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BEACH PETROLEUM N.L.

A REFLECTION SEISMOGRAPH SURVEY
of
THE HALE RIVER FLOODOUT AREA
O.P. 57 NORTHERN TERRITORY

by
Geoseismic (Australia) Pty. Ltd.

ONSHORE

BEACH PETROLEUM N.L.

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October, 1964.

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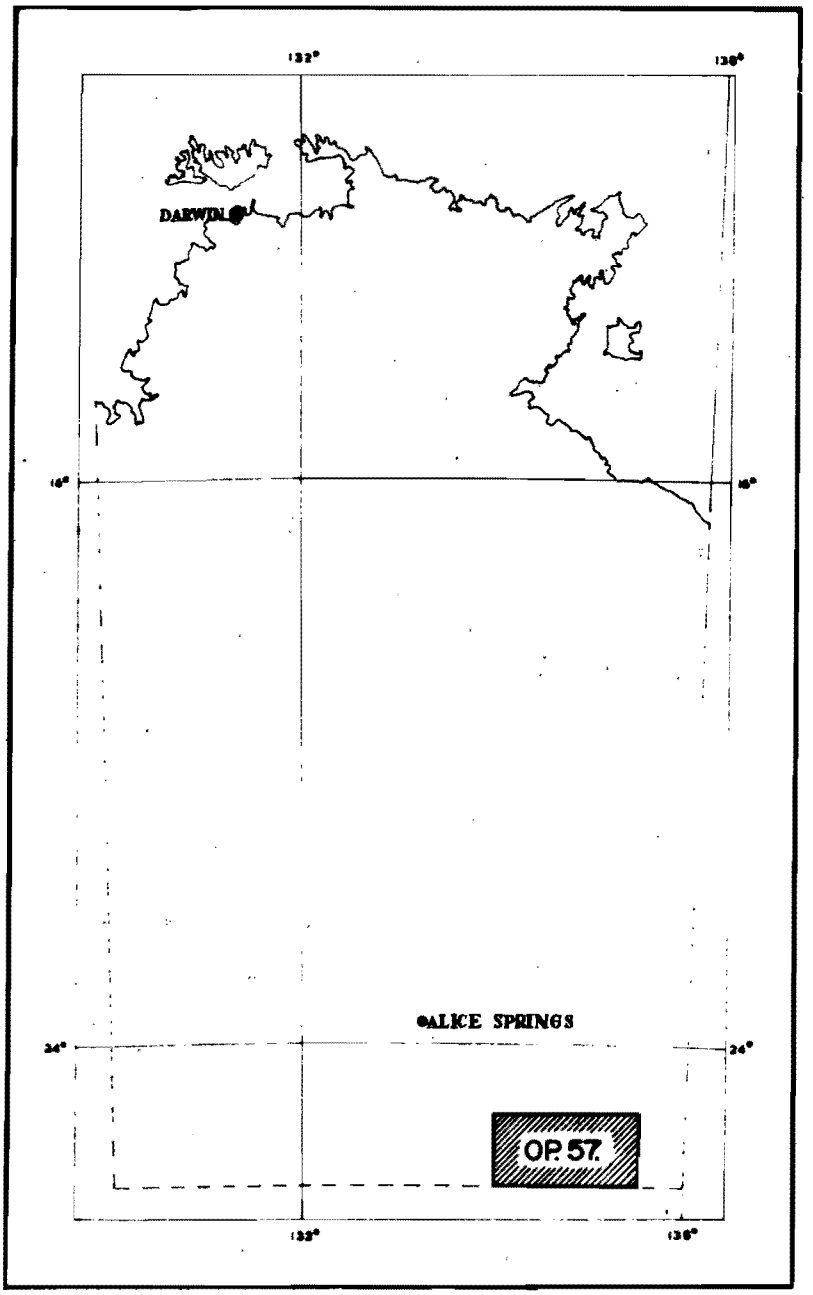
ABSTRACT

A six week seismic survey was completed in the Hale River Floodout area of O.P. 57 Northern Territory Simpson Desert in July, 1964.

This survey was designed to check the north-eastern extension of a large gravity anomaly previously confirmed by seismic at its southwestern end. The present seismic survey confirmed the existence of structure extending to the northeast similar to that found thirty miles southwest although a suggestion of interruption of the structural trend is noted.



INDEX & LOCATION MAP
NORTHERN TERRITORY
AUSTRALIA
SIMPSON DESERT AREA
FOR
BEACH PETROLEM NL.
SCALE
100 50 0 100 200 300 MILES

BP 158.

GEOSEISMIC (AUST) LTD

I. INTRODUCTION

A reflection seismograph survey was conducted in the Hale River region of the Simpson Desert during the period June 2 to July 5, 1964. The area surveyed is geographically located between latitudes 25° 35' to 25° 0' and 136° 15' to 135° 55' longitude in the central portion of O.P. 57 N.T. This area is diagrammatically shown on the index map.

