DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT. BK. NO. 87/52

WELL VELOCITY SURVEY FOR DRILL HOLE C.R.A.E. KD#1A E.L.1054, POLDA BASIN

OIL, GAS AND COAL DIVISION

By

L.P. HOUGH

FEBRUARY, 1987

PIRSA
87/00052
10753764

CONTENTS PAGE

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT. BK. NO. 87/52
D.M.E. NO.
NEC-4

WELL VELOCITY SURVEY FOR DRILL HOLE C.R.A.E. KD#1A E.L. 1054, POLDA BASIN

INTRODUCTION

A check shot velocity survey was conducted by S.A.D.M.E. as part of a normal geophysical logging programme performed for CRAE by GEOSCIENCE ASSOC. PTY LTD. of Adelaide in drill hole CRAE KD#1A on March 15th 1984.

The drill hole is located on S.A.D.M.E. seismic line PB83-001 at shot point 338 (see FIGS 1 & 2) within exploration licence area 1054 which covers part of the onshore section of the Polda Basin.

The survey was undertaken to provide a correlation between the 1983 seismic reflection profile, and the lithological and geophysical borehole logs, and to determine overall average formation velocities.

Drilling was terminated at 1398 metres depth below ground surface (elevation 110.251 A.H.D.) and the well geophone was lowered to a maximum depth of 1380 m due to insufficient logging cable.

PROCEDURE

A wall locking geophone was lowered to pre-determined depths using electric logging cable supplied by the GEOSCIENCE ASSOC PTY LTD. logging unit. The logging cable was coupled to a portable 6 channel OYO M^c^SEIS 150 recording seismograph unit.

The energy source ranged from Anzomex "A" boosters (25 gms) up to Anzite Blue (2 kgs). If a preamplifier had been in place on the well geophone it is considered that the charge size could have been reduced considerably from the 2 kilogram size. Most shots were detonated in the mud pit (18 metres offset from the well head) although 4 records were taken at 50 and 100 m offsets (see Fig. 2).

Results were produced as hard paper copies and also as a timeable video display.

Trace 1 on all records represents the time to a reference geophone located at the top of the well, trace 2 is available as an uphole geophone at the shot point but was not utilized and trace 3-6 inclusive displays the signal of the down hole geophone at different amplifer gain settings.

Thirty-two (32) poor-fair records were taken at twenty one (21) levels in the hole, 12 records being rejected. The well geophone was located at levels chosen to coincide with significant formation boundaries selected from a study of the drill core and cutting sumaries. Geophysical logs were only available from surface to 605 metres at the time of the survey. Intermediate shots were also taken resulting in a maximum subsurface sample interval of 190 metres. Results of the survey are tabulated in TABLE 1. Records were taken both when running in the hole and also on the way up from total depth.

COMPUTATIONS

Values of slant arrival times to the downhole geophone were first corrected to the vertical and secondly corrected to the 100 metre A.H.D. seismic datum by the application of datum statics, see Table 1.

Datum corrections were estimated from results of a refraction spread recorded at the well site Fig. 3 and also from analysis of uphole times recorded along the seismic line in the near vicinity.

An average velocity to datum from surface was estimated at 725 m/sec.

Average velocities to depth and interval velocities between geophone locations were then calculated see TABLE 2. Average formation velocities can be estimated from the plot of corrected times versus depth, FIG. 4, and these can be compared with the interval velocities calculated in Table 2.

Two power curves of the form $y = ax^b$ where:

Y = depth

a,b = are constants

x = time

were fitted to the data points by linear regression see FIG. 5.

RESULTS

On the basis of the average formation velocities calculated by linear regression (fig 4), five (5) velocity zones were identified. These are listed below with their corresponding depth range and for comparison the geological time horizons are also given.

DEPTH (BELOW DATUM)	VELOCITY (M/S)	DEPTH (BELOW DATUM)	GEOLOGICAL AGE
0		0	
90	V_0 1584	104.75	MIOCENE
230	V_1 1761	290.75	EOCENE
506	V_2 2143	572.75	JURASSIC
670	V_3 3098	594.75	PERMIAN
T.D.	V_4 4599	T.D.	CAMBRIAN?

It is obvious that the velocity zones do not compare exactly with the geological time zone boundaries but have a more favourable correlation with geological events with the time zones.

