Ministry of Economic Development
Manatū Ōhanga
Crown Minerals

PETROLEUM REPORT SERIES

PR 648

Title Resolution-1 well completion report

Operator Shell BP Todd Canterbury Services Ltd

Author Milne, A.D.

Date 1975

Report No.	**PR 648**
Year	1975
Licence No.	(PPL)685
Author	Milne, A.D.
Title	Resolution-1 well completion report
Operator	Shell BP Todd Canterbury Services Ltd
Report Type	Well Report - Completion
Region	Offshore Canterbury

Technical Abstract

Resolution-1 exploration well was drilled offshore in the Canterbury Basin, in PPL 685. The stratigraphy of Resolution-1 is presented within the report. Potential reservoirs are the Pareora and Landon limestones and the clean sandstones in the upper part of the ?Mata Sequence. The well was terminated in coarse grained basic igneous rock, interpreted as a sill possibly intruded at the base of the sedimentary section. It is considered to have been a valid test of the structure as indicated on the seismic records although it is not certain that the base of the Cretaceous sedimentary succession was, in fact, penetrated. No hydrocarbon shows occurred and log analysis indicated that all potential reservoir intervals were fresh water-bearing. Resolution-1 was abandoned as a dry hole.

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Encls 4

No.	Description		Type
1	Resolution-1 - location map, PPL 685		Locn
2	74-04	SP 0745 - 0001	Stack
3	74-40	SP 0973 - 0001	Stack
4	Correlation of Resolution-1 with Nth Canterbury ar		Geol

Logs 16

No.	Description	Depth	Scale
1	Composite	65 - 1963m	1/500
2	Mud Log	380 - 1963m	
3	BHC	379 - 1204.6m	1/200
4	BHC	1212 - 1958.3m	1/200
5	BHC	379 - 1207.3m	1/500
5	BHC	1212 - 1958.5m	1/500
6	CDM-HDT-CPI	1212 - 1959m	1/500
7	CDM-HDT-CPI	1212 - 1959m	1/500
8	DLL	379 - 1204.6m	1/200
9	DLL	1213.3 - 1954.8m	1/200
10	DLL	1213.3 - 1954.8m	1/500
10	DLL	379 - 1204.6m	1/500
11	Caliper	379.3 - 1204.6m	1/200
12	Caliper	379 - 1204.6m	1/500
13	CDM-CPI	1212 - 1959m	
14	Velocity log-Linear Time Scale	379 - 1204.6m	
15	Air Gun Velocity & Calibrated Log		
16	Air Gun Monitors 1 to 13		

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BP SHELL TODD (CANTERBURY) SERVICES LIMITED

WELL COMPLETION REPORT

RESOLUTION-1

Offshore Canterbury,
South Island, New Zealand

by

A.D. Milne, C. Simpson,
and P. Threadgold

Wellington October,1975

PR 648

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ENCLOSURES

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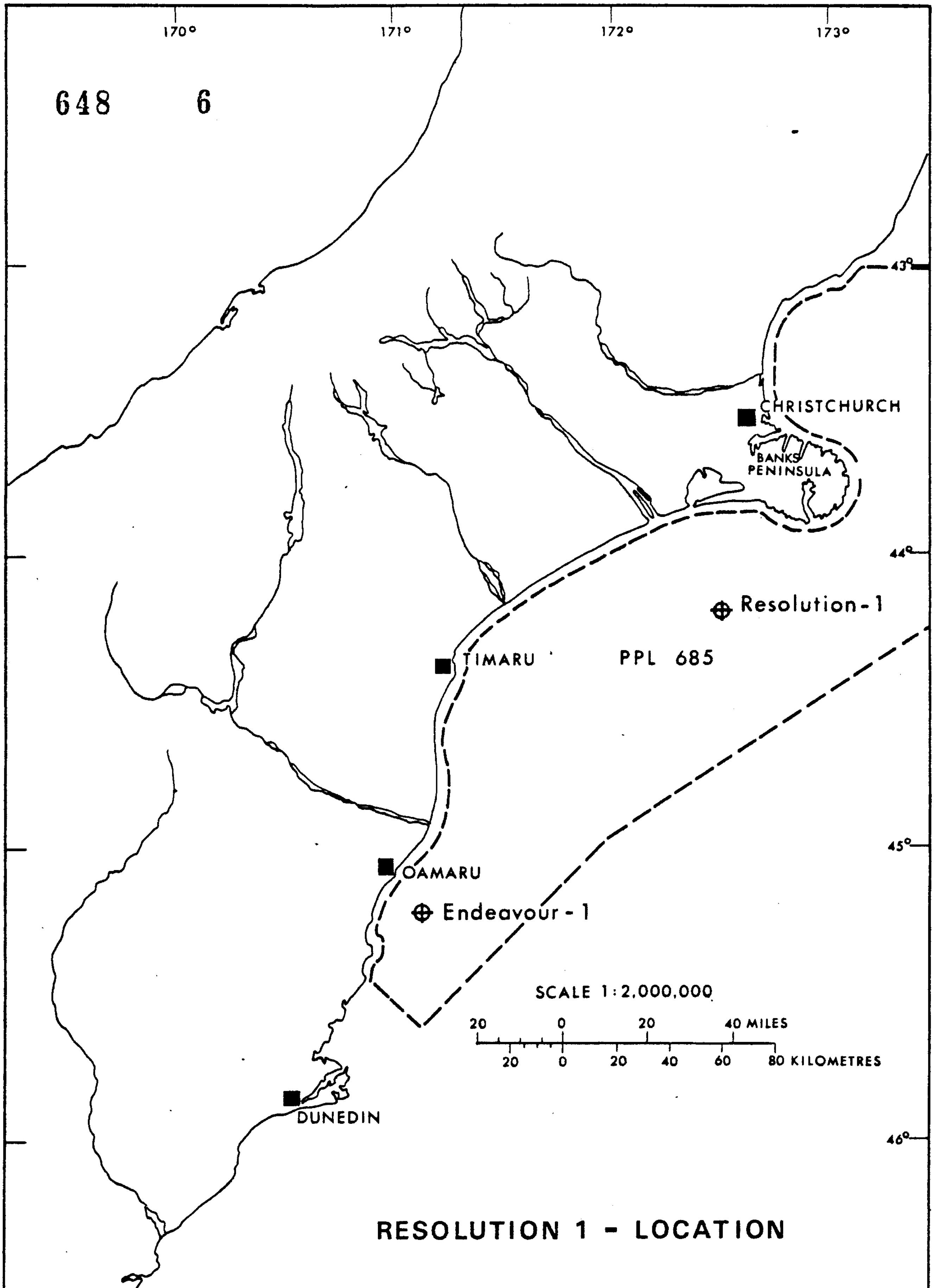