The objective of the survey was to check the configuration of the northern portion of the major feature shown on the Bouguer Plan (BP 142-G) and to establish the general configuration of the sub-surface, to permit by correlation, identification of the section with that of the seismic structure to the south west and thus round out a picture of the entire structure for future planning.

The basic assignment comprised sixty miles of shooting. An additional twenty-five miles of assignment was added to the programme when the crew completed the basic assignment ahead of schedule.

II. GEOLOGY & GEOPHYSICS

a. Geology

The area covered by the survey is located in the Central Simpson Desert. This is an area completely masked by Quaternary deposits. Sand dunes extend throughout the area and prove a major impediment to vehicular movement. The dunes form long parallel dune systems varying in height to eighty feet and are of the "fixed" variety, covered with clumps of spinifex and with avalanche faces to the east. They trend N.N.W. with an average frequency of five per mile. The Simpson Desert and its environs have been adequately covered by R.C. Sprigg, 1963. (see appreciation of geology).

Of recent date new geological information has been provided by

two stratigraphic wells drilled by French Petroleum south of the Northern Territory - South Australian border, fifty to sixty miles south of the present prospect area.

Witcherie No. 1, located 35 miles south of Anacoora Bore, intersected Permian sediments beneath Mesozoic from 1817 to 2150 feet. These were underlain by the Finke River Series to 3838 feet and the bore then penetrated ?Ordovician quartzite to T.D. of 4803 feet. Purnie No. 1, located 35 miles south east of Anacoora Bore, east of the Finke River, intersected Permian below Mesozoic from 4650 feet to 5860 feet, where Precambrian bedrock was intersected. These results indicate a thickening of Mesozoic and particularly of Permian in a general north-easterly direction in this area. In O.P. 57 both gravity and seismic results have indicated an increase of section to the east. It is expected that the Permian section in the Hale River area will be deeper and thicker than this section intersected in these wells.

Information as to the nature of the ?Mid-Lower Palaeozoic section beneath the Permian of the assignment area is uncertain.

b. Gravity

A regional gravity survey has previously been conducted over the prospect area. This survey was carried out by Geoseismic in 1962, the spacing between the stations being 2 miles. This work was successful in outlining the major gravity features of the entire region and was used for planning the present seismic survey.

On the gravity map a number of strong asymmetrical anomalies, extend N.N.W. - S.S.E. and appear to be related to deep seated tectonic movement.

Several symmetrical linear gravity anomalies were considered to be indicative of folding. One particular line extending to the north

east from a point 15 miles north of Mt. Etingambra and lying in a zone of potentially deeper sedimentation, was considered to be particularly attractive in the search for drillable anticlinal targets.

A sub-circular gravity minimum approximately 10 miles across was delineated in the central northern portion of the area. The present prospect is adjacent to this feature the lines lying 10 miles to the north-west of the centre of the gravity minimum.

Sedimentary thicknesses within the survey area were considered to range between 10,000 to 20,000 feet or more. However, in addition to uncertainties arising from station spacing, the problems of such interpretation are presumed to be complicated by the varying thicknesses of underlying unmetamorphosed Upper Proterozoic bedrock, some of which may, however, also constitute prospective sediments (e.g. Bitter Springs Limestone).

c. Aeromagnetics

An aeromagnetic survey has been flown over the prospect area and the results combined with the work completed further to the south.

The map of the aeromagnetic survey indicates a large magnetic anomaly is present over the McDills structure. This intra basement anomaly does not conform in shape or areal extent to the trend shown on the gravity results.

Comparison of the magnetic map to the gravity shows a dissimilarity in the contoured picture. The gravity map indicates a long trend to the northeast where as on the magnetic secondary features are not noticeable.

From this it is probably likely that the gravity picture is based on density contrasts within the sediments. The comparison of the picture at the Purnie Well immediately to the south shows that the

gravity and magnetic agree fairly closely. Here the depth of sediments were in the order of 5,000 feet. The dissimilarity of maps over the Anacoora Area would suggest that deeper section than found at the Purnie Well is present in the prospect area.

d. Seismic Investigations

A reflection seismic survey has been completed along the south western segment of asymmetrical gravity anomaly which extends from a point north of Mt. Etingambra. The results of this survey generally confirmed the gravity picture indicating this gravity anomaly could be related to a strong anticlinal trend. Relatively steeper dip on the northern flank was suggestive of deep seated thrust faulting. However, owing to the masking effect of multiple reflections the geology below the Permian could not be predicted.

The assignment laid out in the Hale River area was based on the good agreement between the seismic and gravity results previously established in the Anacoora Survey. The suggestion of a cross trend over the gravity anomaly in this region in close proximity to a large gravity low made this area particularly attractive. The proof of the cross trend appears certain on the present shooting.