A greater number of sample points in the well would clarify this situation further but basically velocity V_0 = 1484 ms corresponds to the Miocene sequence of clays and sands. Velocity V_1 of 1761 m/sec is correlated with the basal Miocene or possibly the top of the Eocene unit down to a depth of approximately 230 metres below datum. From 230 to about 506 metres below datum the formation velocity is 2143 m/sec. This depth range includes both the basal Eocene and the upper sequence of the Jurassic time zone. A lithological change at about 506 m within the Jurassic sequence causes the V_4 layer velocity of 3098 m/sec. This velocity appears to continue through the Permian formation and into the upper red bed sequence to a depth of approximately 670 m below datum. Below this level the velocity is 4599 m/sec to the total depth of the hole.

These figures of formation velocity are regarded as more reliable than the individual interval velocities calculated between separate data points as tabled in Table 2 and displayed in Fig. 5. Of particular note is the apparent lack of velocity contrast at the top of the Jurassic and Permian sequences.

Two power curves of the form $y = ax^b$
where y = depth (m)
x = time (secs)
a,b are constants
were fitted to the time-depth points (FIG. 5).

These depth functions:-

1. $Z = 1024\ t^{1.11}$ fits the time-depth points down to 505 m. (near base of Jurassic)

2. $Z = 1525\ t^{1.75}$ fits the time-depth points from 505 m - T.D. allow quick prediction of depth from seismic reflection times.

A correlation between the seismic section profile over the drill hole and geological horizons intersected is provided in FIG 6 where check shot times are plotted on the section.

A good correlation between seismic events and geological formations is apparent.

CONCLUSIONS AND RECOMMENDATIONS

Results obtained during the well velocity survey are considered reliable and have enabled a good tie between geological horizons intersected in the drill hole KD#1A and the seismic section PB83-001.

With the good correlation between geological formation and seismic velocity a sound basis for interpretation of future seismic work is now provided for this part of the Polda Basin.

It is recommended further work be conducted westward in the basin to provide a clearer picture of the geology and the seismic velocity distribution, particularly with regard to the Permian and Jurassic formations.

