COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/65

NERRIMA No. 1 BORE SEISMIC VELOCITY SURVEY, WESTERN AUSTRALIA 1955

by

E. R. SMITH

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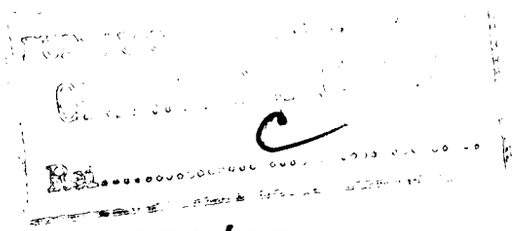

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CONTENTS

ILLUSTRATIONS

SUMMARY

A seismic velocity survey was carried out in Associated Freney Oilfields Nerrima No. 1 Bore by the Bureau of Mineral Resources on the 10th August 1955. The well is situated on the Nerrima Dome in the Fitzroy Basin, W.A. Some trouble was experienced with cable breaks for the shallow part of the hole, but in general it was possible to recognise the true formation break. Average measured velocities ranged from 8000 ft/sec near the top to 12,200 ft/sec for the total depth of the bore.

1. INTRODUCTION

During 1955, Associated Freney Oilfields drilled a bore, called AFO Nerrima No. 1, on the Nerrima Dome in the Fitzroy Basin, W.A. The company requested the Bureau of Mineral Resources to carry out a seismic velocity survey of the bore. The Bureau's seismic party, which was operating in the Fitzroy Basin at the time, performed the survey on the 10th August 1955. The results of the survey are presented in this record.

The Nerrima Dome is an anticlinal structure situated on Nerrima Station in the Kimberley Division of Western Australia. The Dome lies within the geological province known as the Fitzroy Basin, and is exposed in Permian sediments of this Basin. It has been mapped in detail by a Bureau geological party in 1948 (Guppy, Cuthbert and Lindner, 1950). A previous bore had been drilled in 1939-42 by the Freney-Kimberley Oil Co. on the structure, but because of drilling difficulties, this had only penetrated to 4271 ft. A seismic survey of the Dome was carried out in 1952 (Vale, Smith and Garrett, 1953). Reflection profiling was attempted at first, but results were so poor that this was abandoned. A rather unsatisfactory refraction survey was then completed and, after consideration of the results, the site of the present bore was chosen.

A number of refractors were recorded during the seismic refraction survey, and their velocities and approximate depths are:

Refractor	Velocity (ft/sec)	Depth (ft)	Location of Depth Measurement
V1	8450	sub-weathering	-
V2	9700	300	1 mile west
V3	11,550	500	AFO Nerrima No. 1
V4	12,650	2500	8 miles east
V5	14,500	4000	AFO Nerrima No. 1
V6	16,000	7000	" " " "

The velocity survey of the bore was carried out using a Technical Instrument Company well-geophone, which contained three coil elements, all positioned to detect vertical motions. A Schlumberger well-logging unit was present at the bore-site, and the well-geophone was attached to its cable. The recording instruments were also manufactured by the Technical Instrument Co.

2. PROCEDURE

Three shot-holes were used for the survey, each on the same line from the bore and located 250, 500 and 750 ft south-east of the bore. A complete survey of the bore was made from the 500-ft offset hole (Shot-point 2), the 250-ft offset hole (Shot-point 1) was used down to well-geophone depths of 3500 ft and the 750-ft offset hole (Shot-point 3) for depths from 4000 ft to the total depth of 9072 ft. The three shooting distances made it possible to check the records for breaks which

came via the cable instead of through the formations. Charge sizes were about 25lb for the shallow geophone depths and 50 lb for the greater depths. A 100-lb charge was used when the geophone was at the maximum depth of 9072 ft.

The interval between well-geophone depths was generally 1000 ft in the bottom half of the bore but was decreased to about 500 ft for depths less than 5000 ft. The actual depths used are set out on Plates 2 and 3. The output of the well-geophone was recorded through three different channels with their levels set at high, medium and low. Thus a good 'first break' would be preserved on the high-gain channel, while the lower gains on the others would enable a study of the rest of the trace after the 'first break' to facilitate the analysis of cable breaks. However, the low-gain channel was apparently faulty during the survey, for after the first arrival of energy, its trace did not follow the other two. This channel was not used in the analysis of results.

A reference geophone was placed near the top of the bore and connected to a fourth channel. This enabled a check to be made on shot-hole fatigue, i.e. the time delay associated with fracturing of the hole when successive shots are fired in it.

A 12-trace reflection spread was laid out along the line from the bore through the shot-holes. Eight geophones per trace were used and the centres of these groups were spaced at 100-ft intervals from the bore. A diagram of the layout of shot-holes and geophones relative to the bore is shown on Plates 2 and 3.

3. RESULTS

Copies of records obtained from the survey accompany this report. The readings obtained from the records and the subsequent calculations are tabulated on Plates 2 and 3. It is assumed that the seismic pulse travels in a straight line from the charge to the geophone. The recorded time of travel is corrected to an equivalent vertical time that would be recorded if the charge were detonated at the datum level within the bore. From these corrected times, average and interval velocities are calculated.

In carrying out a bore hole survey, there is a possibility that a seismic pulse may travel down the cable to the well-geophone. If this pulse arrives at the geophone before the pulse that travels through the formations, then it may be interpreted wrongly as the true formation pulse, thus leading to erroneous velocity calculations.

The breaks obtained from the shots in Shot-point 2, offset 500 ft from the bore, are generally satisfactory for well-geophone depths of 2068 ft and greater below datum. The average velocities calculated from these times are reasonable and decrease with decreasing depth of geophone; the interval velocity values are also within reasonable limits. The corrected vertical times calculated for equivalent depths from the long offset Shot-point 3, agree, with one exception, to within 2 msec of those from Shot-point 2. The exception is at well-geophone depth 6908 ft below datum, where there is a 7 msec discrepancy. There is no obvious explanation for this. At well-geophone depth 2508 ft below datum the calculated cable break time is 0.247 sec (see below), compared with the recorded time of 0.274 sec for the first arrival. This suggests that the record is free of cable breaks, and this also applies to all records for which the well-geophone depths are greater than 2508 ft.

The record obtained with the well-geophone at 2068 ft below datum (D = 2068 ft) shows a good break, but use of this break in the calculations gave an average velocity of 10,230 ft/sec which was considerably higher than that obtained at D = 2508 ft viz. 9470 ft/sec. Also, the interval velocities of 22,400 ft/sec from 1508 ft to 2068 ft and 6980 ft/sec from 2068 ft to 2508 ft appear abnormal. It was considered therefore that this might be a cable break.

The records obtained from Shot-point 1, offset 250 ft, also gave evidence of cable breaks. The first arrival time recorded at D = 408 ft gave an average velocity of 10,200 ft/sec which appears too high. If the first arrival times at D = 2408 ft and D = 3408 ft are used, the interval velocity obtained is 7250 ft/sec, which is abnormally lower than that obtained between 2508 ft and 3408 ft from Shot-point 2 viz. 12,000 ft/sec. A plot of the first arrival times (corrected for hole fatigue) recorded from Shot-point1with D = 408, 1408, 1908 and 2408 ft gives a reasonably straight line with a slope of 12,700 ft/sec.* These breaks are taken to be cable breaks. Note that they appear to break upwards.

Using 8000 ft/sec for the velocity near the surface and 12,700 ft/sec for the cable velocity, theoretical travel times for cable-borne energy have been calculated for Shot-point 1 assuming the shortest time path for the ray. These times are shown on Plate 3 and it can be seen that they agree with the first arrival times quite well down to D = 2408 ft. At D = 3408 ft the theoretical cable break time is 0.290 sec compared with the first arrival time of 0.344 sec, so it is apparent that cable breaks are absent at this depth.

Cable break times were calculated for Shot-point 2 also, and they showed that the first arrival for D = 2068 ft is probably a cable break, but that at D = 2508 ft the record is free of them.

An attempt has been made to pick the true formation arrivals as secondary arrivals after the cable breaks for the shallow depths from Shot-points 1 and 2. After shot 26(0) from Shot-point 2, a very strong wind sprang up and some noise was apparently transmitted down the hole. This necessitated reducing the amplifier gains a great deal, and apparently removed the cable breaks from the last two records. Naturally the formation breaks are very poor on these two records. Thus, the velocities calculated for the shallow part of the sequence, i.e. above D = 2508 ft, must be regarded as not very reliable. This is demonstrated also by the difference between the velocities calculated from the two shot-points.

The corrected slant and vertical times, and the average and interval velocities calculated from them, are plotted on Plate 4. The average vertical velocity increases from about 8000 ft/sec near the surface to 12,200 ft/sec for the total depth of the bore. The positions of the main stratigraphic units encountered in the bore are shown at the side of the velocity plot. The average velocities in these formations are:

* Note:

The first arrival break on the record from 908 ft appears to be interfered with by cross-feed from the suppression and has not been used (See Plate 9).

	(Noonkanbah Formation	8200 ft/sec
	(	
Permian	(Poole Sandstone	10,200 ft/sec
	(	
	(Grant Formation	13,400 ft/sec
Carboniferous		14,500 ft/sec

Calculated interval velocities which may be expected to correlate with possible refractors are listed below:

Velocity (ft/sec)	Depth (ft) (below Datum)	Stratigraphic Position
8000	sub-weathering	Noonkanbah Formation
9260	408	" "
11,660	1508	Within Poole Formation
12,900	2508	Near top of Grant Formation
13,500	3408	Within " "
14,920	5908	" " "
17,860	6908	Near base of " "

There is a similarity in the distribution of the velocities shown by this table and that shown by the refraction survey. The correlation is by no means good, however.

4. CONCLUSIONS

(1) The velocity survey has given reliable velocity data for depths greater than 2508 ft below datum, but above this depth, the velocities are unreliable owing to interference from cable breaks.

(2) The average vertical velocity increases from about 8000 ft/sec near the surface to 12,200 ft/sec for the total depth of the bore.

5. REFERENCES

GUPPY, D.J., CUTHBERT, J.O., and LINDNER, A.W. 1950 The geology of the Nerrima Dome, Kimberley Division, W.A. Bur. Min. Resour. Aust. Rep. No.4.