III. FIELD PROCEDURES

The seismic survey comprised a total of 76 miles of shooting. The basic traverse consists of 65 miles of line along three north south traverses in the interdune corridors adjacent to and on the Hale River Floodout. The three lines were T,V, W , interconnected by a cross line (AB). On completion of this original survey an additional 25 miles of line were added as northern extensions to the three interdune lines. Owing to the bad dune build up on the T line the northern extension was displaced to the east along the gravity U line.

Access to the area was down the Hale River from track running west through Andado to Finke. Numerous claypans along the dune corridor provided a good track into the work area.

Water for drilling was non existent so that pattern holes were used throughout the prospect. The multiple holes were drilled by air. Little difficulty was experienced in the drilling. However, to move the heavy drills over the dunes required the use of a TD 14 tractor.

The moderate weather during the period of the survey was typical of desert winter conditions, the temperatures being in the 70°F range.

The record results in the area were good and better than previously obtained further to the south west. Several reasons for the improvement of record quality are suggested.

(a) Lower temperatures permitting larger period of fully charged batteries.

(b) Deeper section, the reflections well below any extraneous noise effects.

Multiple holes were drilled throughout the area. Three hole inline patterns were used in the dune corridors and 5 hole inline patterns across the dunes. The spacing of the holes at 15 feet was programmed to reduce surface effects. Sufficient energy was produced at a depth of 30 to 40 feet to provide good definition of the two main reflecting bands. Below the 'P' horizon few continuous energy line ups were noted.

The elevation survey was carried out by level and theodolite from gravity levels established previously at permanent markers. In addition all of the hanging lines were "double run". The mis-ties to the AB line on the "double runs" are as follows:-

W line	+ .5 feet
V line	+ 1.1 feet
T line	+ 1.0 feet

U line + 1.0 feet onto the start.

The V line was carried north to the astrofix position NMA/G/141 where a mis-tie of -1.6 feet was registered.

Horizontal control was carried by chaining and bearings from the astro fix and tied into the gravity permanent markers which are in turn identified on air photos.

At commencement of shooting an uphole velocity survey at shot point V97 was shot to a depth of 200 feet (see Plate I). Three velocities were observed, one of 3500'/s corresponding to a sand layer near the surface, another at 5000'/s corresponding to the clays, and a 6400'/s velocity related to sub weathering. Different filter settings were tested from the tapes on playback, these included 20-42, 20-64, and 30-64. SIE filter settings equivalent to actual frequency cut offs at 67%. The 30-64 filter appeared to be the most satisfactory. For practical purposes i.e. tieing into previous work, and to maintain an adequate production rate. The experimental work was limited, since reliable fair quality records could be obtained.

The corrections used for the area was based on straight line ray paths the centre traces corrected by the normal uphole method to a datum of +300 feet by a replacement velocity of 6000'/s. Incorporated was a correction for weathering below the hole based on a critical distance correction as found in any standard text on geophysics, (See Dobin page 72 & 73).

The computed weathering depths appear to vary considerably increasing from a depth of 60 feet on structure to 120 feet of weathering 20 miles to the south.

Sections showing the results comprise VDF record sections, the horizontal scale $\frac{1}{2}$ the vertical as previously presented for the adjoining area. Since there was no need for migrated sections only work sections of the lines were plotted.

A $T\Delta T$ was computed for the area and the curve integrated with a computed time-depth curve for the Western Artesian Basin to Blythesdale by the South Australian Mines Department. An expression for the curve is $Va=6500 + .5Z$. Since the programme was based on a Bouguer gravity plan of the area a comparison of the observed gravity plotted against the seismic is presented in Plan BP 142-G.

IV. RESULTS

The record quality in the area was generally fair, the quality degenerating on the cross dune AB line. Of the two reflectors mapped the 'P' intermediate reflector is by far the strongest showing good character throughout the area. The shallower horizon varied, generally the quality being worse than shown by the intermediate horizon.

Three time maps of the area are presented, the shallow aquifier (Tentative Blythesdale) the Intermediate horizon Tentative Permian and a time interval map between the two horizons.

The shallow horizon map identified as the shallow aquifier is based on the first leg of a medium strong reflector in the .700 second to 1.050 second time range. The depth range corresponding to 2,800 feet sub sea to 4,000 feet sub sea.

The regional dip shown on the map is to the south east at approximately 300 feet per mile. A structure is seen to trend north east the axis through shot points T95, V100, W103. The crest of the structure dipping northeast at approximately 380 feet per mile.