RESOLUTION 1 - LOCATION

FIG. 1

AUGUST, 1975.
DRG. NO. 42

SUMMARY

Resolution No. 1 exploration well was drilled offshore in the Canterbury Basin, in Petroleum Prospecting Licence No. 685. It was located at shotpoint 640 on Seismic Line 74-04 to test Structure A, an anticlinal feature lying 40 km south of Banks Peninsula (Fig.1). The well was drilled for BP Shell Todd (Canterbury) Services Limited by BOCAL Pty. Limited using the drillship 'Glomar Tasman'.

The well was drilled in 64 m of water, using a sea floor BOP system and marine riser. Total depth of the well was 1963 m BRT, and was attained in 19 days. There were no serious drilling difficulties and hole conditions were good. 30", 20" and 13-3/8" casing strings were run; the 9-5/8" testing string was not required. One 5 m terminal core was cut. Schlumberger logs were run in the 17½" and 12¼" holes. Sidewall cores were taken and a velocity survey was conducted during the final logging, prior to abandonment.

The stratigraphy of Resolution-1 is illustrated in Fig.2. Potential reservoirs are the Pareora and Landon limestones and the clean sandstones in the upper part of the ?Mata sequence. The well was terminated in coarse grained basic igneous rock, interpreted as a sill, possibly intruded at the base of the sedimentary section (see Section 3.4). It is considered to have been a valid test of the structure as indicated on the seismic records although it is not certain that the base of the Cretaceous sedimentary succession was, in fact, penetrated.