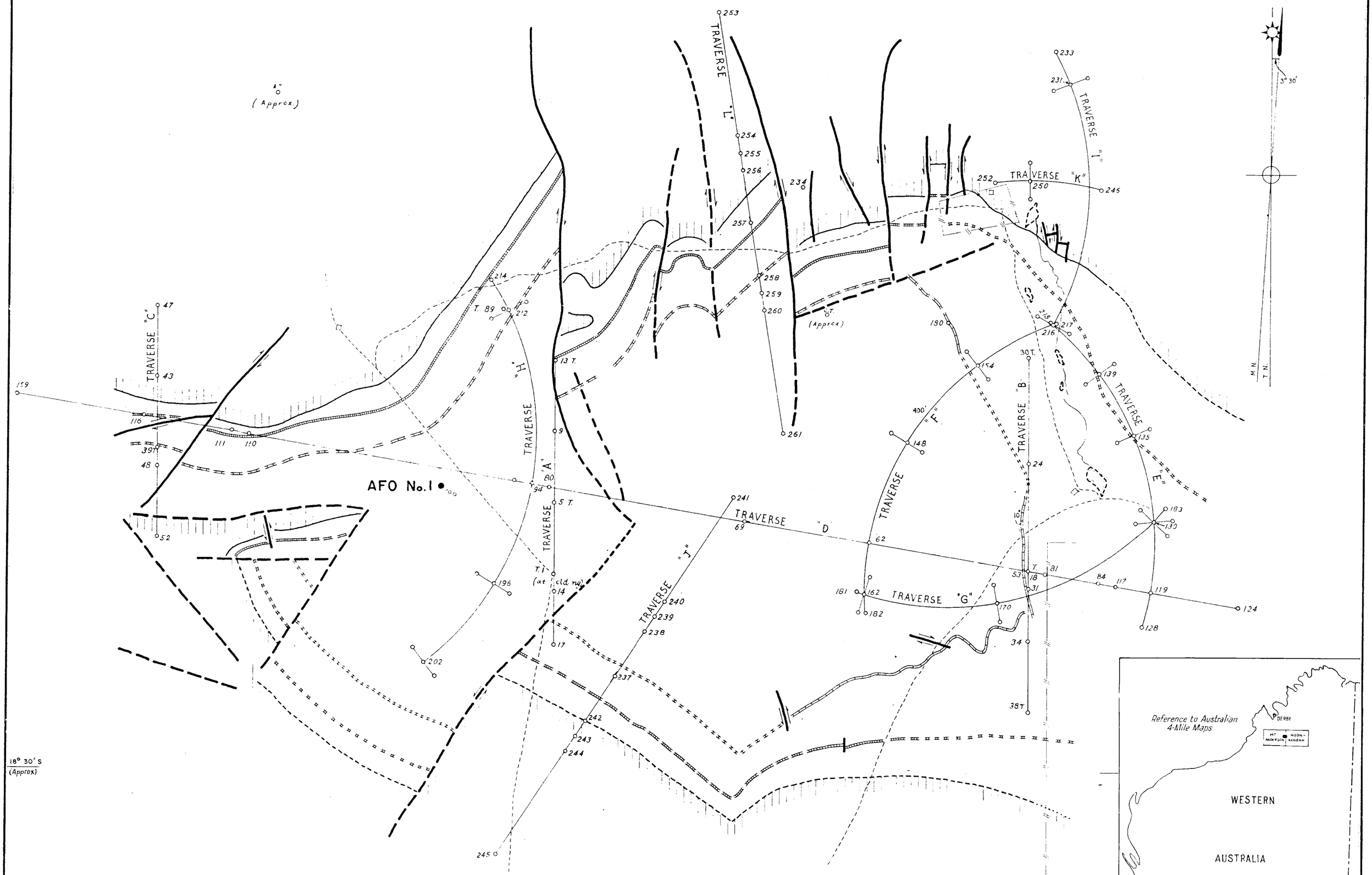
VALE, K.R., SMITH, E.R., and GARRETT, M.J. 1953 Seismic survey of the Nerrima Dome, Kimberley Division, W.A. Bur. Min. Resour. Aust. Rec. 1953/72.

PLATE I

SEISMIC VELOCITY SURVEY IN ASSOCIATED FRENEY OILFIELDS No. 1 WELL NERRIMA DOME, FITZROY BASIN, W.A.

LOCALITY MAP

WITH SURFACE GEOLOGY AND SEISMIC TRAVERSES



SCALE

MILES 0 1 2 3 MILES

FEET 5000 0 5000 10,000 15,000 FEET

FROM GEOLOGICAL MAP

- DEFINITE / PROBABLE — BOUNDARY BETWEEN LIVERINGA SANDSTONE AND NOONKANBAH SHALE
- DEFINITE / PROBABLE — FAULTS AT SURFACE (U (UP), D (DOWN))
- DEFINITE / PROBABLE — STROPHALOSIA KIMBERLEYENSIS MARKER BED
- DEFINITE / PROBABLE — POLYZOAL LIMESTONE MARKER BED
- FENCE
- TRACK
- REFLECTION TEST HOLE
- SHOT POINT

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G132-3-1

To accompany Record No. 1962/65

WELL VELOCITY SURVEY DATA SHEET

WELL NAME *AFO NERRIMA No.1.* OWNER *Associated Freney Oil Fields N.L.* WELL LOGGING CONTRACTOR *Schlumberger*

LOCALITY *FITZROY BASIN, W.A.* ADDRESS ADDRESS

COORDINATES *212215 E, 2682927 N* DRILLING CONTRACTOR *Mines Administration P.L.* TYPE AND NUMBER OF LOGGING UNIT

DATE OF SURVEY *10/8/1955* ADDRESS LOGGING UNIT OPERATOR

ORGANISATION SUPERVISING VELOCITY SURVEY — SEISMIC INSTRUMENTS — WELL GEOPHONE

BUREAU OF MINERAL RESOURCES MAKE *T.I.C.* MAKE *T.I.C.* B.M.R. REPRESENTATIVE *E.R. Smith*

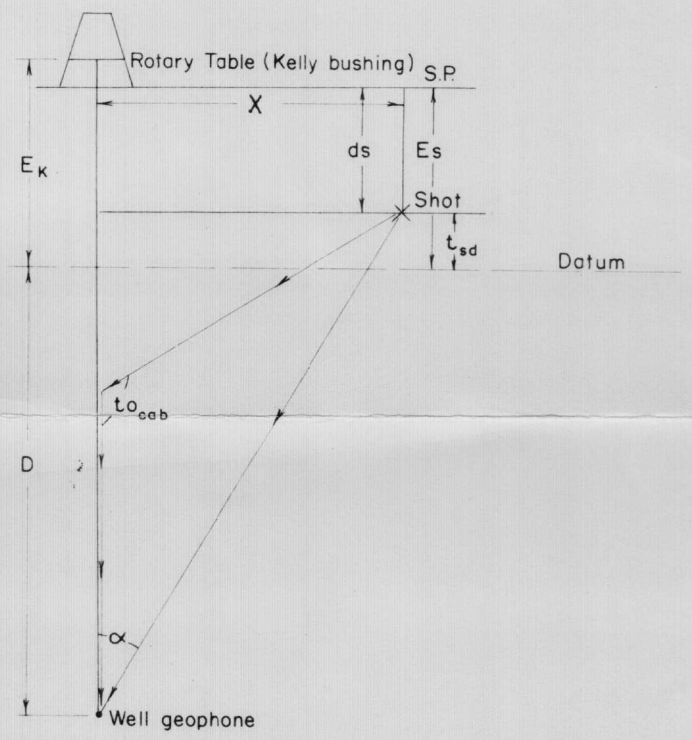
ADDRESS *203 Collins St Melbourne* TYPE *Model 521* TYPE *3-Element Vertical* DATA CALCULATION *E.R.Smith*

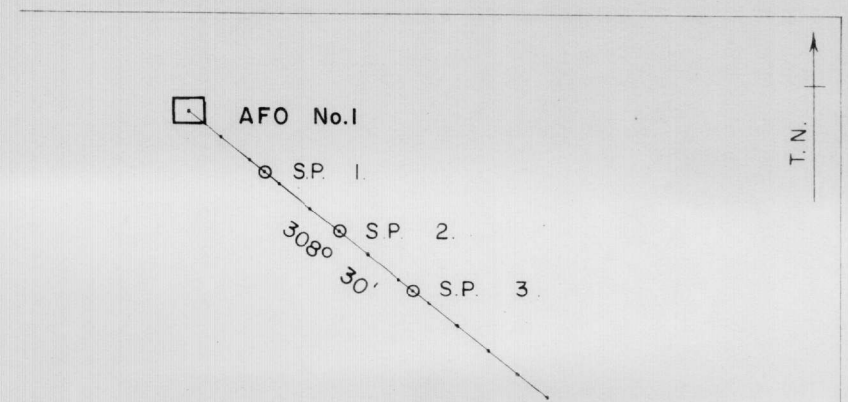
SURVEY SUPERVISOR *E.R. Smith* No

E_K = *92 ft* Vo = — Ve = *8000 ft/sec* Do = *300* ρm = — B.H.T. or Tm = — Vcab (Manufacturer) = — (Test) = — Cable Depth Accuracy = ± *1 ft*

Shot No.	E_K+D	D	S.P.	X	chge	Es	ds	t_{sd}	∝	tv_1. Gr.	tv_2. Gr.	tha_1. Gr.	tha_2. Gr	thb_1. Gr.	thb_2. Gr.	t_{RG} or to_R	Gr.	Δt_{RG} or Δto_R	t_{cab}	to_{cab} Gr.	$t_o - \frac{t_{sd}}{\cos\alpha}$	Cos. ∝	tc	Va	ΔD	Δtc	Vi
29R	1000	908	2	500	25	83	67	·002	28·4°	—	·136 PF	—	—	—	—	·075	G	·001	·121		·128	·880	·111	8180	600	·006	9100
28Q	1600	1508	2	500	25	83	67	·002	18·2°	(PP)	·199 PG	—	—	—	—	·077	G	·003	·168		·189	·950	·177	8520			
26O	2160	2068	2	500	25	83	67	·002	13·5°	—(PP)	·244 PF	—	—	—	—	·077	G	·003	·212	·204P	·233	·972	·225	9190	560	·048	11660
25N	2600	2508	2	500	25	83	67	·002	11·2°	·274 GG	·282 GG	—	—	—	—	·076	G	·002	·247		·272	·981	·265	9470	440	·040	11000
24M	3000	2908	2	500	25	83	67	·002	9·7°	·303 GG	·310 GG	—	—	—	—	·075	G	·001			·302	·986	·296	9825	400	·031	12900
23L	3500	3408	2	500	25	83	67	·002	8·3°	·348 GF	·356 GG	—	—	—	—	·076	G	·002			·346	·990	·340	10020	500	·044	11380
22K	4000	3908	2	500	25	83	77	·001	7·3°	·384 GG	·392 GG	—	—	—	—	·077	G	·003			·381	·992	·377	10370	500	·037	13510
21J	4500	4408	2	500	25	83	60	·003	6·4°	·422 GG	·430 GG	—	—	—	—	·076	G	·002			·420	·994	·414	10640	500	·037	13510
20I	5000	4908	2	500	25	83	55	·003	5·8°	·471 GF	·478 GG	—	—	—	—	·078	G	·004			·467	·995	·462	10630	500	·048	10420
19H	6000	5908	2	500	50	83	70	·002	4·8°	·545 GP	·522 GE	—	—	—	—	·077	G	·003			·542	·996	·538	10980	1000	·076	13150
18G	7000	6908	2	500	50	83	70	·002	4·1°	(GP)	·620 GE	—	—	—	—	·077	G	·003			·609	·997	·605	11420	1000	·067	14920
17F	8000	7908	2	500	50	83	70	·002	3·6°	·666 GG	·674 GG	—	—	—	—	·076	G	·002			·664	·998	·661	11960	1000	·056	17860
16E	8700	8608	2	500	50	83	52/60	·003	3·3°		GF ·725 GE	—	—	—	—	·074	G	·000			·717	·998	·715	12070	700	·052	13460
14C	9072	8980	2	500	100	83	77/80	·000	3·2°	·737 GF	·746 GE	—	—	—	—	·075	G	·001			·736	·999	·735	12220	372	·022	16910
12A	9072	8980	2	500	15	83	74/80	·000	3·2°	(GP)	·744 GE	—	—	—	—	·074	G	—			·736	·999	·735				

REMARKS:





LAYOUT OF WELL, SHOT-POINTS AND GEOPHONE SPREAD

SCALE IN FEET

500 0 500 1000 1500

DEFINITIONS OF SYMBOLS AND COLUMN HEADINGS:

S.N. Shot number

E_K+D Depth of well geophone below rotary table Kelly bushing

Do Elevation of Datum above S.L.