The deeper horizon map identified as the Intermediate horizon Permian is the strongest and most reliable reflection present. In this area it covers the time range from .900 seconds to 1.400 seconds. The depths in the -3900 to -7000 feet range sub sea. The picture presented is similar to the shallow map a structural build being present, the axis trending northeast directly below

that for the shallow map. Regional dip is to the southeast at 490 feet per mile. Dip on the flanks and on the crest of the structure is steeper at 400 feet per mile. On this map a suggestion of saddling is noted on the 'W' line.

The isopach map presented, covers the .400 to .350 second time range, Thinning occurs over the structures mapped on the two horizon maps. Thickening is at its maximum in a trough which parallels the structure to the north. This trough appears to be thickening to the southwest down from the structure in reverse of the dip shown on the structure maps.

The values presented on the north end of the V line are questionable owing to the poor data on the shallow horizon.

V. INTERPRETATION AND DISCUSSION OF RESULTS

The results presented on both horizon maps are generally in good agreement and are considered reliable.

Of the two bands of energy mapped the 'P' reflector is the most prominant although the shallower 'C' reflection is also continuous throughout the area.

The two reflectors have been compared by character and interval to the former Anacoora Seismic survey 30 miles south west for the reflection identification. In this last survey the reflections were compared against bore information for their identification (see plate III), the shallow horizon equivalent to the aquifier and the Intermediate horizon to the Upper Permian.

The structural picture presented on the two horizons indicates a continuation of a large structure rising to the southwest. The trend of this structure when compared to the Bouguer gravity map suggests it is a combination of the large McDills anticline.

The agreement between the seismic and gravity on the general structural configurations shown on the maps appears good. A plot of the observed gravity and the two seismic reflectors along the V line show a marked similarity.

Considering the generally good agreement between the seismic and gravity the cross trend shown on the gravity Bouguer map does not appear obvious on the seismic horizon maps. Possibly the cross trend is represented on the seismic map by what appears to be the termination of the very large Mc Dills anticline on the 'W' line. The isopach map shows the termination of this structure more clearly and suggest another structural build up beyond the 'W' line.

Depths to the horizons are much deeper when compared to the McDills structure. By $T_{\Delta}T$ depth to the 'P' reflector on structure is placed 1500 feet deeper in this region at approximately -4500 feet sub sea. A considerable depth of section below the 'P' appears probable with conformable reflectors extending .300 seconds below the 'P'. This could place an additional 1000 feet of section above the Permian-Palaeozoic unconformity. Dips observed up to 3 seconds appear to be conformable while regional dip observed is to the southeast. The large steep dips found on the north flank of the structure in the nearby Anacoora Bore survey have disappeared the reversal in this case to the north being in the order of .100 seconds.

The structure shown on the maps suggests a good thickness of Permian section present with the possibility of additional section below the Permian. The agreement between the seismic and gravity appears to extend to this region. This factor will be of significance in planning future surveys in the area.

VI. CONCLUSIONS AND RECOMMENDATIONS

The seismic survey in the Hale River Floodout area has shown that two continuous reliable reflection bands of energy are present throughout the area. This work has confirmed the existence of an anticlinal development, apparently co-existent with the structure previously checked in the Anacoora Area, is suggested by the previous gravity survey, and has enabled correlation with the Anacoora Area. The presence of a significant thickness of Permian

is indicated and presence of deeper section suggested there is evidence of an interruption of the structural trend beyond the 'W' line. As the Permian has been shown elsewhere in the region to be prospective, the definition by the seismic of the Permian formations is considered very important.

Similarity between the seismic and Bouguer gravity map is apparent suggesting full use can be made of the gravity results to plan further seismic in the general area.

It is recommended that additional seismic work be carried out along this trend and that a stratigraphic test well be drilled to check the section.

A. YAKUNIN.

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APPENDIX I - STATISTICS

General

Commencement Date of Survey	June 2nd, 1964.
Completion Date of Survey	July 5th, 1964.
Miles Traversed	76 miles
Number of position holes shot	318

Recording

Average depth of the best shot	40 feet
Number of field recording hours	286 hours
Number of hours drive	54 hours

Amount of explosives used

Geophex - 5 lb sticks	2108 lbs.
Ammonium Nitrate - prills	4780 lbs.
Detonators 60 foot leads	1200 Dets.
Usual size of shot	5 lbs.

Drilling

Number of drills used	2 Drills
Number of hours drilling	1037 hours
Number of hours driving	71 hours *
*Drill rig on standby remainder of time.	
Total footage drilled	10,920 feet
Average rate of production	105.3 ft/hr.
Type of bits	Skidmore - crooks
Size	$4\frac{1}{4}$"
Number of bits	6 bits
Lost Time	Nil
Casing used	Nil

APPENDIX II - EQUIPMENT

Seismograph

Make of Seismograph	S.I.E.
No. of channels	24
Type of Camera	PRO-11
Type of Amplifier	P-11
Type of Geophones	HS HSJ
Frequency	20 cycles
Geophones per trace	variable
Connection	Series parallel not to exceed 20% of 500 ohms impedance
Spacing in Group	10 feet (Dependent upon noise analysis)
Spread Length	1,320 feet.
Geophone Interval	110 feet
Shot Point to near Geophones	110 feet
End Trace Geophones	At Interlocking shot points.
Number of Cables	3

Magnetic Recorder

Make of Magnetic Recorder	Electro-Tech
Type	DS-7 Direct Recorder
No. of Traces	27 (including 3 information traces)

Equipped with movable heads and velocity cams if required.

