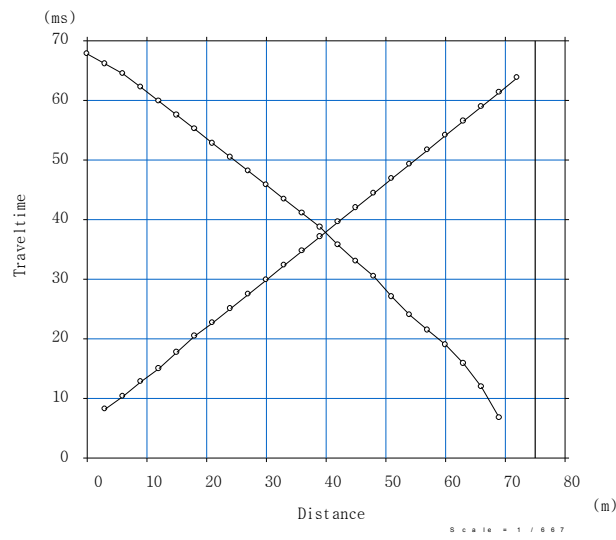


(b)

Figure 7a&b: pick first arrival time and model of Traverse5

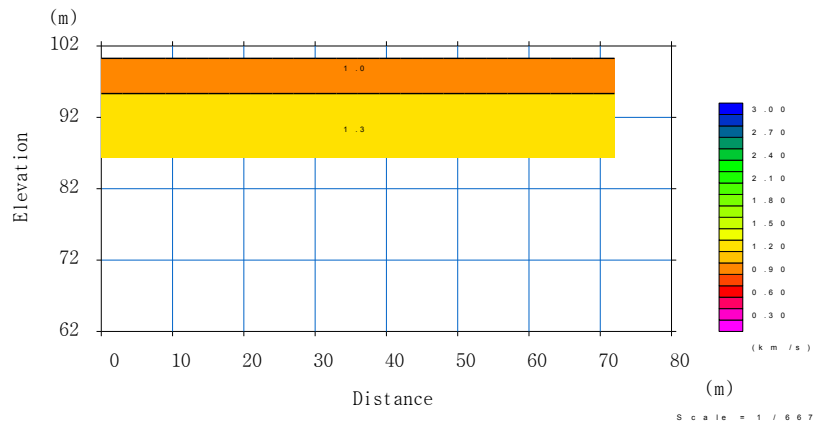


(a)

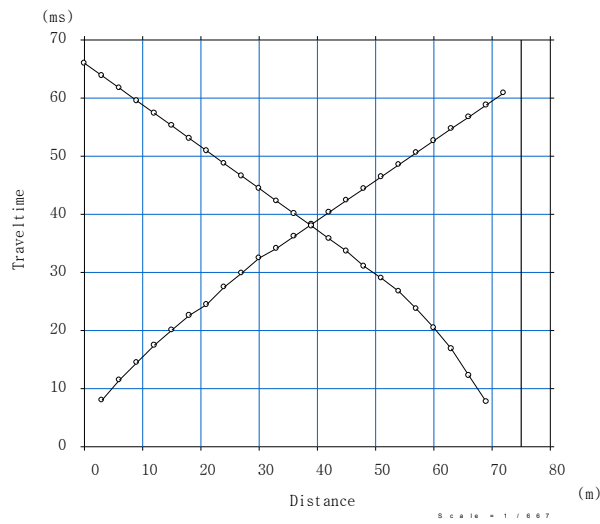


(b)