E_K Elevation of rotary table Kelly bushing referred to datum plane

D Depth of well geophone below datum plane

ΔD Difference between depths of well geophone for two shots

S.P. Shot-point

X Distance of shot-point from centre of well

chge Pounds weight of explosive fired

Es Elevation of shot-point referred to datum plane

ds Depth of shot below surface

Vo Weathering velocity

Ve Subweathering velocity

t_{sd} Vertical time from shot to datum plane. Normally = $\frac{Es-ds}{Ve}$

∝ Vertical angle subtended by straight line from shot to well geophone = $\tan^{-1}\frac{X}{D+Es-ds}$

tv_1 Vertical component first break time for well geophone

tv_2 Vertical component first trough time for well geophone

tha_1 Horizontal component A first break time for well geophone

tha_2 Horizontal component A first trough time for well geophone

thb_1 Horizontal component B first break time for well geophone

thb_2 Horizontal component B first trough time for well geophone

RG Reference geophone

t_{RG} Reference geophone time

Δt_{RG} Reference geophone correction time. In general practice $tv_1 - \Delta t_{RG}$ is best estimate of t_o

to_R Reference reflection time

Δto_R Reference reflection correction time. In general practice $tv_1 - \Delta to_R$ is best estimate of $t_o - \frac{t_{sd}}{\cos\alpha}$

t_{cab} Calculated cable break time

to_{cab} Observed vertical component cable break time

Δto_{cab} Difference between to_{cab} corresponding to well geophone depth difference ΔD

t_o Accepted time for straight line ray from shot to well geophone. In idealized case t_o would equal tv_1, tha_1 and thb_1

tc Vertical time from datum plane to well geophone = $t_o \cos\alpha - t_{sd}$

Va Average vertical velocity between datum plane and well geophone = $\frac{D}{tc}$

Δtc Difference between tc corresponding to well geophone depth difference ΔD

Vi Interval velocity over depth difference ΔD $\left(=\frac{\Delta D}{\Delta tc}\right)$

Vcab Logging cable velocity = $\frac{\Delta D}{to_{cab}}$

T.D. Total depth of well referred to rotary table Kelly bushing

ρm Density of mud in well

Tm Temperature of mud returns when circulating in hole

B.H.T. Bottom hole temperature i.e. temperature at T.D.

Gr. Grading of certainty and accuracy of time:

1st grade G means: Certain that true formation break selected
P " : Some doubt " " " " "

2nd grade G " : Accuracy less than ± ·001 seconds
F " : " " " ± ·003 "
P " : " " " ± ·005 "

? grade means very doubtful certainty or time

FIELD INSTRUCTIONS:

1. Do not use outer sheath of cable or other neutral lead as geophone lead.
2. Before running geophone in well, shoot buried detonator under well geophone or do tap test to check all connections and polarity.
3. While running geophone into well fasten small geophone and a clamp to cable and strike a vertical blow on the clamp to check manufacturer's figure for cable velocity.
4. As soon as cable and shallow formation velocities are sufficiently well known, and before survey proceeds, construct calculated cable break curves for all shot-point offsets.
5. Do complete calculation as survey progresses and watch for cable breaks.
6. Where possible obtain copies of C.V.L., electric and lithologic logs and fill in all information required on this sheet.

AFTER G. 85 – 113

To accompany Record No. 1962/65

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G132–14

PLATE 2

WELL VELOCITY SURVEY DATA SHEET

WELL NAME *AFO NERRIMA No.1.* OWNER *Associated Freney Oil Fields N.L.* WELL LOGGING CONTRACTOR *Schlumberger*

LOCALITY *FITZROY BASIN, W.A.* ADDRESS ADDRESS

COORDINATES *212215 E, 2682927 N* DRILLING CONTRACTOR *Mines Administration P.L.* TYPE AND NUMBER OF LOGGING UNIT

DATE OF SURVEY *10/8/1955* ADDRESS LOGGING UNIT OPERATOR

ORGANISATION SUPERVISING VELOCITY SURVEY — SEISMIC INSTRUMENTS — WELL GEOPHONE

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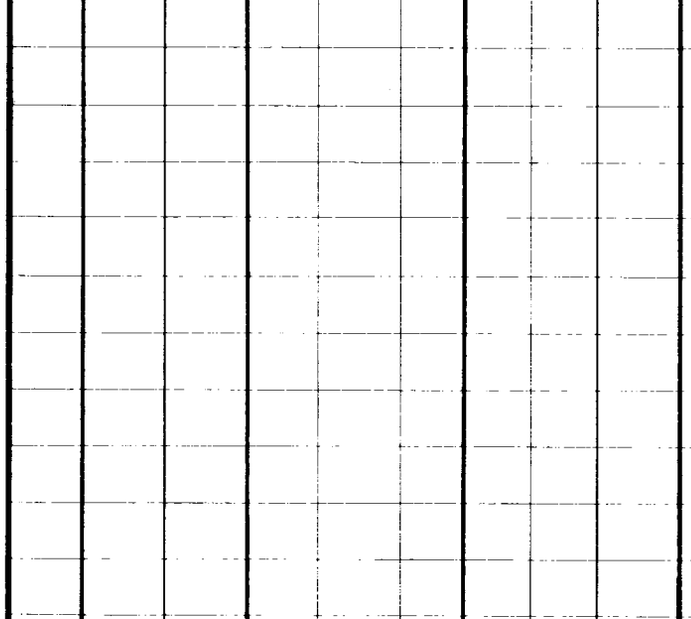
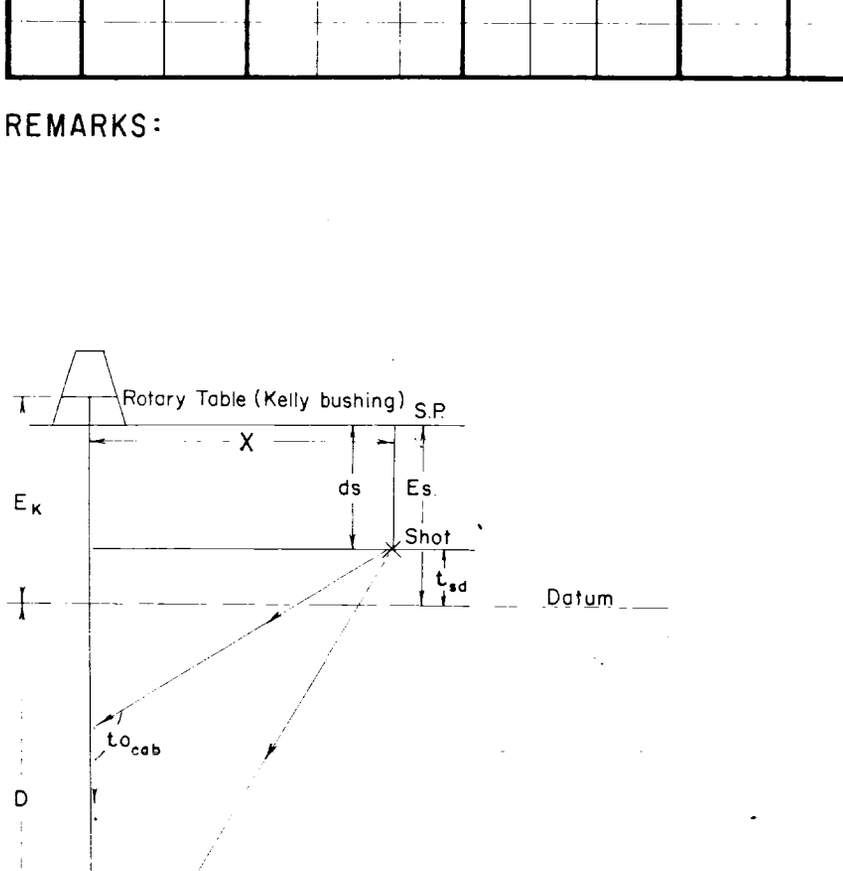
SURVEY SUPERVISOR *E.R.Smith* No

E_K = *92ft* Vo = Ve = *8000 ft/sec* Do = *300* ρm = — B.H.T. or Tm = — Vcab (Manufacturer) = — (Test) = — Cable Depth Accuracy = ± *1 ft*

Shot No.	E_K+D	D	S.P.	X	chge	Es	ds	t_{sd}	∝	tv_1. Gr.	tv_2. Gr.	tha_1. Gr.	tha_2. Gr	thb_1. Gr.	thb_2. Gr.	t_{RG} or to_R Gr.	Δt_{RG} or Δto_R	t_{cab}	to_{cab} Gr.	$\frac{t_{sd}}{t_o=\cos\alpha}$	Cos ∝	tc	Va	ΔD	Δtc	Vi
7A	4000	3908	3	750	15	83	78/84	000	10·9°	·385 GF	·392 GG	—	—	—	—	·106 G	—			·385	·982	·378	10340			
																								1000	·083	12040
8B	5000	4908	3	750	50	83	68/73	·001	8·7°	·467 PF	·475 PG	—	—	—	—	·105 G	·000			·467	·989	·461	10640			
																								1000	·076	13150
9C	6000	5908	3	750	50	83	70	·002	7·2°	·544 GF	·550 GG	—	—	—	—	·105 G	·000			·543	·992	·537	11000			
																								1000	·061	16390
10D	7000	6908	3	750	50	83	70	·002	6·2°	GP	·610 GG	—	—	—	—	·105 G	·000			·603	·994	·598	11550			
																								2072	·139	14900
11E	9072	8980	3	750	50 50	83	35/50 60/70	·004	4·8°		·753 GF	—	—	—	—	·109 G	·003			·743	·997	·737	12180			
1A	500	408	1	250	10	83	106/110	−·003	33·3°	(PP)	·065 PF	—	—	—	—	·044	—	·054	·054F	·059	·836	·052	7850			
																								500	·054	9260
2B	1000	908	1	250	25	83	100/110	−·003	15·9°	(PP)	·115 PP	—	—	—	—	·045	·001	·094	—	·107	·962	·106	8570			
																								500	·052	9620
3C	1500	1408	1	250	30	83	107/110	−·003	10·2°	(PP)	·165 PF	—	—	—	—	·044	·000	·133	·128F	·158	·984	·158	8900			
																								500	·046	10870
4D	2000	1908	1	250	30	83	109/110	−·003	7·6°	·203 PP	210 PF	—	—	—	—	004	·000	·172	·170P	·203	·991	·204	9350			
																								500	·054	9250
5E	2500	2408	1	250	30	83	108/110	−·003	6·0°		·266 PP	—	—	—	—	·048	·004	·212	·211 P	·255	·994	·258	9330			
																								1000	·086	11630
6F	3500	3408	1	250	50	83	105/110	−·003	4·2°	·344 PF	·355 PG	—	—	—	—	·046 G	·002	·290		·342	·997	·344	9910			

REMARKS:





LAYOUT OF WELL, SHOT-POINTS AND GEOPHONE SPREAD

SCALE IN FEET

500 0 500 1000 1500

DEFINITIONS OF SYMBOLS AND COLUMN HEADINGS:

E_K+D Depth of well geophone below rotary table Kelly bushing

Do Elevation of Datum above S.L.