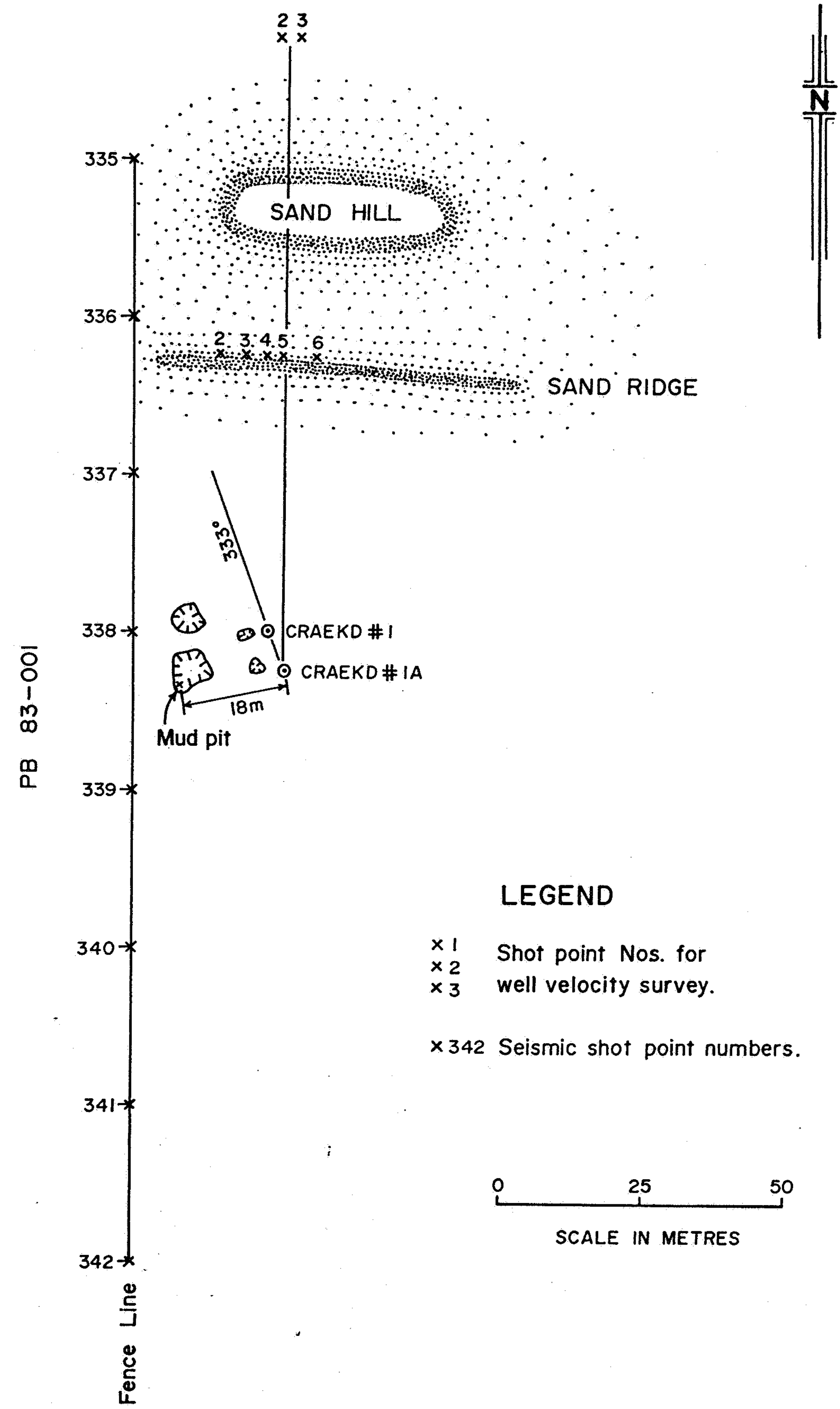


FIG. 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED L.P. Hough	C.D.O. DATE 10·3·87
WELL VELOCITY SURVEY FOR DRILLHOLE C.R.A.E. KDIA EL 1054, POLDA BASIN	DRAWN T. McKenzie	SCALE
WELL SITE DIAGRAM	DATE Jan '87	PLAN NUMBER
	CHECKED	S19012