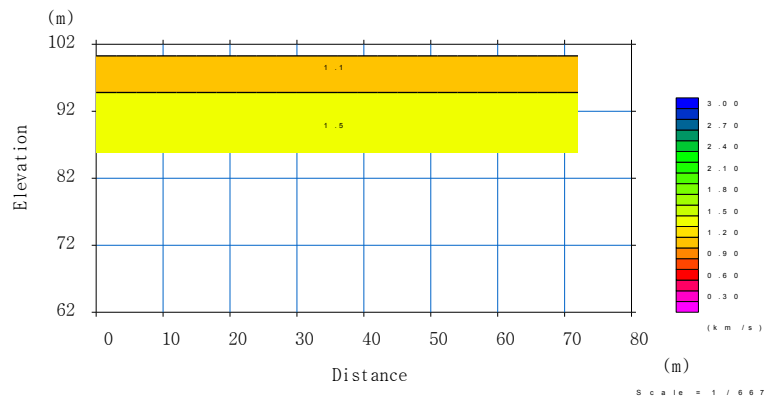
Figure 8 a&b: pick first arrival time and model of Traverse6



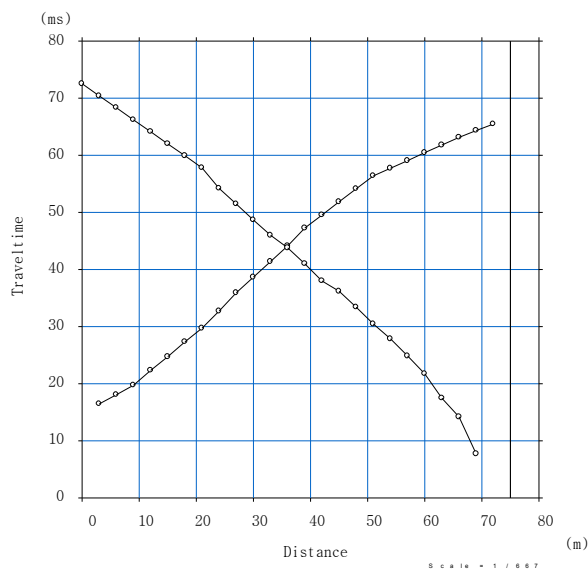
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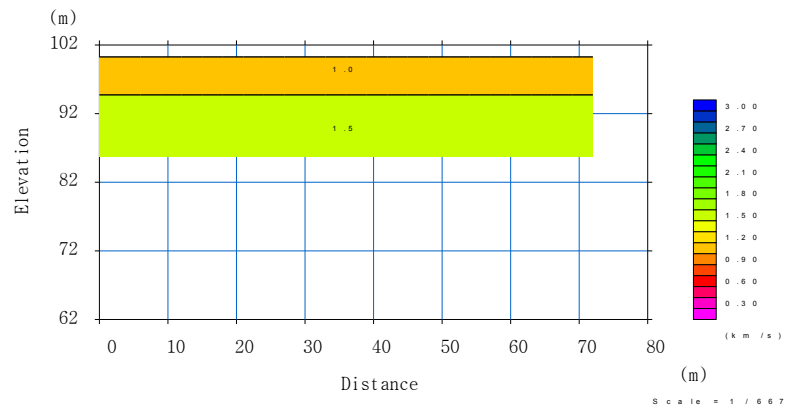
(b) Figure 9 a&b: pick first arrival time and model of Traverse7



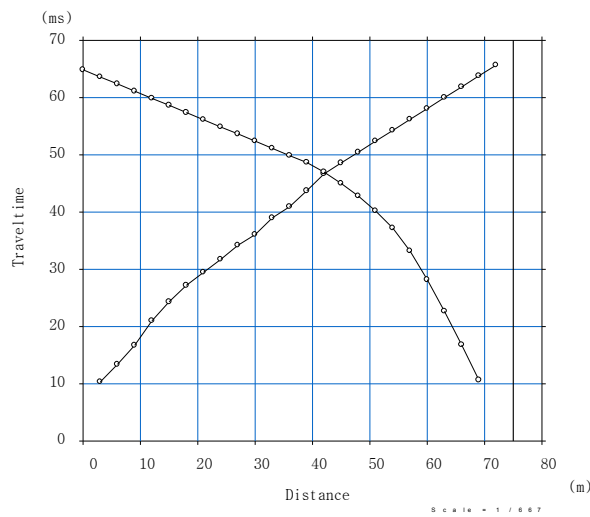
(a)