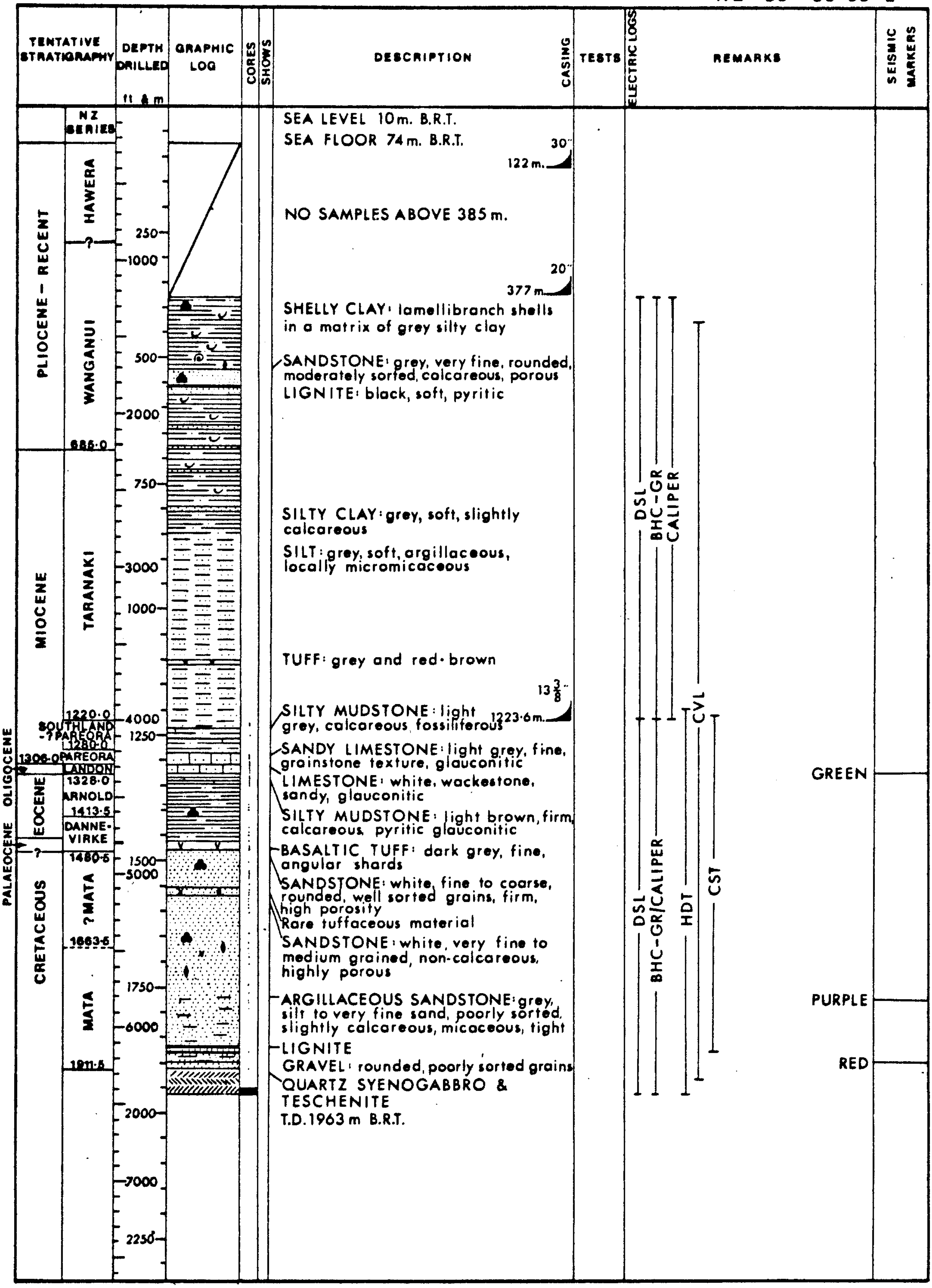
No hydrocarbon shows occurred and log analysis indicated that all potential reservoir intervals were fresh water-bearing. Resolution-1 was abandoned as a dry hole.

SUMMARISED WELL LOG

RESOLUTION-1

SCALE 1:10,000

LOCATION: 44° 11′ 16·20″S
172° 38′ 09·69″E



JULY, 1975
BRB NO. 25

FIG. 2

DATA SHEET 648 9

WELL: Resolution No. 1
Offshore Canterbury

OPERATOR: BP Shell Todd (Canterbury) Services Limited

LATITUDE: 44° 11' 16.20" S

LONGITUDE: 172° 38' 09.69" E

N.Z.S.I. GRID: 476,488 yards N
559,336 yards E

RTE: 10.0 m.a.m.s.l.
74.0 m.a.s.b.

PETROLEUM PROSPECTING LICENCE: 685

WATER DEPTH: 64.0 m

TYPE OF RIG: Drillship

NAME: Glomar Tasman

OBJECTIVE: To test the hydrocarbon potential of basal Tertiary/Upper Cretaceous sandstones in a closed anticlinal high.

DATE SPUDDED: 9th July, 1975

DATE ABANDONED: 31st July, 1975

DEPTH: 1963.0 m BRT 1953.0 m SS

WELL STATUS: Dry and abandoned

GEOLOGICAL DATA

Stratigraphy	Tops DD	Tops SS	Thickness
Hawera - Wanganui Series (part)	74.0 m	64.0 m	311.0 m +
Wanganui Series	385.0 m	375.0 m	300.0 m
Nukumaruan	385.0 m	375.0 m	40.0 m
Waipipian-Opoitian	425.0 m	415.0 m	200.0 m
? Opoitian	625.0 m	615.0 m	60.0 m
Taranaki Series	685.0 m	675.0 m	535.0 m
Tongaporutuan	685.0 m	675.0 m	535.0 m
Southland Series	1220.0 m	1210.0 m	28.0 m
Waiauan-Lillburnian	1220.0 m	1210.0 m	28.0 m
Southland -?Pareora Series	1248.0 m	1238.0 m	32.0 m
Clifdenian-?Altonian	1248.0 m	1238.0 m	32.0 m
Pareora Series	1280.0 m	1270.0 m	26.0 m
Altonian	1280.0 m	1270.0 m	26.0 m
Landon Series	1306.0 m	1296.0 m	22.0 m
Whaingaroan	1306.0 m	1296.0 m	22.0 m
Arnold Series	1328.0 m	1318.0 m	85.5 m
Runangan	1328.0 m	1318.0 m	7.0 m
Kaiatan	1335.0 m	1325.0 m	36.0 m
U. Bortonian	1371.0 m	1361.0 m	22.5 m
L. Bortonian	1393.5 m	1383.5 m	20.0 m
Dannevirke Series	1413.5 m	1403.5 m	67.0 m
Heretaungan-Teurian	1413.5 m	1403.5 m	67.0 m
? Mata Series	1480.5 m	1470.5 m	183.0 m
Mata Series	1663.5 m	1653.5 m	248.0 m
Haumurian	1663.5 m	1653.5 m	248.0 m
Igneous Intrusive	1911.5 m	1901.5 m	51.5 m +
TD	1963.0 m	1953.0 m	