Drilling

1 Mayhew 1000' drilling rig equipped with 10 foot Kelly, air and water drilling (Gardner Denver $4\frac{1}{2}$" x 6" pump and WCG 427 cubic foot air compressor) mounted on a 1961 Bedford 4 x 4 truck and complete with 250 feet of drill stem plus drilling accessories.

APPENDIX III - PERSONNEL

Party Chief	A. Yakunin
Party Manager	J. Hastie
Seismologist	A. Moore
Chief Computer	R. Mather
Draftsman	M. Upton
Observer	D. McNutt
Junior Observer	R. Hasee
Shooter	J. Owens
	3 helpers
Surveyor	T. Campion
	One Rodman
Drillers	C. Grigor
	T. Quarry
	2 helpers
Mechanic	D. Howell
Cook	R. Sampson
2nd Cook	D. Millbrook
Supply Truck Driver	P. Howard

1 Mayhew 1000 drill rig equipped with 15 foot Kelly, air and water combination (Gardner Denver 5" x 6" pump and WCG 480 cubic feet air compressor) mounted on 4 x 6 1961 International with size 1700 tyres in addition 300 feet 2 7/8" OD drill stem and all drilling accessories.

2 1000 gallon tankers with built in gear pumps mounted on four wheel drive Bedfords.

Shooting

1 Bedford mounted with 600 gallon Griffin tank and related shooting accessories.

1 4000 lb. licensed dynamite storage equipped as per explosive regulations.

1 Complete set of shooting equipment with two multihole blasters.

Surveying

1 Toyota (4 x 4) Landcruiser.

1 Wild T1 Theodolite

1 Stadia Rod

Transport

1 Landrover (4 x 4) Personnel carrier.

1 Landcruiser (4 x 4) Toyota office and scouting vehicle.

1 Ford F600 Supply truck.

Recording

1 International 120 (4 x 4) fitted with recording cab.

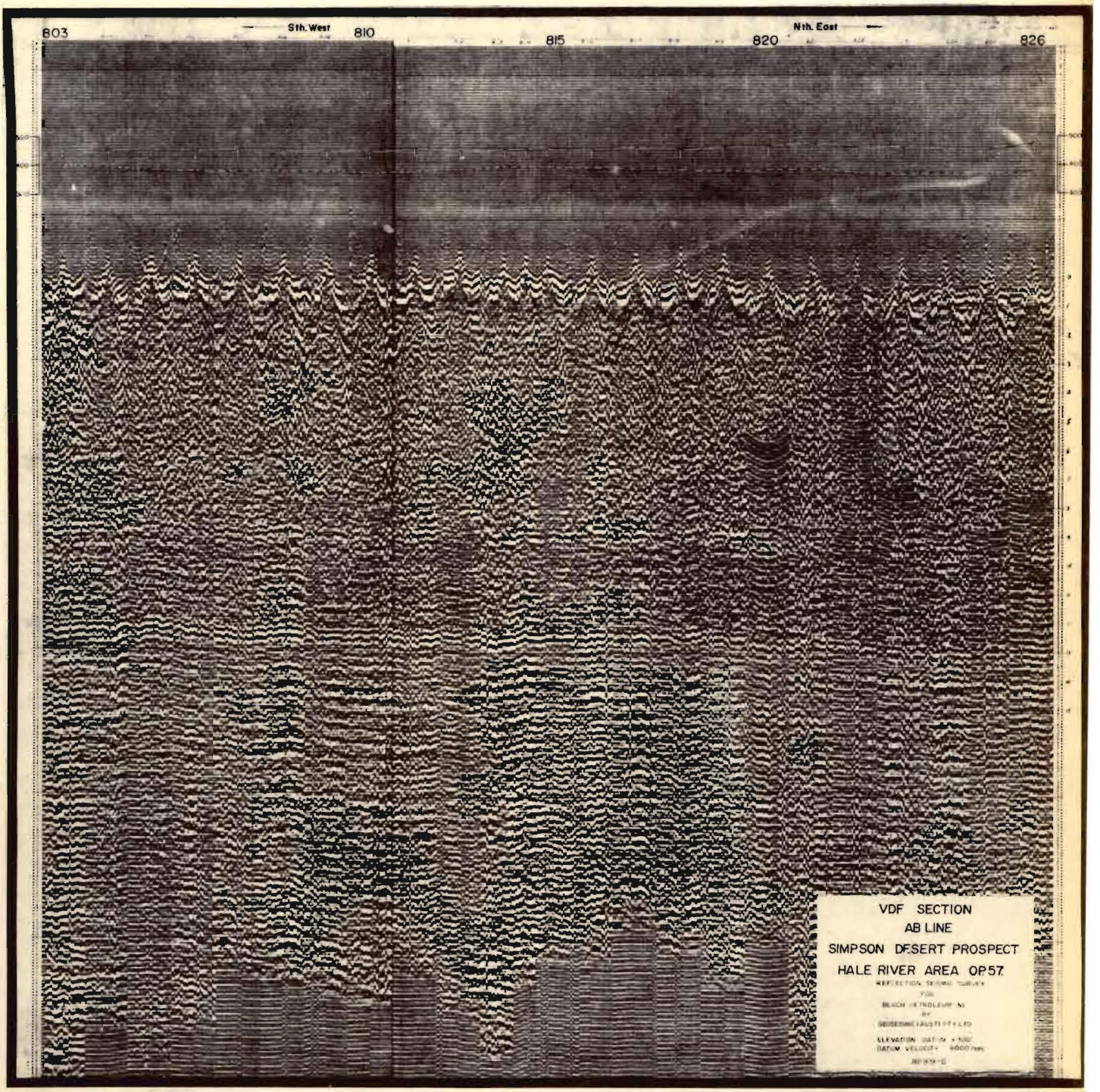
1 Toyota (4 x 4) Landcruiser fitted as cable and geophone laying unit.