(b) Figure 10 a&b: pick first arrival time and model of Traverse8

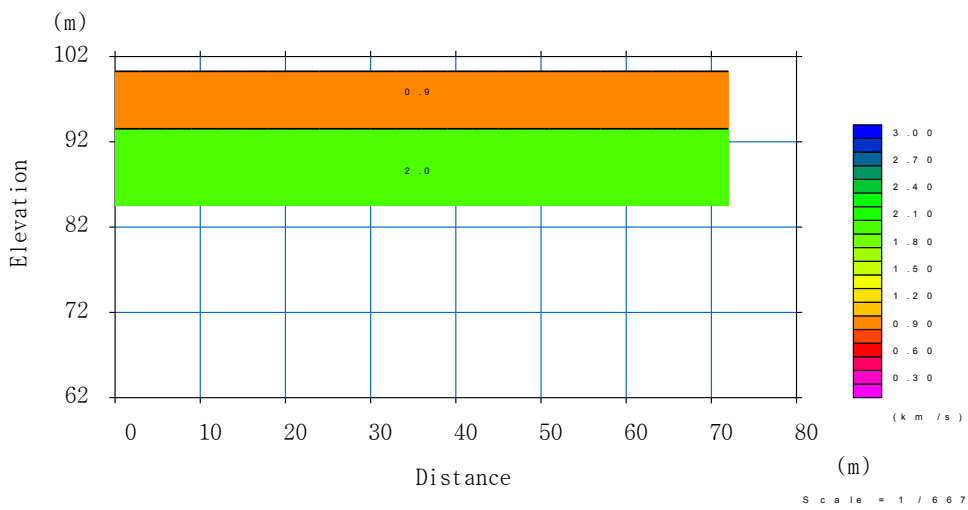


(a)

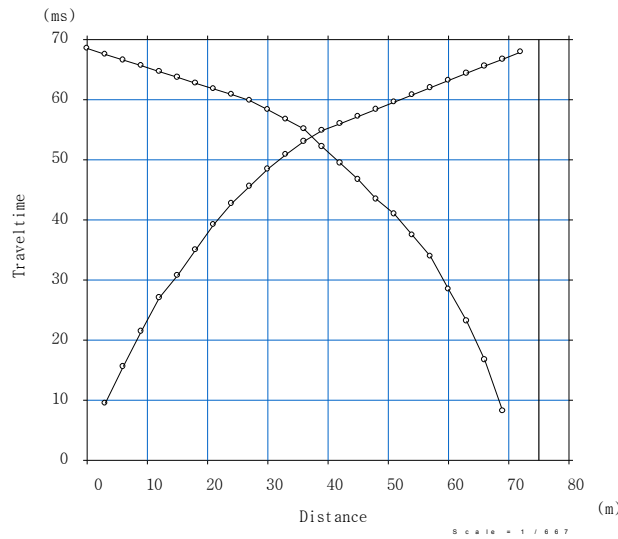


(b)

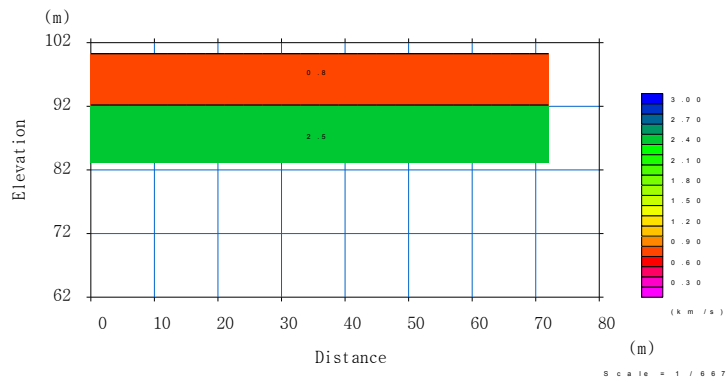
Figure 11 a&b: pick first arrival time and model of Traverse9