CORES

(a) Conventional Cores
Core No. 1 Depth 1958.0-1963.0 m, Recovery 100%.

(b) Sidewall Cores
Interval 1221.5 m - 1908.5 m, 60 cores attempted, 56 recovered.

SHOWS Shale gas only; no hydrocarbon fluorescence or cut.

TESTS None

COMMENTS All potential reservoirs were fresh water bearing, probably due to flushing.

REPORT REFERENCE Completion Report Resolution-1.

AUTHORS A.D. Milne, C. Simpson and P. Threadgold.

DATE October, 1975.

PART 1.

DRILLING

by

C. Simpson

1.1 INTRODUCTION

The 'Glomar Tasman' is a ten year old converted drillship which has worked for a number of years under contract to BOCAL off the North West Shelf of Australia. It had been brought to New Zealand, still under contract to BOCAL, for a drilling programme for several operators as a package deal. This included supply of consumable materials (optional), all major support services and supervisory personnel.

Resolution-1 was the first well following an extensive refit in Singapore during which a diesel electric SCR package and motion compensator were installed. The SCR package was not completely checked out in Singapore and 14 days were spent in Nelson for repairs en route to Resolution-1. The diesel-electric package and the motion compensator required minor repairs during the well, but were both of great benefit in achieving a creditable time (18 days spud to T.D.) for the well which was drilled to 1,963 m.

1.2 GENERAL DATA

Well:	Resolution-1.
Rig:	'Glomar Tasman'.
Drilling Contractor:	Global Marine Drilling Co., P.O. Box 743, Nelson.
Elevation:	RTE 10 m above sea level Water depth 64 m.
Equipment:	National 162S DE draw works with 2 x GE 752 motors. National C375 rotary table, independent drive. Pumps 2 x National 12P160 triplex slush pumps with 7" liners rated at 3,450 psi. Stroke 12". 20-3/4" 2000 psi BOP stack with 2 rams (CIW type U), and 1 bag preventer. 13-3/8" 5000 psi BOP stack with three rams (CIW type U), and 1 bag preventer. Both BOP stacks have kill and choke valves on the sidearms.

Timing:	Arrived on location:	5 July 1975
	Spudded:	9 July 1975
	Abandoned:	31 July 1975
	Left location:	3 August 1975
Total Depth:	Below Rotary Table:	1,963 m.
	Below Seabed:	1,899 m.

Present Well Status:	Permanently Abandonded. Wellhead recovered - Seabed clear.

List of Contractors to BOCAL Pty Ltd.:	Drilling Vessel	'Glomar Tasman'	Global Marine Inc.
	Supply Vessel	'Lady Vilma"	Australian Offshore Services.
	Supply Vessel	'Sydney Tide'	Tidewater Port Jackson Marine Pty. Ltd.
	Standby Vessel	'M.F.V. Brothers'	Life Rafts Limited.
	Hélicopters	Two Alouette SA319B	Helicopters (New Zealand) Limited.
	Fixed Wing Aircraft	Cesna 402	Capital Air Services Limited.

Diving Service	Ocean Systems Australasia Pty. Limited.
Wireline Logging	Schlumberger Seaco Inc.
Cementing	Halliburton Manufacturing and Services Limited.
Mud Chemicals and Engineering Service	Dresser Products Australia Pty. Limited.
Testing Service	Flopetrol S.A.
Mud Logging Service	Core Laboratories Australia (Qld) Limited.
Automatic Choke	Cameron Iron Works Pty. Limited.
Velocity Survey	Seismograph Services Limited
Rig Positioning	Buxton, Tudor and Waugh
Subsea Test Tree	Otis Engineering Corporation
Casing Cutting Tools	A-1 Bit & Tool Company
Local Agency, Nelson	Transport (Nelson) Ltd.

NOTES:

1. Actual location:
   Lat: 44° 11' 16·20" S
   Long: 172° 38' 09·69" E
   This is 11yds west and 25yds. north of intended location.