Office

1 20 ft. Carapark Caravan modified as Mobile Office, complete with office equipment.

Camp

a. Tents with stretchers, blankets, and sheets.
b. 1 Kitchen caravan fitted with gas stoves and electric freezer.
c. 1 Dining marquee.
d. 1 Shower caravan fitted with pressure pumps, lockers and washing facilities.
e. 1 Lighting plant - 6 KVA Dunlite and accessory cables.
f. 1 Mobile workshop with welder, mounted on (4 x 4) Ford Blitz.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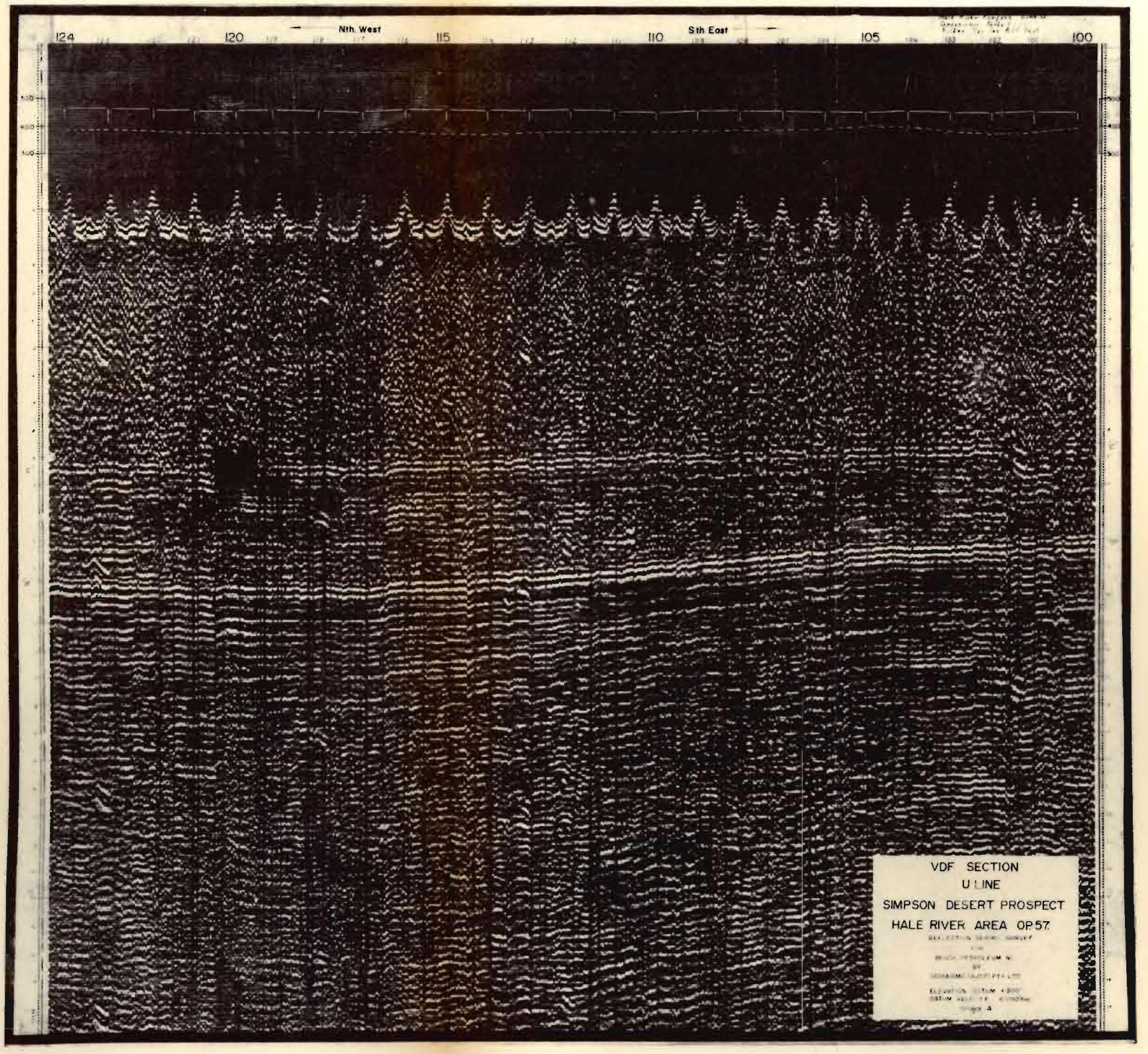
Sth. West
810
815
820
Nth. East
826
VDF SECTION
AB LINE
SIMPSON DESERT PROSPECT
HALE RIVER AREA OP57