4271

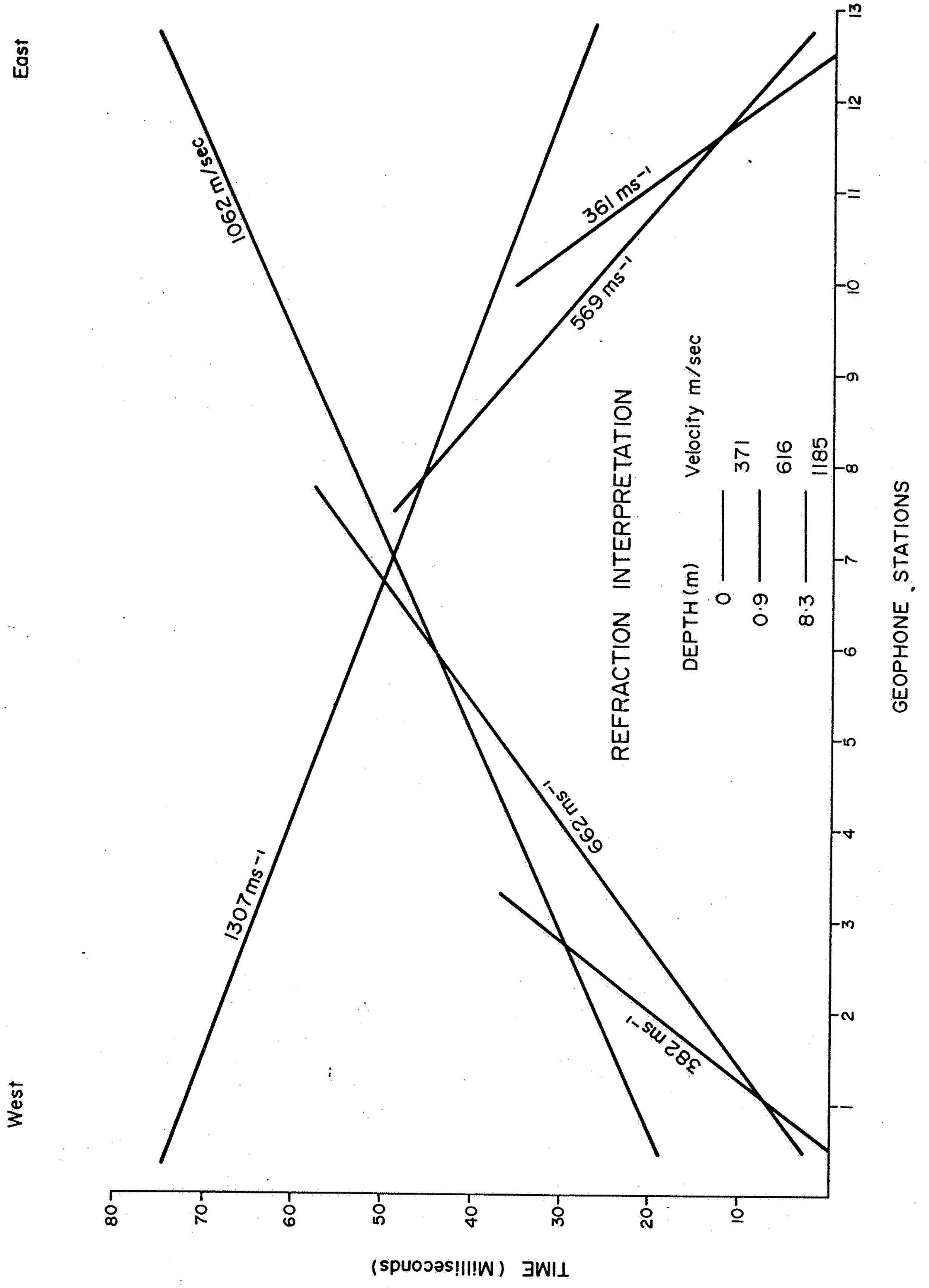


FIG. 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

WELL VELOCITY SURVEY
FOR DRILLHOLE C.R.A.E. KDIA EL 1054 POLDA BASIN

SEISMIC REFRACTION ANALYSIS

COMPILED L.P. Hough	C.D.O.	DATE 11-3-87
DRAWN T. McK.	SCALE	
DATE Jan. 87	PLAN NUMBER	
CHECKED	S19013	