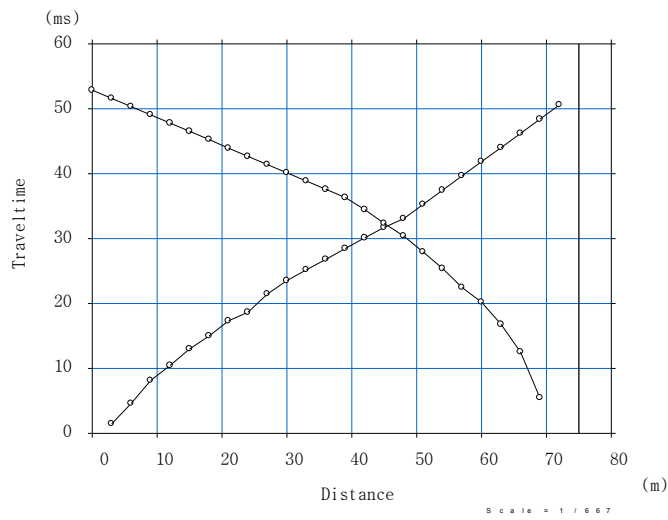
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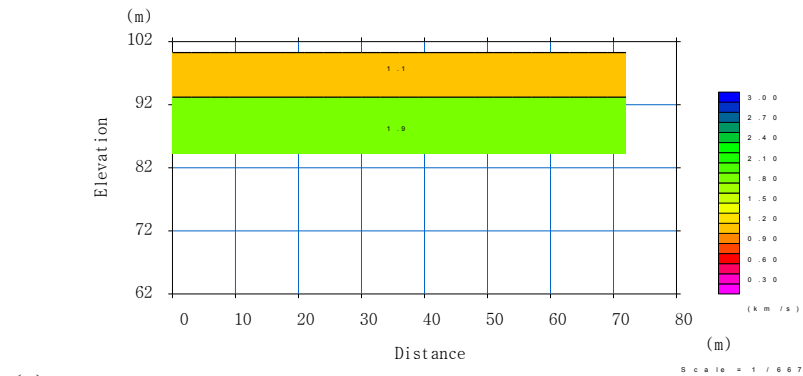
(b) Figure 12 a&b: pick first arrival time and model of Traverse10



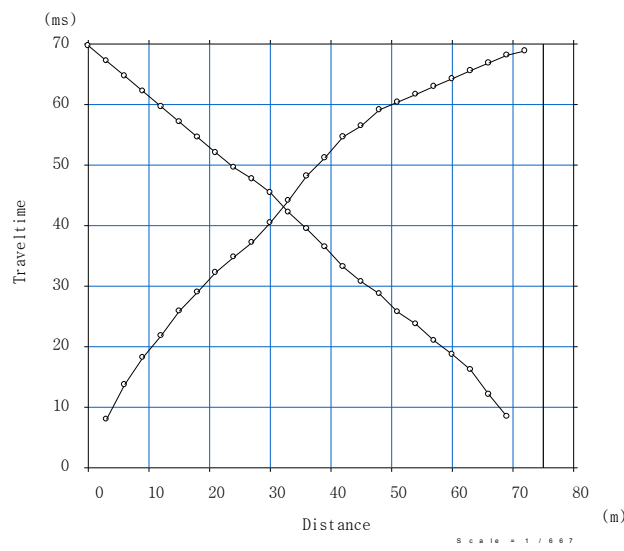
(a)