Nth. West
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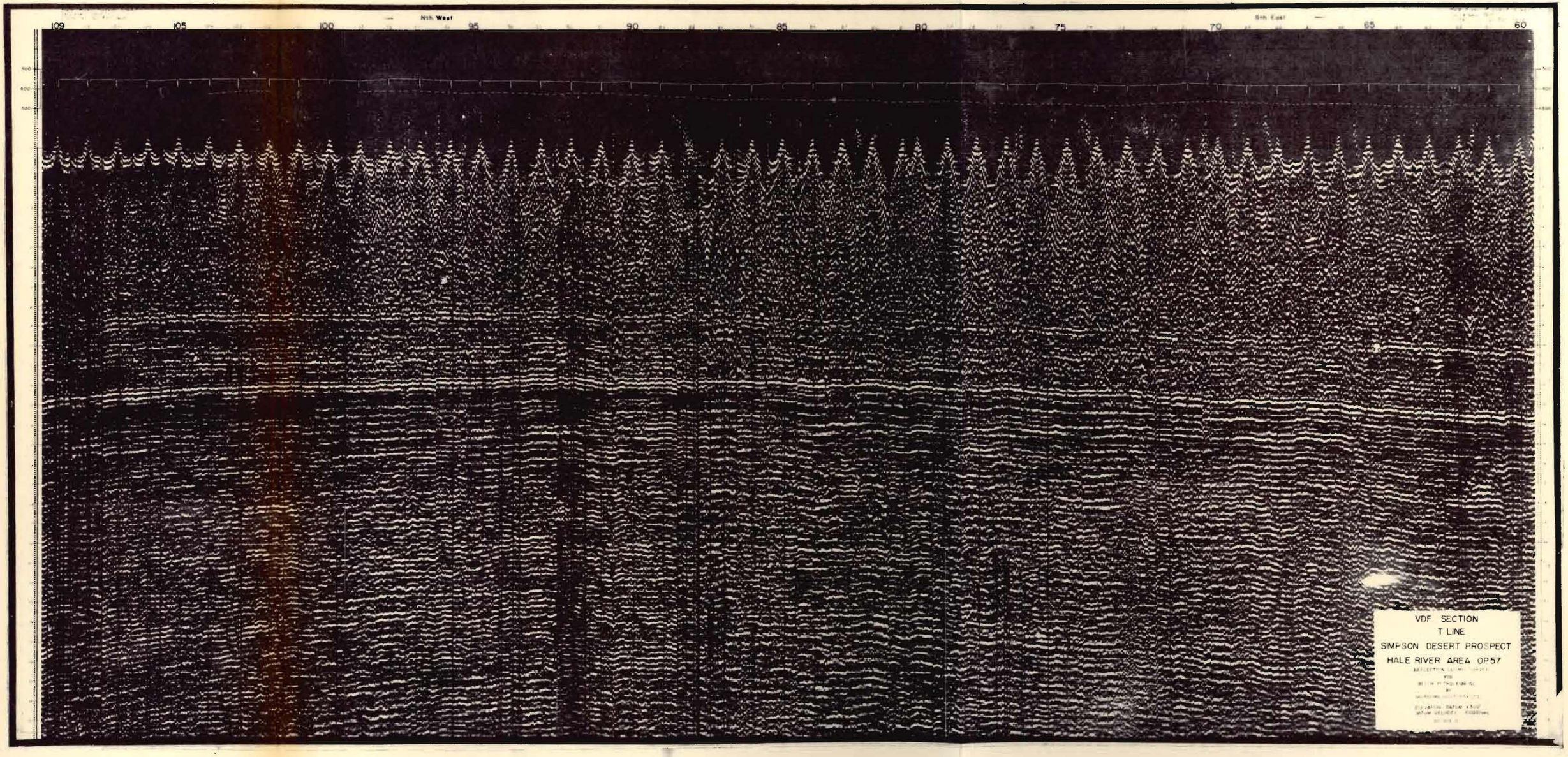
VDF SECTION
U LINE
SIMPSON DESERT PROSPECT
HALE RIVER AREA