E_K Elevation of rotary table Kelly bushing referred to datum plane

D Depth of well geophone below datum plane

ΔD Difference between depths of well geophone for two shots

S.P. Shot-point

X Distance of shot-point from centre of well

chge Pounds weight of explosive fired

Es Elevation of shot-point referred to datum plane

ds Depth of shot below surface

Vo Weathering velocity

Ve Subweathering velocity

t_{sd} Vertical time from shot to datum plane. Normally = $\frac{Es-ds}{Ve}$

∝ Vertical angle subtended by straight line from shot to well geophone = $\tan^{-1}\frac{X}{D+Es-ds}$

tv_1 Vertical component first break time for well geophone

tv_2 Vertical component first trough time for well geophone

tha_1 Horizontal component A first break time for well geophone

tha_2 Horizontal component A first trough time for well geophone

thb_1 Horizontal component B first break time for well geophone

thb_2 Horizontal component B first trough time for well geophone

RG Reference geophone

t_{RG} Reference geophone time

Δt_{RG} Reference geophone correction time. In general practice $tv_1 - \Delta t_{RG}$ is best estimate of t_o

to_R Reference reflection time

Δto_R Reference reflection correction time. In general practice $tv_1 - \Delta to_R$ is best estimate of $t_o - \frac{t_{sd}}{\cos\alpha}$

t_{cab} Calculated cable break time

to_{cab} Observed vertical component cable break time

Δto_{cab} Difference between to_{cab} corresponding to well geophone depth difference ΔD

t_o Accepted time for straight line ray from shot to well geophone. In idealized case t_o would equal tv_1, tha_1 and thb_1

tc Vertical time from datum plane to well geophone = $t_o\cos\alpha - t_{sd}$

Va Average vertical velocity between datum plane and well geophone = $\frac{D}{tc}$

Δtc Difference between tc corresponding to well geophone depth difference ΔD

Vi Interval velocity over depth difference ΔD $\left(=\frac{\Delta D}{\Delta tc}\right)$

Vcab Logging cable velocity = $\frac{\Delta D}{to_{cab}}$

T.D. Total depth of well referred to rotary table Kelly bushing

ρm Density of mud in well

Tm Temperature of mud returns when circulating in hole

B.H.T. Bottom hole temperature i.e. temperature at T.D.

Gr. Grading of certainty and accuracy of time:

1st grade G means: Certain that true formation break selected
P " :Some doubt" " " " " "

2nd grade G " :Accuracy less than ± ·001 seconds
F " : " " " ± ·003 "
P " : " " " ± ·005 "

? grade means very doubtful certainty or time

FIELD INSTRUCTIONS:

1. Do not use outer sheath of cable or other neutral lead as geophone lead.
2. Before running geophone in well, shoot buried detonator under well geophone or do tap test to check all connections and polarity.
3. While running geophone into well fasten small geophone and a clamp to cable and strike a vertical blow on the clamp to check manufacturer's figure for cable velocity.
4. As soon as cable and shallow formation velocities are sufficiently well known, and before survey proceeds, construct calculated cable break curves for all shot-point offsets.
5. Do complete calculation as survey progresses and watch for cable breaks.
6. Where possible obtain copies of C.V.L., electric and lithologic logs and fill in all information required on this sheet.

AFTER G 85 — 113

To accompany Record No. 1962/65

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 132—15

PLATE 3

NERRIMA, FITZROY BASIN 1955

PLATE 4

AFTER G 85–114

Age	Formation	Lithology	Resistivity Log	Continuous Velocity Log
PERMIAN	NOONKANBAH			
	POOLE Sst.			
	GRANT FORMATION			
CARBONIFEROUS	Upper Carboniferous			

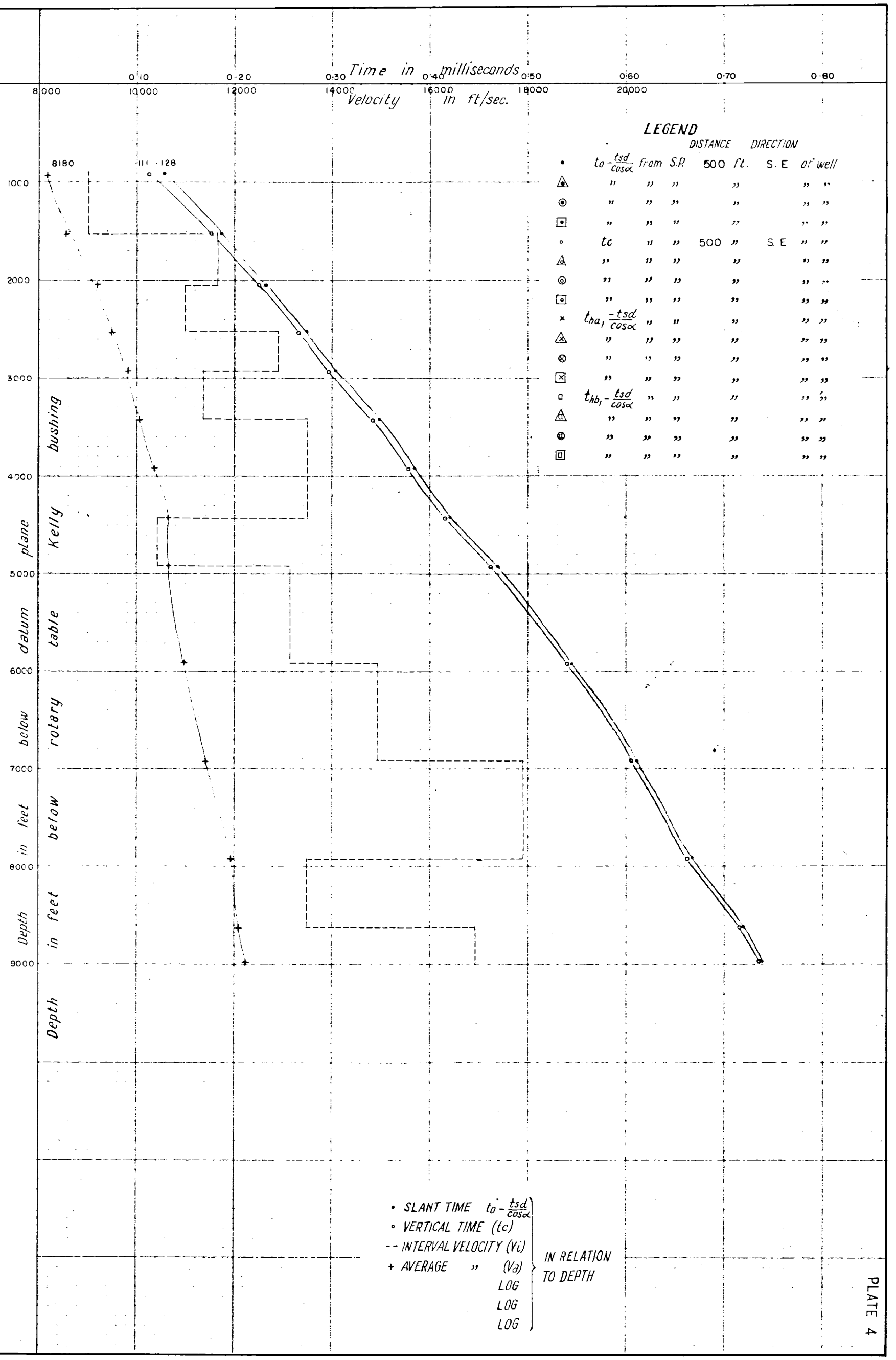
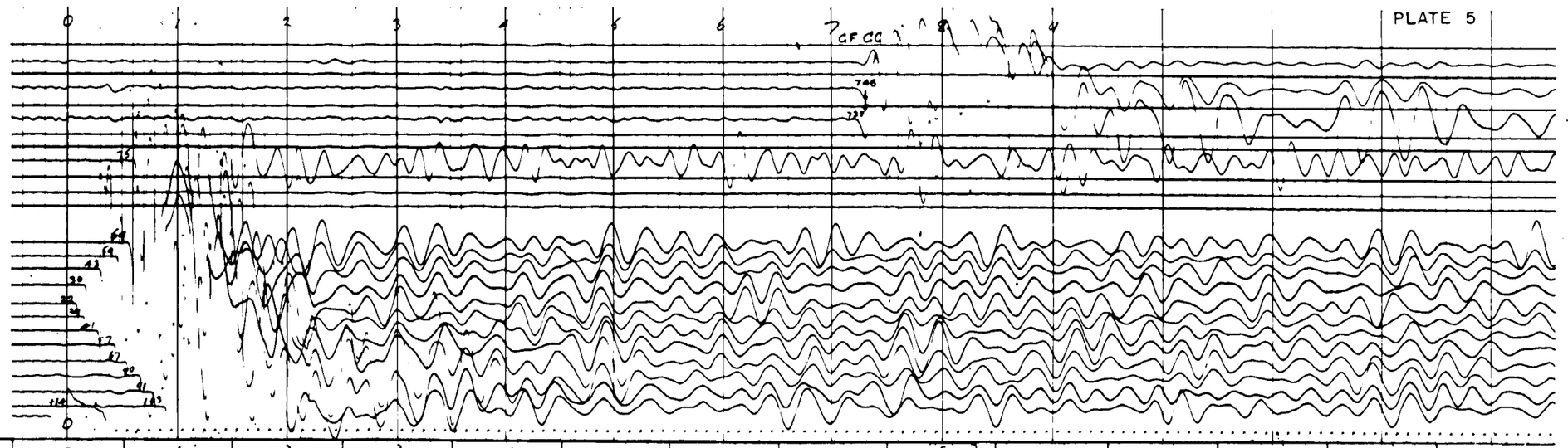