4271

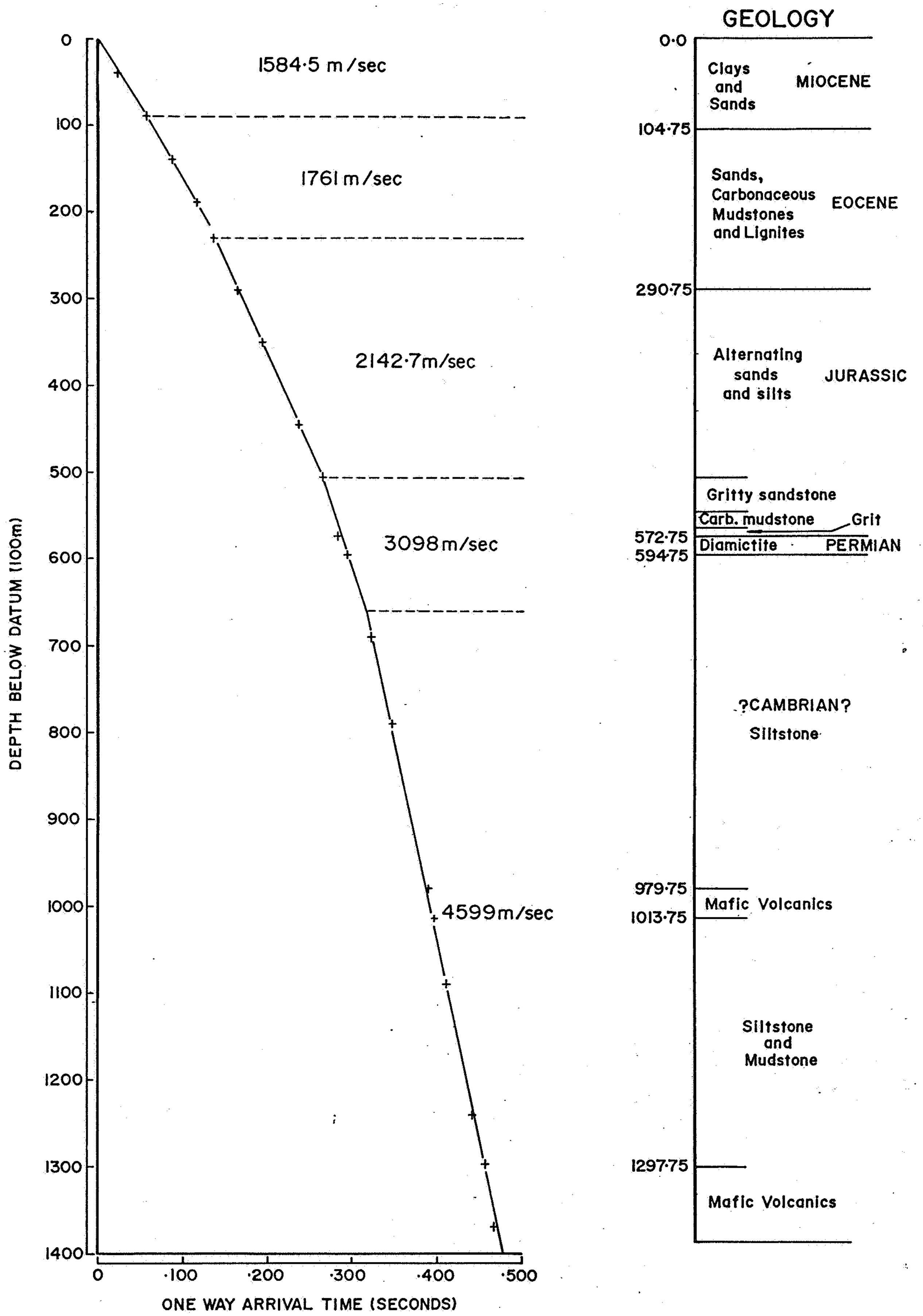


FIG. 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED L.P. Hough	[initials] C.D.O.	11·3·87 DATE
WELL VELOCITY SURVEY FOR DRILLHOLE C.R.A.E. KD#1A EL 1054 POLDA BASIN **TIME VERSUS DEPTH CURVE**	DRAWN J.W.	SCALE	
	DATE Jan '87	PLAN NUMBER	
	CHECKED	**S19014**	