OP57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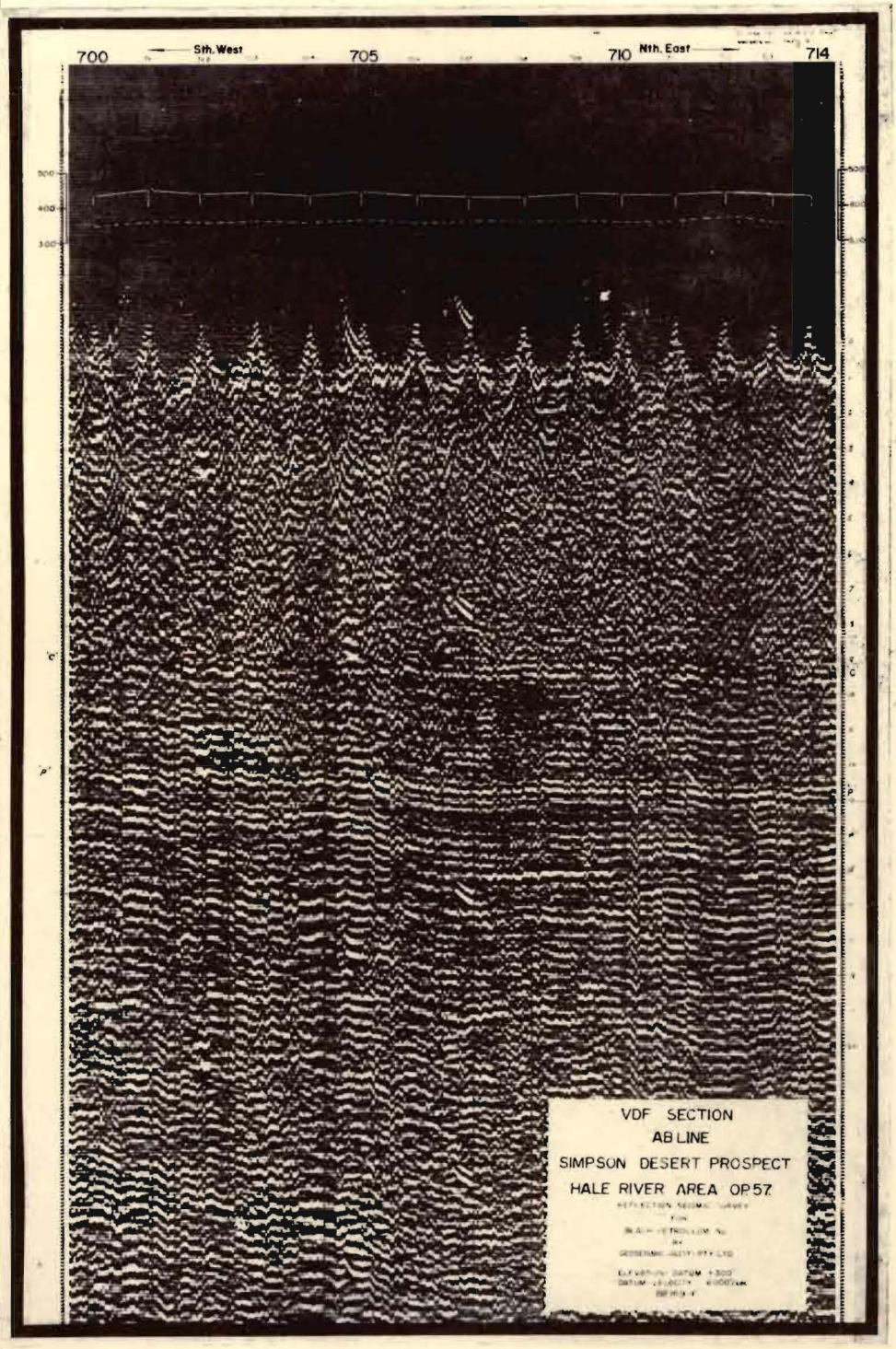
HALE RIVER AREA OP57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HALE RIVER AREA OP57