PLATE 4

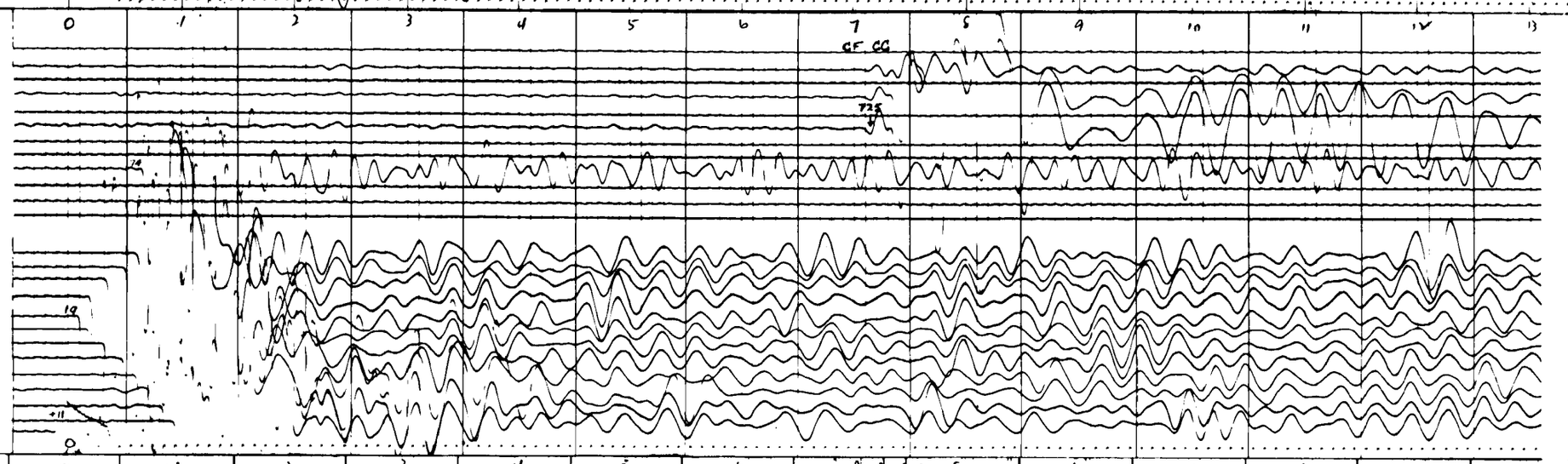
To accompany Record No 1962/65

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS G132–13

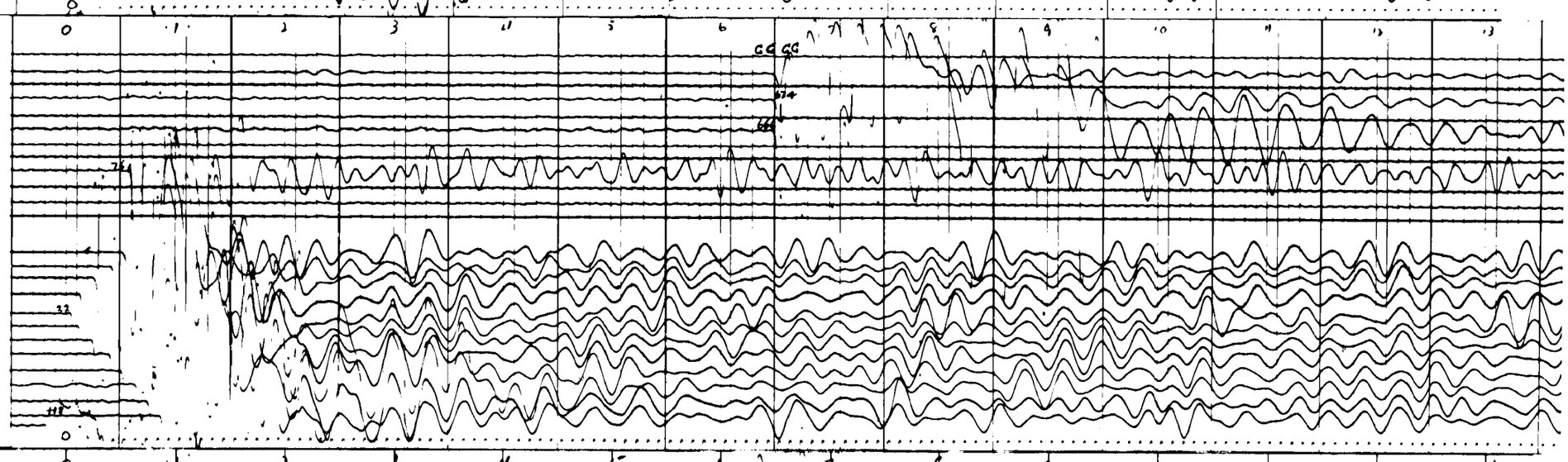
SEISMIC VELOCITY SURVEY
NERRIMA V.2 10-8-55
2 500
14C 100 80/77
9072
TIC 3 ELEM VERT WELL G/PTIC
L.2.H.4 0
15 NW-24 SE
2 M AT 100' INTERVALS
4 M TIC G/Ps
6 M 8 PER TRACE
9 M AS FOR 15B
17 MIXED.
25



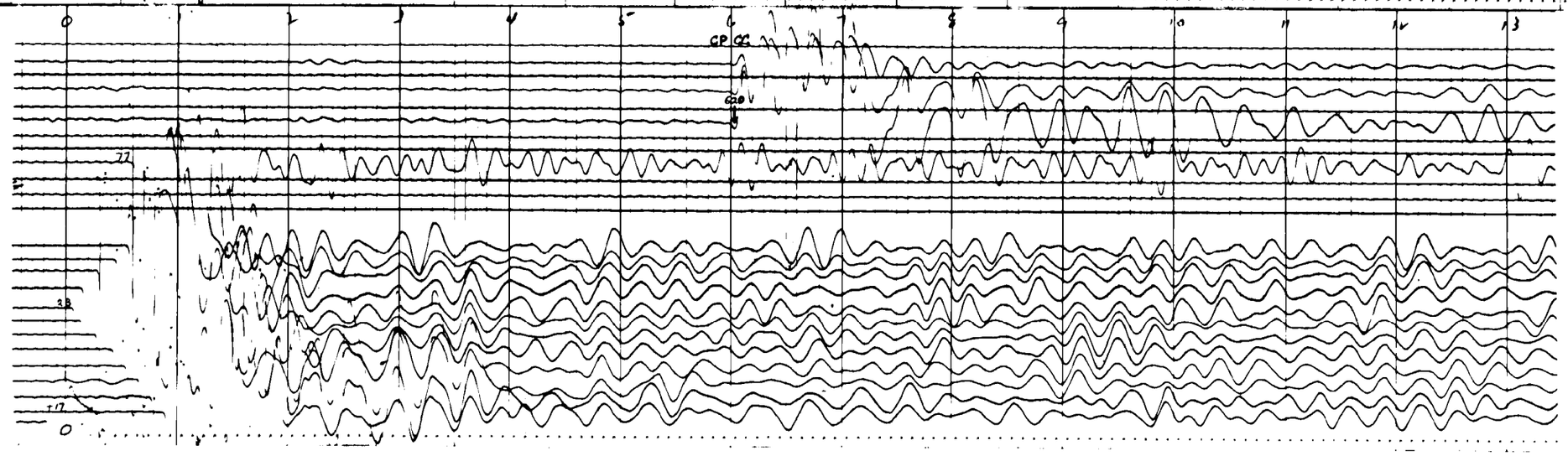
SEISMIC VELOCITY SURVEY
NERRIMA A.F.O.-1 10-8-55
2 500
16E 50 60/52
9700
TIC 3 ELEM VERT WELL G/PTIC
L.2.H.4 0
15 NW-24 SE
2 M AT 100' INTERVALS
4 M TIC G/Ps
6 M 8 PER TRACE
9 M
17 MIXED
25



SEISMIC VELOCITY SURVEY
NERRIMA A.F.O.-1 10-8-55
2 500
17F 50 70
8000
TIC 3 ELEM VERT WELL G/PTIC
L.2.H.4 0
15 NW-24 SE
2 M AT 100' INTERVALS
4 M TIC G/Ps
6 M 8 PER TRACE
9 M AS FOR 16E
17 MIXED
25



SEISMIC VELOCITY SURVEY
NERRIMA A.F.O.-1 10-8-55
2 500
18G 50 70
7000
TIC 3 ELEM VERT WELL G/PTIC
L.2.H.4 0
15 NW-24 SE
2 M AT 100' INTERVALS
4 M TIC G/Ps
6 M 8 PER TRACE
9 M AS FOR 16E
17 MIXED
25



SEISMOGRAMS FROM WELL-GEOPHONE
SHOT-POINT 2

To accompany Record No. 1962/65
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

G 132-9

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area NERRIMA	Well A.F.O.-1		10-8-55
S.P. 2	500		
19H	50		70
8000	Well Elev.		
TIC		3ELEM VERT WELL G/PTIC	
L.2.H.4	0		
		13NW-24SE	
	2 M	AT 100' INTERVALS	
	4 M	TIC G/Ps	
	6 M	8 PER TRACE	
	9 M	AS FOR IGE	
	17	MIXED	
	25		

CP CG

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area NERRIMA	Well A.F.O-1		10-8-55
S.P. 2	500		
20 I	25		56
5000			
TIC		3ELEM VERT WELL G/PTIC	
L.2.H.4	0		
		13NW-24SE	
	2 M	AT 100' INTERVALS	
	4 M	TIC G/Ps	
	6 M	8 PER TRACE	
	9 M	AS FOR IGE	
	17	MIXED	
	25		

CF CG

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area NERRIMA	Well A.F.O-1		10-8-55
S.P. 2	500		
21 J	25		60
4500			
TIC		3ELEM VERT WELL G/PTIC	
L.2.H.4	0		
		13NW-24SE	
	2 M	AT 100' INTERVALS	
	4 M	TIC G/Ps	
	6 M	8 PER TRACE	
	9 M	AS IGE	
	17	MIXED	
	25		

CC CG

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

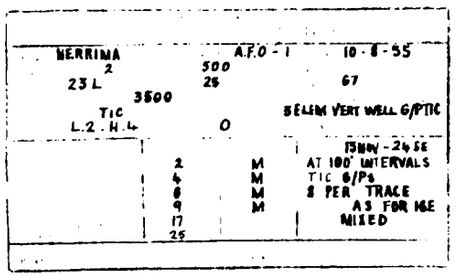
Area NERRIMA	Well AFO-1		10-8-55
S.P. 2.	500		
22 K	25		77
4000			
TIC		3ELEM VERT WELL G/PTIC	
L.2.H.4	0		
		13NW-24SE	
	2. M	AT 100' INTERVALS	
	4 M	TIC G/Ps	
	6 M	8 PER TRACE	
	9 M	AS FOR IGE	
	17	MIXED	
	25	LABELLED REPLACED SUMMED	