(b) Figure 13 a&b: pick first arrival time and model of Traverse11

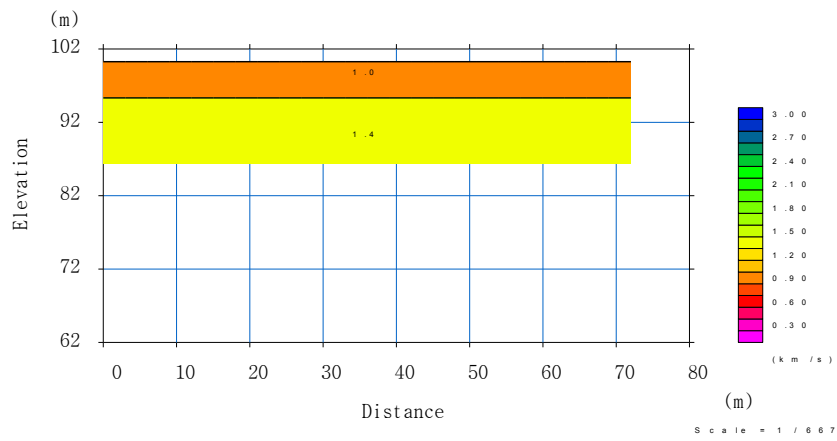


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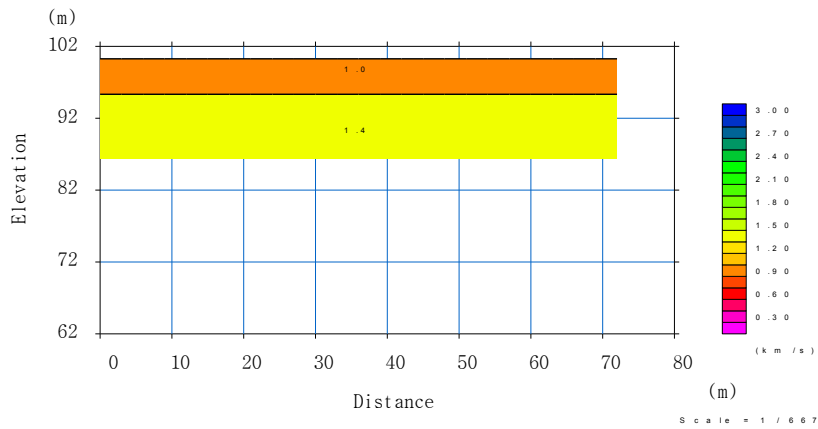


(b)

Figure 14 a&b: pick first arrival time and model of Traverse12



(a)



(b)

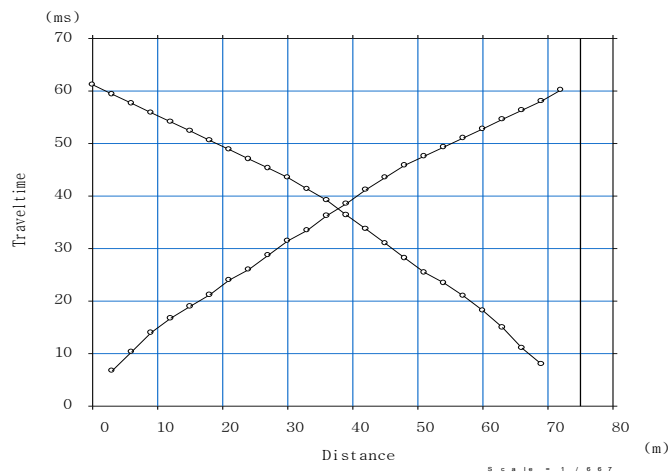


Figure15 a&b: pick first arrival time and model of Traverse13

TABLE 1 The P- Waves velocities and thickness of first and second layer of profiles 1-5