2. No. 5 Anchor was 20,000 lb. All others were 30,000 lb.

3. All anchors tensioned to 150,000 lb. before spud.

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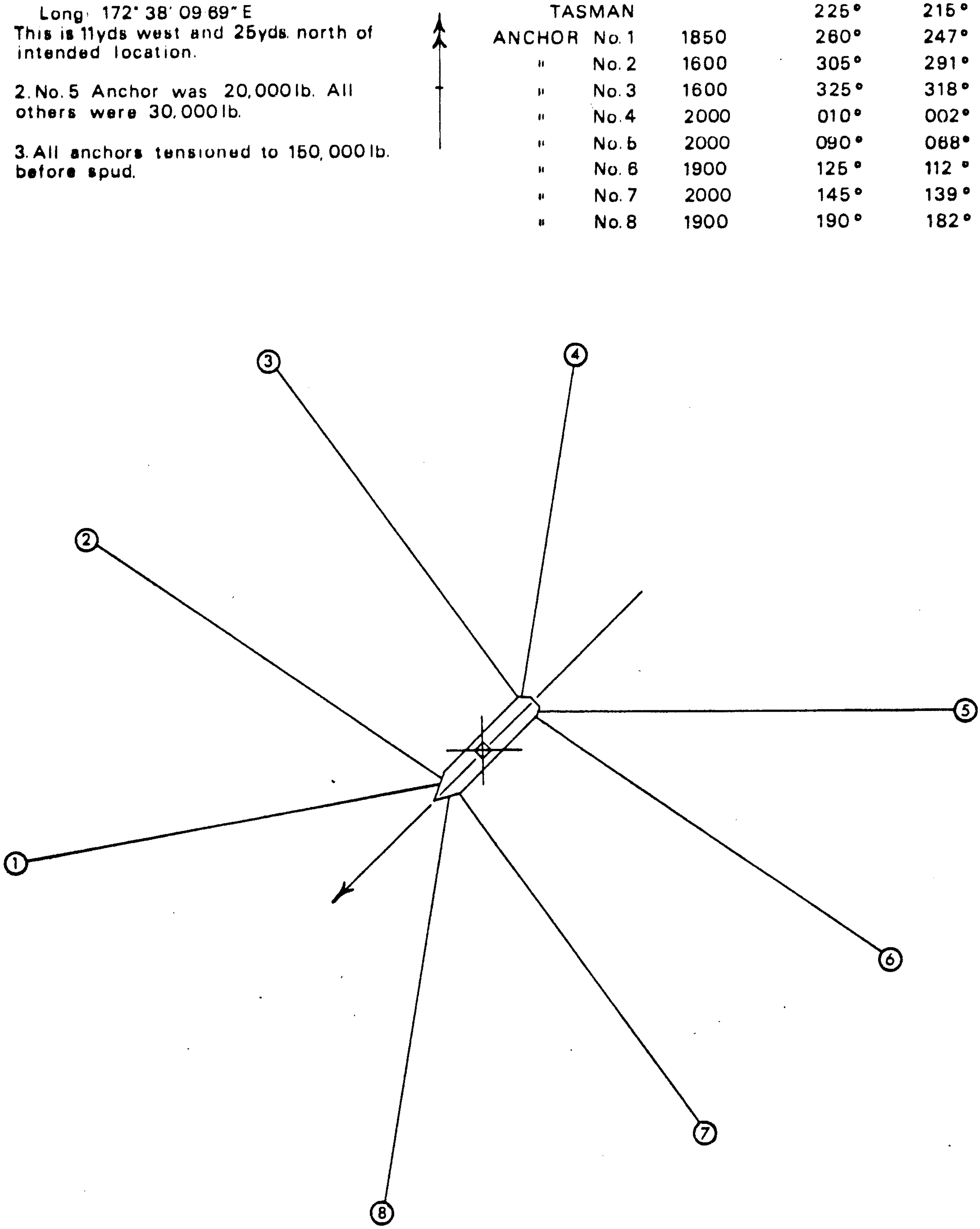
		CHAIN OUT (ft.)	HEADING PLANNED	HEADING ACTUAL
TASMAN			225°	215°
ANCHOR	No. 1	1850	260°	247°
"	No. 2	1600	305°	291°
"	No. 3	1600	325°	318°
"	No. 4	2000	010°	002°
"	No. 5	2000	090°	088°
"	No. 6	1900	125°	112°
"	No. 7	2000	145°	139°
"	No. 8	1900	190°	182°



RESOLUTION No. 1

GLOMAR TASMAN HEADING & ANCHOR PATTERN

FIG. 3

SEPT. 1975

1.3 POSITIONING

The equipment used for the positioning of the 'Glomar Tasman' was the Decca Trisponder 202. This is a Range Range or line of sight electronic positioning system which relies on the nearly constant velocity of the X band radio waves through the atmosphere. The time lapse between the emission of a coded pulsed transmission from the mobile station on the survey vessel and its reception from the transponder concerned on shore is measured to give a distance.