4271

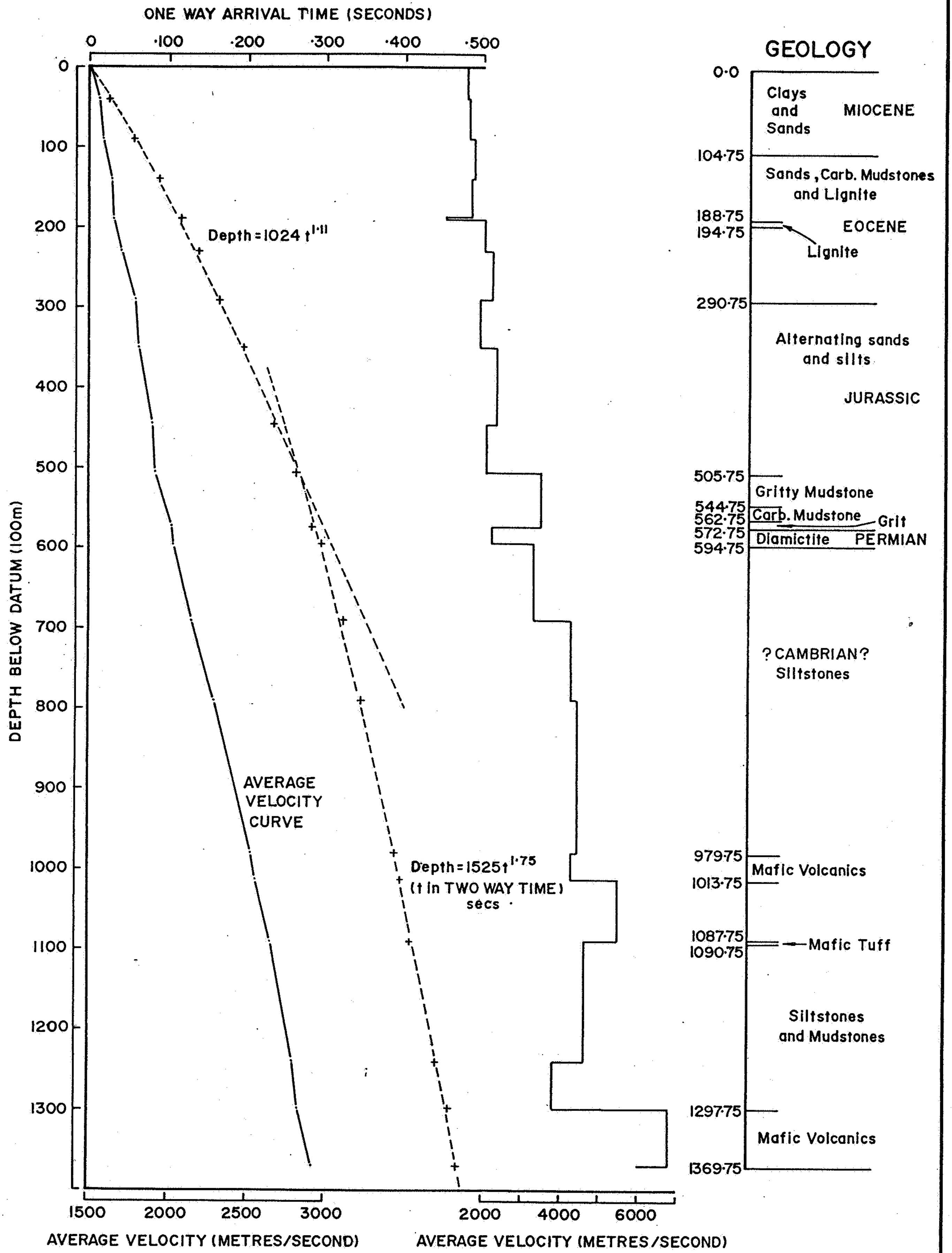


FIG. 5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

WELL VELOCITY SURVEY
FOR DRILLHOLE CRAE. KD#1A EL 1054 POLDA BASIN

POWER CURVE FIT OF TIME VERSUS DEPTH

COMPILED L.P.Hough	C.D.O.	DATE 11·3·87
DRAWN J.W.	SCALE	
DATE Jan '87	PLAN NUMBER	
CHECKED	S19015	

4271

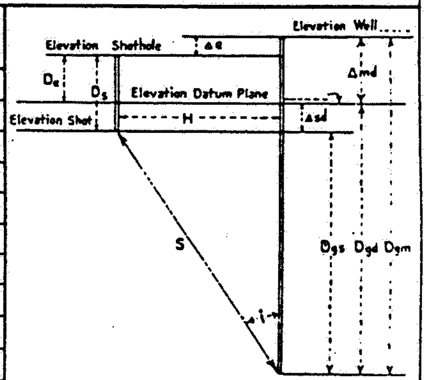
Department of Mines and Energy – South Australia

WELL VELOCITY CALCULATION FORM

MF172

SHOTHOLE INFORMATION	WELL	Elevation (Derrick Floor)	Total Depth	LOCATION
Elevation: Elevation of mud sump 109·77m Distance & Direction from Well: Distance 18m west of well	Name: C.R.A.E. KD # 1A Unit Number: 6130004SW00138	110·25m A.H.D.	1398 metres	Coordinates: 33° 35' 00" / 136° 2' 38" approx. Section: SEC. 70 Hundred, 1:250000 Sheet: Hundred of Smeaton Area or Field: Polda Basin