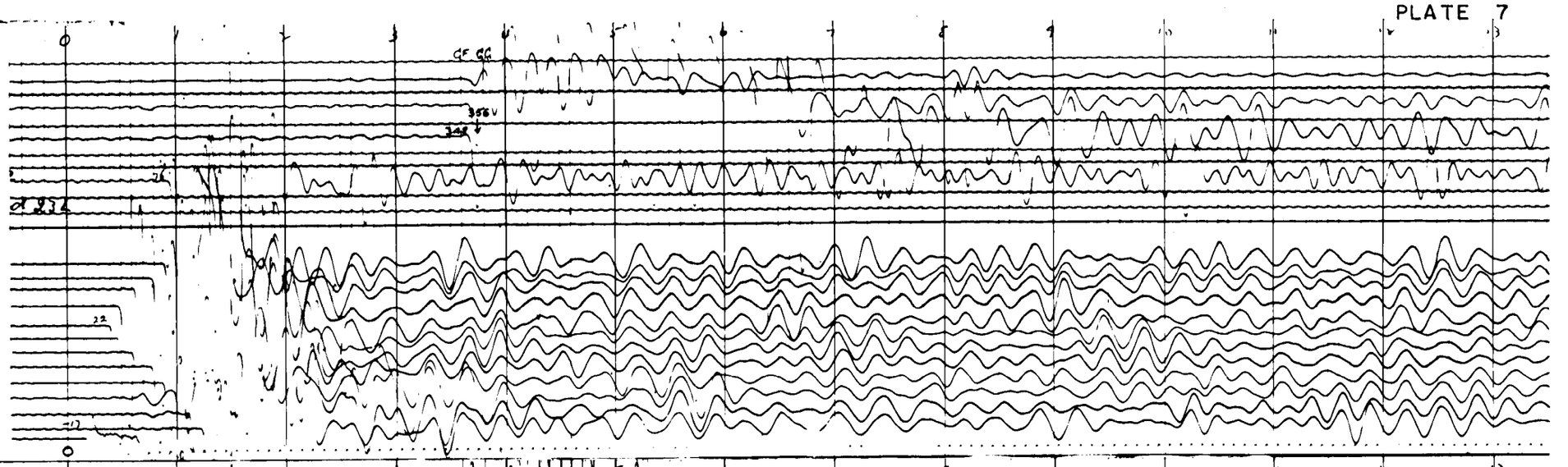
CG CG

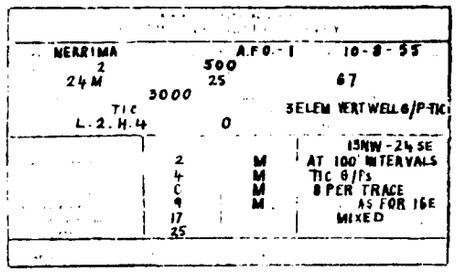
SEISMOGRAMS FROM WELL-GEOPHONE
SHOT-POINT 2

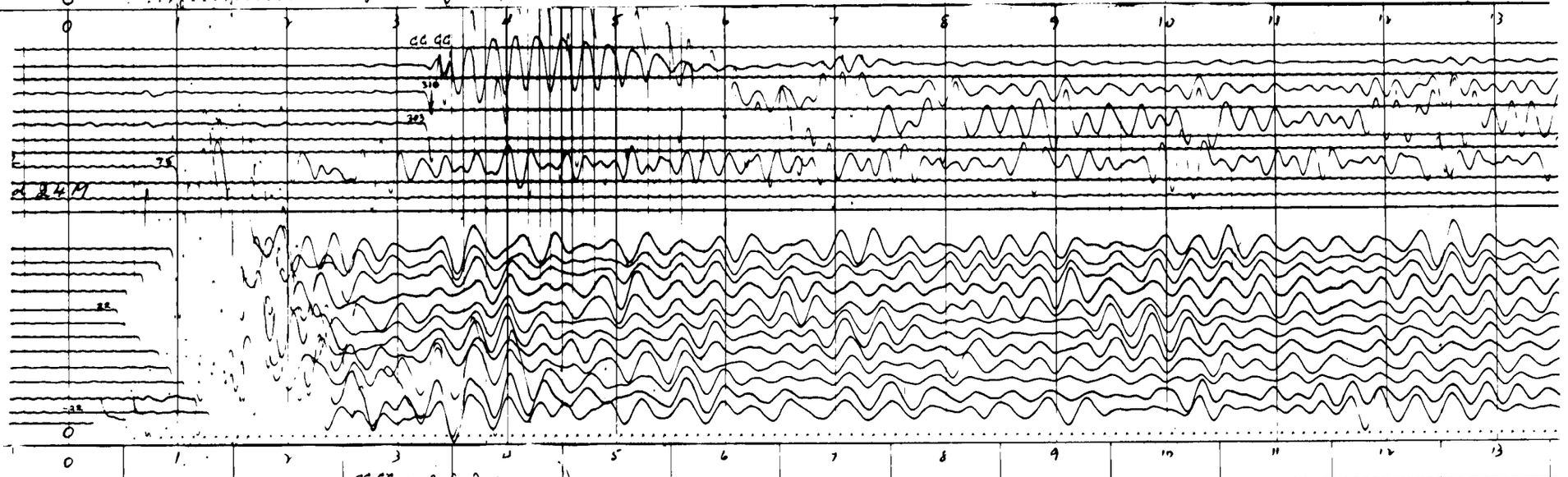
To accompany Record No. 1962/65
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