The system comprises on the survey vessel or mobile station a base unit with omni directional aerial and a distance measuring unit. The remote stations comprise a transponder with directional aerial.

The survey vessel used to position the rig was the 'M.F.V. Brothers', a single screw fishing boat 18.2 metres in length. This vessel also acted as standby vessel throughout the well. The location was marked with plastic buoys moored with 3 or 5 100 lb concrete blocks. One buoy was set at each anchor position and three buoys 50 ft apart and in line to mark the moonpool location (Fig. 3). The first buoys were set on 10/11 June and the balance on 24 June. Because of repairs carried out in Nelson, the 'Glomar Tasman' did not arrive on location until 5 July. Bad weather delayed setting anchors and the final fix was taken on 8 July (Enclosure 1). A confirmation fix by triangulation was taken on 9 July.

The final position of the rig was fixed as being 25 yds north and 11 yds west of the required location. The final position was New Zealand South Island Grid:

North	476,488 yards
East	599,336 yards

Geographical:

Latitude	44° 11' 16.20"	South
Longitude	172° 38' 09.69"	East

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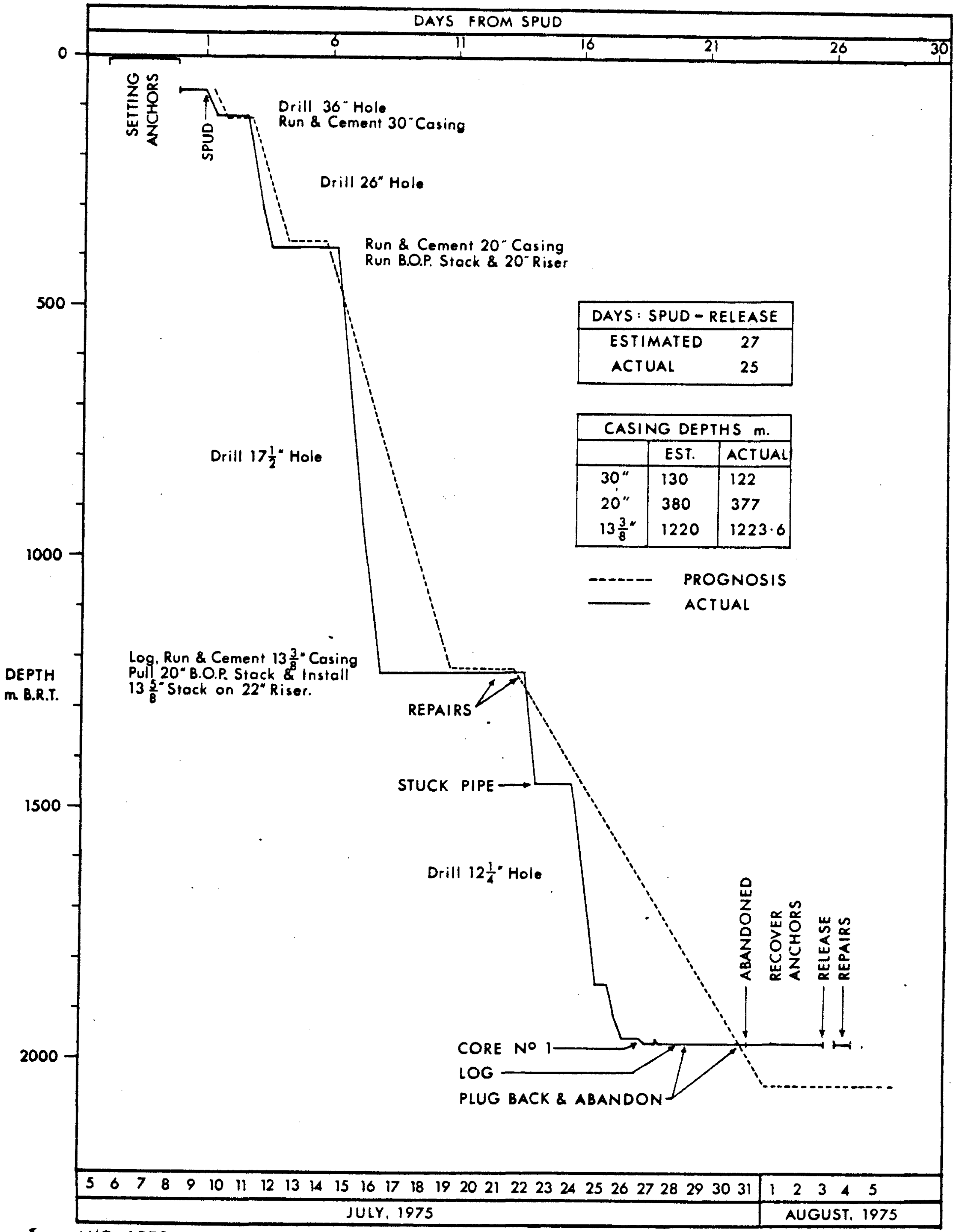
TIME-DEPTH CURVE

RESOLUTION - 1

RIG: GLOMAR TASMAN
WATER DEPTH: 64 m.
R.T.E.: 74 m. A.S.B.
T.D.: 1963 m. B.R.T.