Record Number	Shothole Number	D_{gm}	D_s	t_{us}	t_r	T Reading	T Polarity	T Grade	D_{gs}	H	cotan i	cos i	T_{gs}	Δsd	Δsd/V	T_{gd}	T_{gd} Average	D_{gd}	ΔD_{gd}	ΔT_{gd}	V_i Interval Velocity	V_a Average Velocity
1	2ozs	200	0·5		32	128·6			199·03	18		0·996	128·09	9·27	12·8	115·29	115·29	189·75				1646
2	1ozs	100	0·5		32	?			99·03	18		0·984	–	9·27	12·8							
3	DET	200	0		0	?			200	0		1·000	–	CASING								
4	2ozs	200	0·5		26	?			199·03	18		0·996	–	9·27	12·8							
5	5ozs	301	0·5		32	175·8			300·03	18		0·998	175·45	9·27	12·8	162·65	162·65	290·75				1788
6	10ozs	516	0·5		34	277·0			515·03	18		0·999	276·72	9·27	12·8	263·92	263·92	505·75				1916
7	10ozs	605	0·5		32	306			604·03	18		1·000	306·0	9·27	12·8	293·20	293·20	594·75				2028
8	15ozs	990	0·5		32	401			989·03	18		1·000	401·0	9·27	12·8	388·20	388·20	979·75				2524
9	3/2kg	1380	0·74		–	–			1381·22	100_3		0·997	–	11·47	15·8							
10	2/2kg	1380	0·74		100	486			1381·48	100_2		0·997	484·54	11·73	16·2	468·34	468·34	1369·75				2925
11	1/2kg	1380	0·74		–	–			1381·19	50_1		0·999	–	11·44	15·8							
12	20ozs	1380	0·5		34	–			1379·03	18		1·000	–	9·27	12·8							
13	20ozs	1308	0·5		–	–			1307·03	18		1·000	–	9·27	12·8							
14	20ozs	1250	0·5		–	–			1249·03	18		1·000	–	9·27	12·8							
15	2/2kg	1250	0·74		60	459			1251·35	50_2		0·999	458·54	11·60	16·0	442·54	442·54	1239·75				2801
16	3/2kg	1308	0·74		–	–			1309·37	50_3		0·999		11·62	16·0							
17	2/2kg	1308	0·90		–	474			1309·19	50_2		0·999	473·53	11·44	15·8	457·73	457·73	1297·75				2835
18	4/2kg	1200	0·74		–	–			1201·37	50_4		0·999	–	11·62	16·0							
19	5/2kg	1100	0·74		58	426·5			1101·35	50_5		0·999	426·07	11·60	16·0	410·07	410·07	1089·75				2657
20	6/2kg	1024	0·74		–	–			1025·58	50_6		0·999	–	11·83	16·3							
21	20ozs	1024	0·5		–	–			1023·03	18		1·000	–	9·27	12·8							
22	20ozs	1024	0·5		–	409			1023·03	18		1·000	409·0	9·27	12·8	396·20	396·2	1013·75				2559
23	15ozs	800	0·5		33	358			799·03	18		1·000	358·0	9·27	12·8	345·20	345·2	789·75				2288
24	15ozs	700	0·5		34	334·5			699·03	18		1·000	334·5	9·27	12·5	321·70	321·7	689·75				2144
25	15ozs	583	0·5		33	296			582·03	18		1·000	296·0	9·27	12·8	283·20	283·2	572·75				2022
26	15ozs	455	0·5		35·5	247·5			454·03	18		0·999	247·25	9·27	12·8	234·45	234·45	444·75				1897
27	10ozs	360	0·5		36·0	206·5			359·03	18		0·999	206·29	9·27	12·8	193·49	193·49	349·75				1808
28	10ozs	240	0·5		35·4	148·2			239·03	18		0·997	147·76	9·27	12·8	134·96	134·96	229·75				1702
29	10ozs	199	0·5		36·0	127·6			198·03	18		0·996	127·09	9·27	12·8	114·29	114·29	188·75				1652
30	10ozs	150	0·5		36·6	98·8			149·03	18		0·993	98·11	9·27	12·8	85·31	85·51	139·75				1638
31	5ozs	100	0·5		38·0	70·6			99·03	18		0·984	69·47	9·27	12·8	56·67	56·67	89·75				1584
32	5ozs	50	0·5		37·6	40·8			49·03	18		0·939	38·31	9·27	12·8	25·51	25·51	39·75				1558



D_{gm} = Geophone depth measured from well elevation
D_{gs} = " " " " shot "
D_{gd} = " " " " datum "
D_s = Depth of shot
D_e = Shothole elevation to datum plane
H = Horizontal distance from well to shotpoint
S = Straight line travel path from shot to well geophone
t_{us} = Uphole time at shotpoint
T = Observed time from shotpoint to well geophone.
t_r = " " " to reference geophone.
Δe = Difference in elevation between well & shotpoint.
Δsd = " " " " shot & datum plane.
Δsd = D_s − D_e
D_{gs} = D_{gm} − D_s ± Δe ; $\tan i = \frac{H}{D_{gs}}$
T_{gs} = cos i T = Vert. travel time from shot elev. to geophone
T_{gd} = $T_{gs} \pm \frac{\Delta sd}{V}$ " " " datum plane " "
D_{gd} = D_{gm} − Δmd
V_i = Interval velocity = $\frac{\Delta D_{gd}}{\Delta T_{gd}}$
V_a = Average " $\frac{D_{gd}}{T_{gd}}$

Surveyed by: ....