PROFILE	TRAVERSE	P- WAVES VELOCITIES (KMS ⁻¹)						THICKNESS OF FIRST LAYERS(M)
		1 st Layer readings			2 nd Layer readings			
		1 st	2 nd	Average	1 st	2 nd	Average	
1	1	1.13	1.10	1.12	2.58	2.21	2.40	9.40
	2	1.08	1.11	1.09	1.50	1.58	1.54	5.90
	3	1.00	1.80	1.40	1.87	1.63	1.75	6.60
	4	0.95	1.00	0.98	1.65	1.54	1.59	5.90
	5	0.77	0.94	0.86	1.87	1.78	1.83	6.20
	6	1.11	1.53	1.32	1.52	1.36	1.44	6.60
2	7	0.97	1.27	1.12	1.35	1.26	1.31	5.00
	8	0.98	1.19	1.09	1.43	1.50	1.47	5.60
3	9	0.74	1.08	0.91	1.58	2.37	1.98	7.30
	10	0.74	1.08	0.91	1.58	2.37	1.98	7.30
	11	0.70	0.79	0.75	2.48	2.54	2.51	7.70
4	12	0.88	1.36	1.12	1.42	2.29	1.86	7.10
5	13	1.07	0.84	0.96	1.56	1.21	1.39	4.90

IV. Discussions/Interpretations

The velocity of first layer in traverse 1 had the value of 1.12km/s indicating the presence of clayey sand with depth of about 9.40m. the second layer had the velocity of 2.40km/s that shows the presence of sandstone with clay.

The traverse 2 had the velocity of 1.10km/s which has interpreted to be sands and has the thickness of about 5.90m. The second layer had the velocity of 1.54km/s which shows the presence of clay. Traverse 3 with velocity 1.02km/s in the first layer interpreted to be clay with the thickness of 6.60m. The velocity of the second layer was 1.75km/s shows the presence of clayey sand.

The velocity of the first layer of traverse 4 is 0.98km/s indicated as sands with depth of about 5.90m. The velocity of the second layer was 1.59km/s which shows the presence of sand with water saturation.

The traverse 5 with velocity of 0.86km/s in the first layer with depth of about 6.20m indicated sa sands. And the second layer with velocity of 1.83km/s shows the presence of sand and clay. Philips and Brooks (2002).

In traverse 6 and 7, velocity of the first and second layers ranges from 1.10km/s to 1.44km/s shows the likelihood of tar sands in the area. Han *et al* (2008).

The velocity of first layer of traverse 9 had the velocity of 1.05km/s which shows the presence of clayey sands with depth 5.90m and second layer had the velocity of 1.53km/s indicating the presence of sands and clay.

The velocity of layer in traverse 10 is 0.91km/s which shows the likelihood of sands with depth of about 7.30m. The second layer with velocity of 1.98km/s interpreted as sand with saturation and clay.

The first layer of traverse 11 had velocity of 0.75km/s which shows the presence of sands with thickness of about 7.70m and the velocity of the second was 2.51km/s which indicates the presence of sandstone.

The velocities of the first and second layers of traverse 12 ranges 1.12km/s – 1.86km/s indicating the presence of tar sands with depth of the first layer to be 7.70m. Han, *et al* (2008).

In traverse 13, the velocity of the first layer was 0.96km/s shows the presence of sands with depth of about 4.90m. The second layer had the velocity of 1.39km/s which shows likelihood of presence of sand and clay.

V. Conclusion

The seismic refraction gives a better understanding the subsurface for the time distance curve to get the arrival time.

The velocity of the P-wave for the traverse were determine for interpreting the lithology of clayey sand, sand stone, tar sands for the layer 1 and 2 and the depth of layer was determine to be within the ranges of (4.90-9.40)m.

The presence of tar sands was observed in traverse 6, 7, 8 and 12 with velocity values ranges from (1.32-1.44)km/s, (1.12-1.31)km/s, (1.10-1.47)km/s and (1.10-1.98)km/s respectively. The depth of the first layer of the above profile ranges from (5.00-7.10)m. Traverse 1,5, 9-11 and 13 shows the presence of clayed sand, sand, sandstone clay and sands with water saturation respectively was observed.

This concises with geologic trend of the trend of the rock type in the area.

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