CO-ORDINATES: LAT: 44° 11' 16·20"S
LONG: 172°38' 09·69"E
N.Z. S.I. GRID: 476, 488 YARDS NORTH
599, 336 YARDS EAST



DAYS: SPUD - RELEASE	
ESTIMATED	27
ACTUAL	25

CASING DEPTHS m.		
	EST.	ACTUAL
30"	130	122
20"	380	377
$13\frac{3}{8}$"	1220	1223·6

AUG. 1975.

FIG 4

1.4 DRILLING OPERATIONS

A summary of drilling operations is given below. For the daily diary refer to Appendix 1 and for the corresponding Time-Depth Curve to Fig. 4.

The 'Glomar Tasman' arrived on location 5 July 1975 and dropped the first anchor at 2100 hr. Setting of the moorings was delayed due to inclement weather (Appendix 2). Mooring operations were completed on 8 July and a confirmation fix of the rig position taken.

The well was spudded at 1700 hr on 9 July and 36" hole drilled to 127 m BRT. Conductor pipe, 30" OD x 1" wall, was set and cemented at 122 m. The shoe was drilled out with a 26" bit (TOC at 111 m) and 26" hole continued to 390 m. After spotting viscous mud and making a wiper trip, the 20" casing was run and cemented at 377 m.

The 20" 2000 psi BOP stack was run on a 22" riser and latched to the 20" housing. After drilling out the shoe and pilotting to 397 m, a formation leak-off test equivalent to 11.3 lb/gal was carried out (Section 1.10.1). The 17½" hole was continued to 1,235 m with wiper trips. After logging and a wiper trip, 13-3/8" casing was run cleanly and cemented at 1,223.6 m.

The 20" BOP stack was recovered and the 13-5/8" 5000 psi stack run and tested. Some delays were experienced in testing the surface lines. The casing was drilled out with a 12¼" bit and a leak-off test carried out equivalent to 14.7 lb/gal.

Whilst carrying out a short trip from 1,451 m, the pipe stuck with the bit at 1,322 m. Pipe Lax and an overpull of 100,000 lb failed to free the string. The string came free after resuming circulation and increasing the overpull to 125,000 lb. It was noted that moderate deposits of gumbo had accumulated on the stabilisers and drill collars. The major factor in the pipe having stuck was probably excessive fluid loss resulting from sea water getting into the mud system at the time of drilling out the cement plugs. The fluid loss was subsequently reduced to below 5 cc and no further hole problems were experienced.

The 12¼" hole was continued to 1,958 m, at which point an 8½" core, with 100% recovery, was cut to 1,963 m, which was T.D. for the well. The rat hole was drilled out to 12¼" on a wiper trip prior to logging.

A cement plug was set across the 13-3/8" shoe, from 1,325 m to 1,200 m and a bridge plug set at 1,150 m with cement on top back to 1,121 m. After recovering the BOP stack and riser, the 13-3/8", 20" and 30" casing strings were cut at 80 m BRT. Following unsuccessful attempts to recover the wellhead housings, an explosive charge was set off in the wellhead with the rig 100 m off location. The wellheads and TGB were then recovered and a final cement plug set from 84 m to seabed before recovering the TGB. The well was abandoned and anchor handling commenced at 0800 hr on 31 July.

Delays occurred in recovering the anchors due to seas of up to 18 ft. and winds of 60 knots. The rig was released at 0945 hr on 3 August after the last anchor had been raised. It then steamed to sheltered waters off Godley Head to effect repairs to the hull which was damaged when housing No. 5 anchor. The 'Glomar Tasman' departed from Godley Head 1445 hr on 4 August 1975 for SBPT location 'D' in the South Taranaki Bight. A release time adjusted to allow for the repairs was 0330 hr on 4 August.

1.5 CASING AND CEMENTATION

30" Conductor

36" Hole:	127 m
30" Casing:	122 m
Casing Details:	1" wall 308 lb/ft Grade B Range 3 4 Joints with 'ATD' Squnch Connectors. Housing 2.30 m above seabed (71.70 m BRT)
Shoe:	Halliburton Self-fill

Circulated with 19 bbl seawater pre-flush prior to cementation. Cemented with 800 sax Class 'G' cement + 2% $CaCl_2$ at 1.88 S.G., mixed with drill water, displaced with 101 bbl seawater to leave 9 m cement inside shoe. Float held. Cement excess 133%.