Date: ....

Weathering Data:

Av. velocity from surface to 100m A.H.D. 725m/sec.

Casing Record

PLAN S19016A

Department of Mines and Energy – South Australia

WELL VELOCITY CALCULATION FORM

MF172

SHOTHOLE INFORMATION

Elevation: Elevation of mud sump 109·77m

Distance & Direction from Well: Distance 18m west of well

WELL

Name: C.R.A.E. KD # 1A

Unit Number: Point 338 P.B. 83-001

Elevation (Derrick Floor): 110·25 metres

Total Depth: 1398

LOCATION

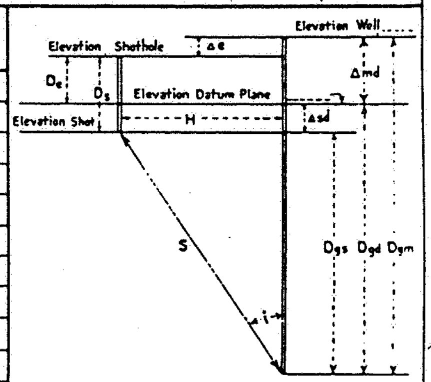
Coordinates: 33° 35' 00" 136° 2' 38" approx.

Section: SEC. 70

Hundred, 1:250000 Sheet: Hundred of Smeaton

Area or Field: Polda Basin

Record Number	Shothole Number	D_{gm}	D_s	t_{us}	t_r	T Reading	T Polarity	T Grade	D_{gs}	H	cotan i	cos i	T_{gs}	Δsd	$\frac{\Delta sd}{V}$	T_{gd}	T_{gd} Average	D_{gd}	ΔD_{gd}	ΔT_{gd}	V_i Interval Velocity	V_a Average Velocity
																	0	0				
		50															25·51	39·75	39·75	25·51	1558	
		100															56·67	89·75	50·0	31·16	1605	
		150															85·31	139·75	50·0	28·64	1746	
		199															114·29	188·75	49·0	28·98	1691	
		200															115·29	189·75	1·00	1·00	1000	
		240															134·96	229·75	40·00	19·67	2034	
		301															162·65	290·75	61·00	27·66	2205	
		360															193·49	349·75	59·00	30·84	1913	
		455															234·45	444·75	95·00	40·96	2319	
		516															263·92	505·75	61·00	29·47	2070	
		583															283·20	572·75	67·00	19·28	3475	
		605															293·20	594·75	22·00	10·00	2200	
		700															321·70	689·75	95·00	28·50	3330	
		800															345·20	789·75	100·0	23·50	4255	
		990															388·20	979·75	190·0	43·00	4419	
		1024															396·20	1013·75	34·0	8·00	4250	
		1100															410·07	1089·75	76·0	13·87	5479	
		1250															442·54	1239·75	150·0	32·47	4620	
		1308															457·73	1297·75	58·0	15·19	3818	
		1380															468·34	1369·75	72·0	10·61	6786	



D_{gm} = Geophone depth measured from well elevation
D_{gs} = " " " " shot "
D_{gd} = " " " " datum "
D_s = Depth of shot
D_e = Shothole elevation to datum plane
H = Horizontal distance from well to shotpoint
S = Straight line travel path from shot to well geophone
t_{us} = Uphole time at shotpoint
T = Observed time from shotpoint to well geophone.
t_r = " " " to reference geophone.
Δe = Difference in elevation between well & shotpoint.
Δsd = " " " " shot & datum plane.
$\Delta sd = D_s - D_e$
$D_{gs} = D_{gm} - D_s \pm \Delta e$; $\tan i = \frac{H}{D_{gs}}$
$T_{gs} = \cos i \, T$ = Vert. travel time from shot elev. to geophone
$T_{gd} = T_{gs} \pm \frac{\Delta sd}{V}$ = " " " datum plane " "
$D_{gd} = D_{gm} - \Delta md$
V_i = Interval velocity = $\frac{\Delta D_{gd}}{\Delta T_{gd}}$
V_a = Average " $\frac{D_{gd}}{T_{gd}}$

Surveyed by: ....

Date: ....

Weathering Data:

Casing Record

PLAN S190168

4271