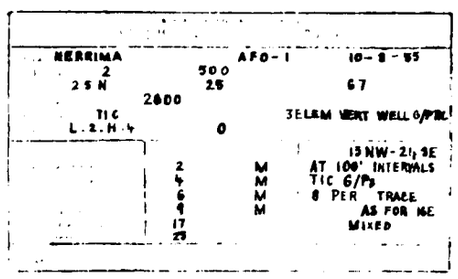
G132-10

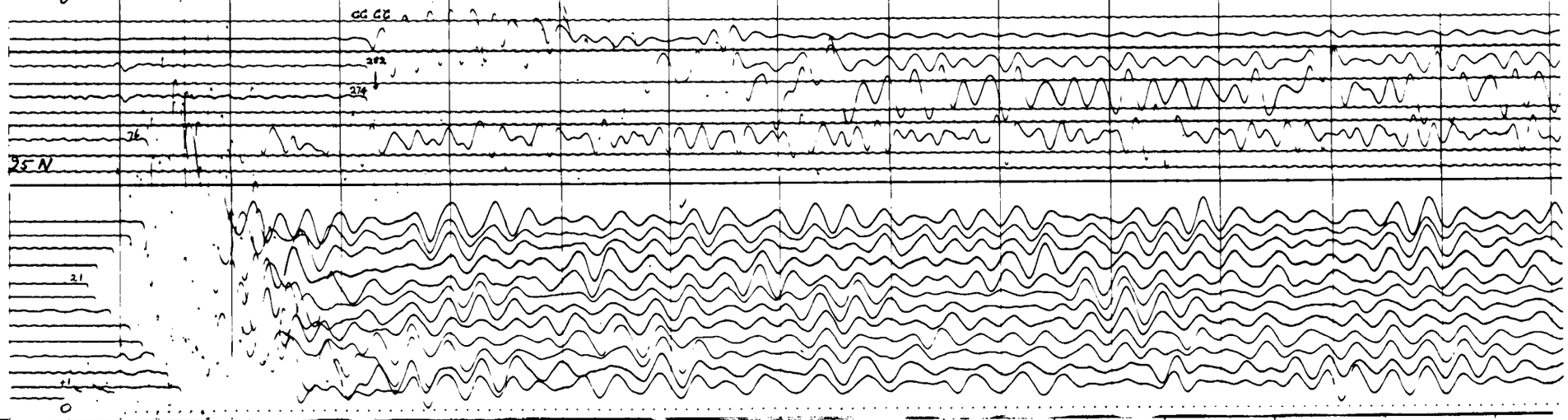


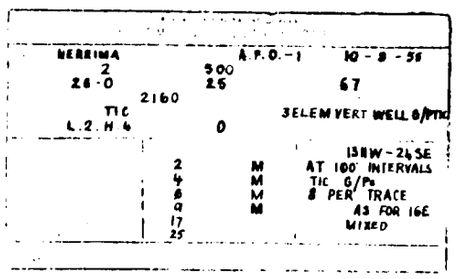


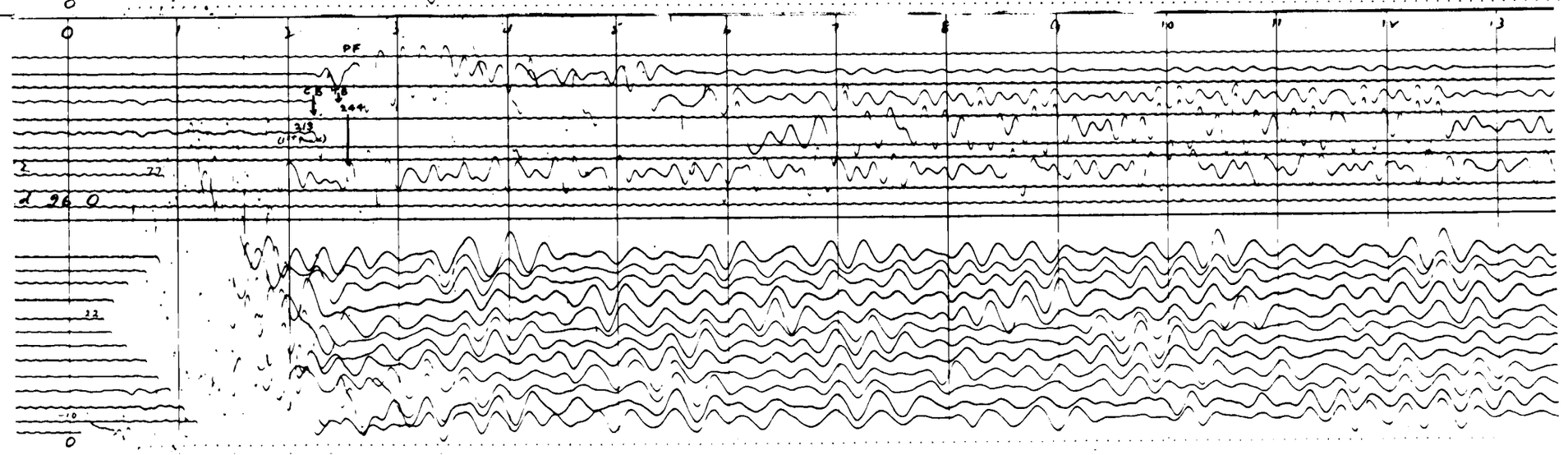












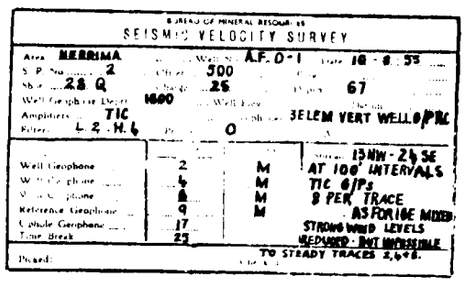
SEISMOGRAMS FROM WELL - GEOPHONE

SHOT-POINT 2

To accompany Record No. 1962/65

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

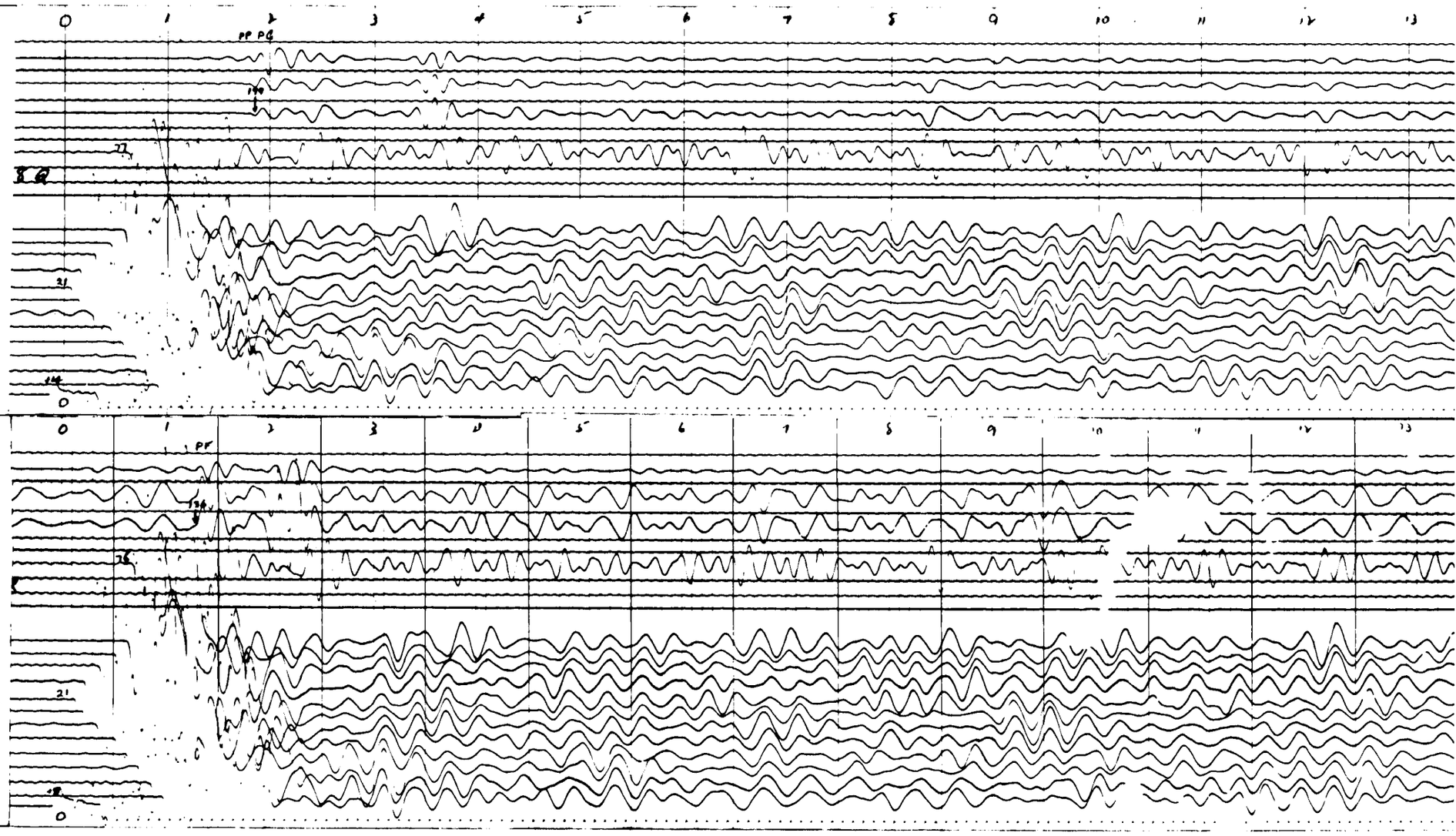
G 132-11

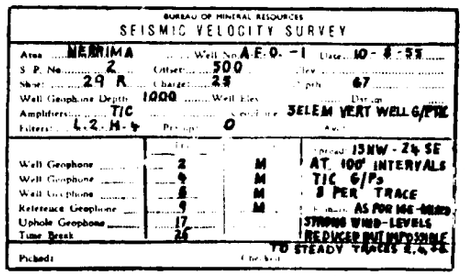

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area MERRIMA Well No A.E.O. -1 Date 10 - 8 - 55
S. P. No. 2 Offset 500 Elev.
Shot 28 Q Charge 25 Depth 67
Well Geophone Depth 1800 Well Elev. Datum
Amplifiers TIC Recorder 3ELEM VERT WELL G/PIC
Filters L.2 - H.4 Pre-amp 0 Azi.

Well Geophone	2	M	Spread 13NW - 24SE
Well Geophone	4	M	AT 100' INTERVALS
Well Geophone	6	M	TIC G/Ps
Reference Geophone	9	M	3 PER TRACE
Uphole Geophone	17		Remarks AS FOR 106 ABOVE
Time Break	25		STRONG WIND LEVELS
			REDUCED BUT IMPOSSIBLE
			TO STEADY TRACES 2,4+6.

Picked: Checked:




BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area MERRIMA Well No A.E.O. -1 Date 10 - 8 - 55
S. P. No. 2 Offset 500 Elev.
Shot 29 R Charge 25 Depth 67
Well Geophone Depth 1000 Well Elev. Datum
Amplifiers TIC Recorder 3ELEM VERT WELL G/PIC
Filters L.2 - H.4 Pre-amp 0 Azi.

Well Geophone	2	M	Spread 13NW - 24SE
Well Geophone	4	M	AT 100' INTERVALS
Well Geophone	6	M	TIC G/Ps
Reference Geophone	9	M	3 PER TRACE
Uphole Geophone	17		Remarks AS FOR 106 ABOVE
Time Break	25		STRONG WIND-LEVELS
			REDUCED BUT IMPOSSIBLE
			TO STEADY TRACES 2, 4, 6.

Picked: Checked:

SEISMOGRAMS FROM WELL - GEOPHONE

SHOT - POINT 2

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics. G 132 - 12

To accompany Record No. 1962/65

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: MERRIMA Well No. A.F.O - 1 Date: 10 - 8 - 55
S. P. No. 1 Offset: 250 Elev:
Shot: 2 B Charge: 10 Depth: 118/118
Well Geophone Depth: 500 Well Elev.: Datum
Amplifiers: T1C Geophones: 3 ELEM VERT WELL GP. T1C
Filters: L. 2 - H. 4 Preamp: 0 Ave:

	Trace		
Well Geophone	2	M	Spread: 13NW - 24 SE
Well Geophone	4	50% L.M.	AT 100' INTERVALS
Well Geophone	6	20% L.M.	8 G/Ps PER TRACE
Reference Geophone	9	M L.H.	Remarks: Ref G/P
Uphole Geophone	24		70 ft from Shot
Time Break	25		

Picked: Checked:

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: MERRIMA Well No. A.F.O - 1 Date: 10 - 8 - 55
S. P. No. 1 Offset: 250 Elev:
Shot: 2 B Charge: 25 Depth: 118/118
Well Geophone Depth: 1000 Well Elev.: Datum
Amplifiers: T1C Geophones: 3 ELEM VERT WELL G/P.T1C
Filters: L. 2 - H. 4 Preamp: 0 Ave:

	Trace		
Well Geophone	2	M	Spread: 13NW - 24 SE
Well Geophone	4	M 50%	AT 100' INTERVALS
Well Geophone	6	M 20%	8 G/Ps PER TRACE
Reference Geophone	9	M L.H.	Remarks: WELL G/P
Uphole Geophone	24		FILTERS ALL L.I - H.L.
Time Break	25		

Picked: Checked:

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: MERRIMA Well No. AFO No1 Date: 10/8/55
S. P. No. 1 Offset: 250' Elev:
Shot: 4D Charge: 30 Depth: 110/109
Well Geophone Depth: 2000' Well Elev.: Datum
Amplifiers: T1C Geophones: 3 ELEM. VERT WELL G/P(T1C)
Filters: L2. H.4 Preamp: 0 Ave:

	Trace		
Well Geophone	2	M	13NW - 24 SE
	4	M	AT 100' INTERVALS
	6	M	8 G/Ps per TRACE
Reference Geop	9	M	LEVEL OF Nos
Uphole Geophone	20		DECREASED V. SLIGHTLY
Time Break	25		FROM 2C

Picked: Checked:

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: MERRIMA Well No. AFO 1 Date: 10/8/55
S P No. 1 Offset: 250 Elev:
Shot: 3C Charge: 30 Depth: 110/107
Well Geophone Depth: 1500 Well Elev.: Datum
Amplifiers: T1C Geophones: 3 ELEM VERT WELL G/P.T1C
Filters: L.2 H.4 Preamp: 00 Ave:

	Trace		
Well Geophone	2	M	Spread: 13NW - 24 SE
	4	M	AT 100' INTERVALS
	6	M	
Reference Geop	9	M	Remarks: LEVELS Nos 9&6
Uphole Geophone	24		INCREASED SLIGHTLY
Time Break	25		WELL G/P FILTERS L.I. H.I.

Picked: Checked:

SEISMOGRAMS FROM WELL- GEOPHONE
SHOT - POINT 1

To accompany Record No. 1962/65
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

G 132 - 6

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: NERRIMA Well No: AFO No1 Date: 10/8/55
S P No.: 1 Offset: 250' Elev:
Shot: 5E Depth: 30 Depth: 110/108
Well Geophone Dep: 2500' Datum:
Amplifier: TIC Datum: 3 ELEM VERT WELL G/P(TIC)
Filters: L.2. H.4 Dep: 0 Ave:

Well Geophone	2	M	Spread 13 N W - 24 SE AT 100' INTERVALS TIC G/Ps, 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	Remarks LEVELS 2 & 6 AGAIN INCREASED SLIGHTLY
Uphole Geophone	24		
Time Break	25		

Picked: Checked:

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: NERRIMA Well No: AFO No1 Date: 10/8/55
S P No.: 1 Offset: 250' Elev:
Shot: 6F Depth: 50 Depth: 110/105
Well Geophone Dep: 3500' Datum:
Amplifier: TIC Datum: 3 ELEM VERT WELL G/P(TIC)
Filters: L.2. H.4 Dep: 0 Ave:

Well Geophone	2	M	Spread 13NW-24 SE AT 100' INTERVALS TIC G/Ps, 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	Remarks AS 5E
Uphole Geophone	24		
Time Break	25		

Picked: Checked:

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: NERRIMA Well No: AFONo1 Date: 10/8/55
S P No.: 7A Offset: 750' Elev:
Shot: B Depth: 15 Depth: 84/78
Well Geophone Dep: 4000' Datum:
Amplifier: TIC Datum: 3 ELEM. VERT WELL G/P(TIC)
Filters: L 2 H 4 Dep: 0 Ave:

Well Geophone	2	M	Spread 13 NW - 24 SE AT 100' INTERVALS TIC G/Ps, 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	Remarks AS 6E
Uphole Geophone	24		
Time Break	25		

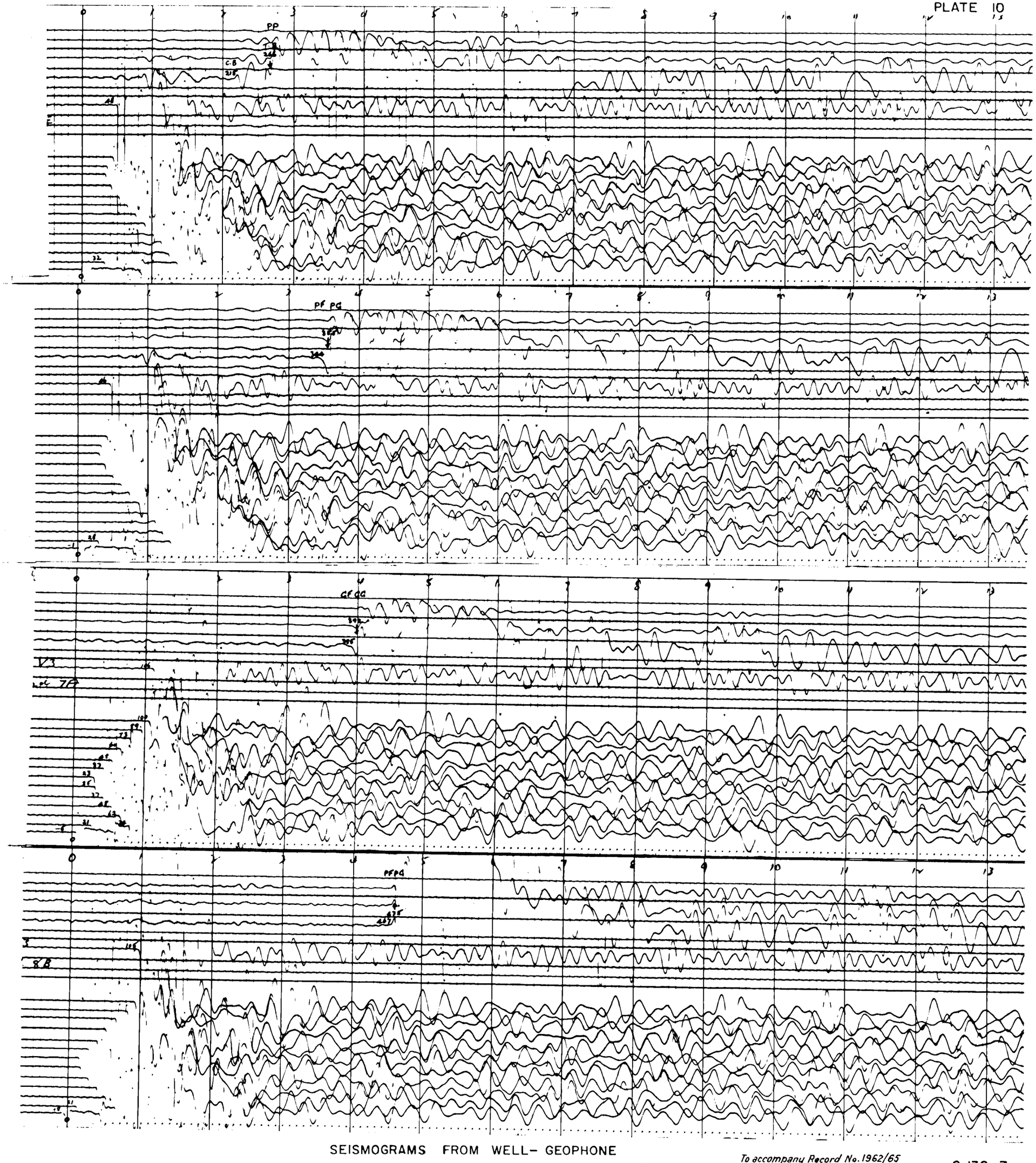
Picked: Checked:

BUREAU OF MINERAL RESOURCES
SEISMIC VELOCITY SURVEY

Area: NERRIMA Well No: AFO No1 Date: 10/8/55
S P No.: 8B Offset: 750' Elev:
Shot: 3 Depth: 30 Depth: 75/68
Well Geophone Dep: 6000' Datum:
Amplifier: TIC Datum: 3 ELEM. VERT WELL G/P(TIC)
Filters: L.2. H 4 Dep: 0 Ave:

Well Geophone	2	M	Spread 13NW-24SE AT 100' INTERVALS, TIC G/Ps 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	Remarks LEVELS 2.4.8 INCREASED SLIGHTLY
Uphole Geophone	24		
Time Break	25		

Picked: Checked:



SEISMOGRAMS FROM WELL- GEOPHONE
SHOT - POINTS 1 AND 3

To accompany Record No. 1962/65
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

G 132-7

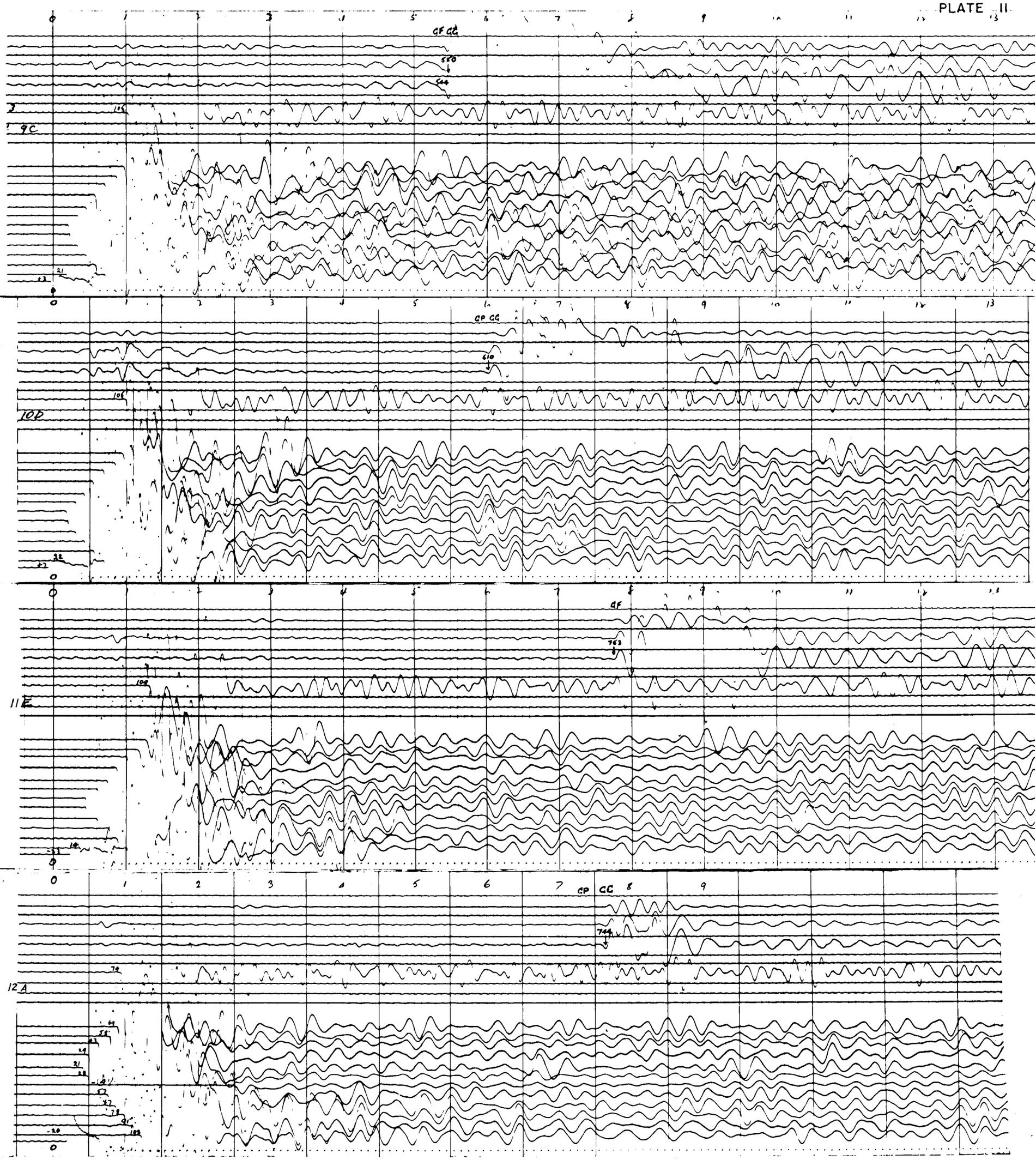
PLATE II

SEISMIC VELOCITY SURVEY

Area NERRIMA Well A.F.O No1 Date 10/8/55
S.P. No 3 750
Shot 9C 50 Depth 70
Well Geophone Depth 6000'
Amplifier TIC 3 ELEM. VERT. WELL G/P TIC
Filters L.2. H.4 0

Well Geophone	2	M	15NE-24SW AT 100' INTERVALS TIC G/PS, 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	AS 8B
Uphole Geophone	24		
Time Break	25		

Picked: Checked:



SEISMIC VELOCITY SURVEY

Area NERRIMA Well A.F.O No1 Date 10/8/55
S.P. No 5 750'
Shot 10D 50 Depth 70
Well Geophone Depth 7000
Amplifier TIC 3 ELEM. VERT. WELL G/P TIC
Filters L.2. H.H 0

Well Geophone	2	M	15NW-24SE AT 100' INTERVALS TIC G/Pa - 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	A3.9C (MIXED)
Uphole Geophone	24		
Time Break	25		

Picked: Checked:

SEISMIC VELOCITY SURVEY

Area NERRIMA Well A.F.O-1 Date 10-8-55
S.P. No 2 500
Shot 12A 80 Depth 74
Well Geophone Depth 9012
Amplifier TIC 3 ELEM VERT WELL G/P TIC
Filters L 2 H 4 0

Well Geophone	2	M	15NW-24SE AT 100' INTERVALS TIC G/Pa · 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	A3 FOR 11E MIXED
Uphole Geophone	17		
Time Break	25		

Picked: Checked:

SEISMIC VELOCITY SURVEY

Area NERRIMA Well A.F.O-1 Date 10-8-55
S.P. No 3 750
Shot NE 50 x 50 x 100 Depth 35/50 AND 70/60
Well Geophone Depth 4012
Amplifier TIC 3 ELEM VERT WELL G/P TIC
Filters L.2.H.4 0

Well Geophone	2	M	15NW-24SE AT 100' INTERVALS TIC G/PS - 8 PER TRACE
	4	M	
	6	M	
Reference Geophone	9	M	A 9C MIXED
Uphole Geophone	24		
Time Break	25		

Picked: Checked:

SEISMOGRAMS FROM WELL-GEOPHONE
SHOT POINTS 3 AND 2

To accompany Record No. 1962/65
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 132-8