20" Surface String

26" Hole:	390 m
20" Casing:	377 m
Casing Details:	94 lb/ft Grade X-52 Range 3 25 Joints with 'ST' Squnch Connectors. Housing 3.70 m above seabed (70.30 m BRT)
Shoe:	Halliburton Self-fill

Self-fill shoe did not function properly, filled casing from surface. Circulated casing capacity of seawater. Cemented with 1,200 sax Class 'G' cement + 8% gel in drill water at 1.57 S.G. followed by 300 sax neat Class 'G' mixed with seawater at 1.90 S.G. Displaced with 343 bbl seawater to leave 15 m cement inside casing. Shoe did not hold backflow. Shut in for 2 hours and released, no backflow.

Landing string - drillpipe with 4 m stinger. No centralisers used.

13-3/8" Intermediate String

17½" Hole:	1,235 m
13-3/8" Casing:	1,223.57 m
Casing Details:	68 lb/ft Grade J-55 Range 3 97 Joints with Buttress Threads
Shoe:	Halliburton Differential fill
Float:	Ran Baffle collar 1 joint up.

Circulated casing volume and pumped 20 bbl mud flush. Cemented with 1,700 sax Class 'G' cement + 8% gel + 0.25% HR-7 in drill water at 1.58 S.G. followed by 400 sax neat Class 'G' + 0.3% HR-L in sea water at 1.85 S.G. Displaced with 561 bbl mud and bumped plug with 1,800 psi. Bled off pressure, float held. Full circulation throughout. Used drill pipe landing string.

One centraliser on shoe joint and one on each of first two joints inside 20" shoe.

Abandonment

Plug No. 1; 1,325-1,200 m (open hole)
Cemented with 300 sax neat 'G' cement in sea water at 1.90 S.G. and displaced with 70 bbl mud.

Plug No. 2; 1,150-1,121 m (inside 13-3/8" casing)
Cemented with 70 sax neat'G' cement in sea water at 1.90 S.G. and displaced with 65.3 bbl mud.

Plug No. 3; 84-74 m (at seabed)
Cemented with 100 sax neat 'G' cement in seawater at 1.90 S.G. and displaced with 4.3 bbl seawater.

The three abandonment plugs were set through open-ended drill pipe.

1.6 MUD

The Mud Engineering service for this well was supplied by Dresser Magcobar, who also drew up the basic programme. Their statement of the daily properties and consumption is given in Enclosure 2.

The 36" and 26" hole intervals were drilled with sea water with slugs of gel used for hole cleaning. The hole was also filled with gel prior to running casing. This proved effective in keeping the hole clean, though in fact the gel consumption could probably have been reduced without any adverse effects.

The 17½" hole was drilled with a lightly treated XP-20/Spersene system. There were no hole problems during drilling, tripping or logging.

The 12¼" hole was drilled with a dispersed XP-20/Spersene system built up by treating mud from the 17½" hole. Unfortunately, sea water was inadvertently mixed in the system when drilling out the shoe resulting in a higher than programmed fluid loss. This was probably instrumental in the pipe sticking when carrying out a short trip from 1,451 m. The pipe was eventually freed with an overpull of 125,000 lb after having spotted diesel and Pipe Lax. The stabilisers and drill collars had accumulated gumbo. The water loss was subsequently reduced to below 5 cc and no further hole problems were experienced.

1.7 BIT RECORD

A total of five rock bits, one hole-opener and one diamond core head were used on the well (Enclosure 3). The formations encountered were generally soft drilling and satisfactory penetration rates were achieved with less than optimum bit weights and rotary speeds. Total rotating hours were 112¾ (including coring but excluding reaming out the cored rat hole), which gave an average penetration rate for the well of 16.84 m/hr.

The 8-7/16" diamond core head was severely worn by 5 m of hard fresh igneous core and would give very little recovery, most of the diamonds having been smoothed off.

1.8 TIME ANAYLSIS

The daily time analysis is given in Enclosure 4 and summarised below.

		Hours	%	Hours	%
Anchor Handling:	Actual	54.00	7.70		
	Waiting on Weather	85.25	12.15	139.25	19.85
Drilling:	On Bottom	106.25	15.13		
	Round Trips	29.50	4.21		
	Deviation Surveys	12.75	1.82		
	Reaming, Conditioning Hole & Cond. Trips	37.50	5.35		
	Running & Cementing Casing	87.00	12.39		
	Running & Pulling Subsea Equipment	77.50	11.03		
	Testing Wellhead & BOP's	2.75	.39		
	Plugging Back and Abandonment	49.50	7.05		
	Well Control, Blowout Kicks, incl. Drills	1.00	.14		
	Formation Leak-off Test	2.25	.32	406.00	57.83
Downtime:	Weather	-	-		
	Mechanical Surface	42.75	6.09		
	Mechanical Subsea	27.75	3.88		
	Other (Recovery of BOP Skate)	4.75	.68		
	(Reposition Vessel)	1.75	.25	77.00	10.90
Evaluation:	Circulating Samples	2.25	.32		
	Coring	25.50	3.63		
	Electric Logging	52.50	7.47	80.25	11.42
TOTAL:				702.50	100.00

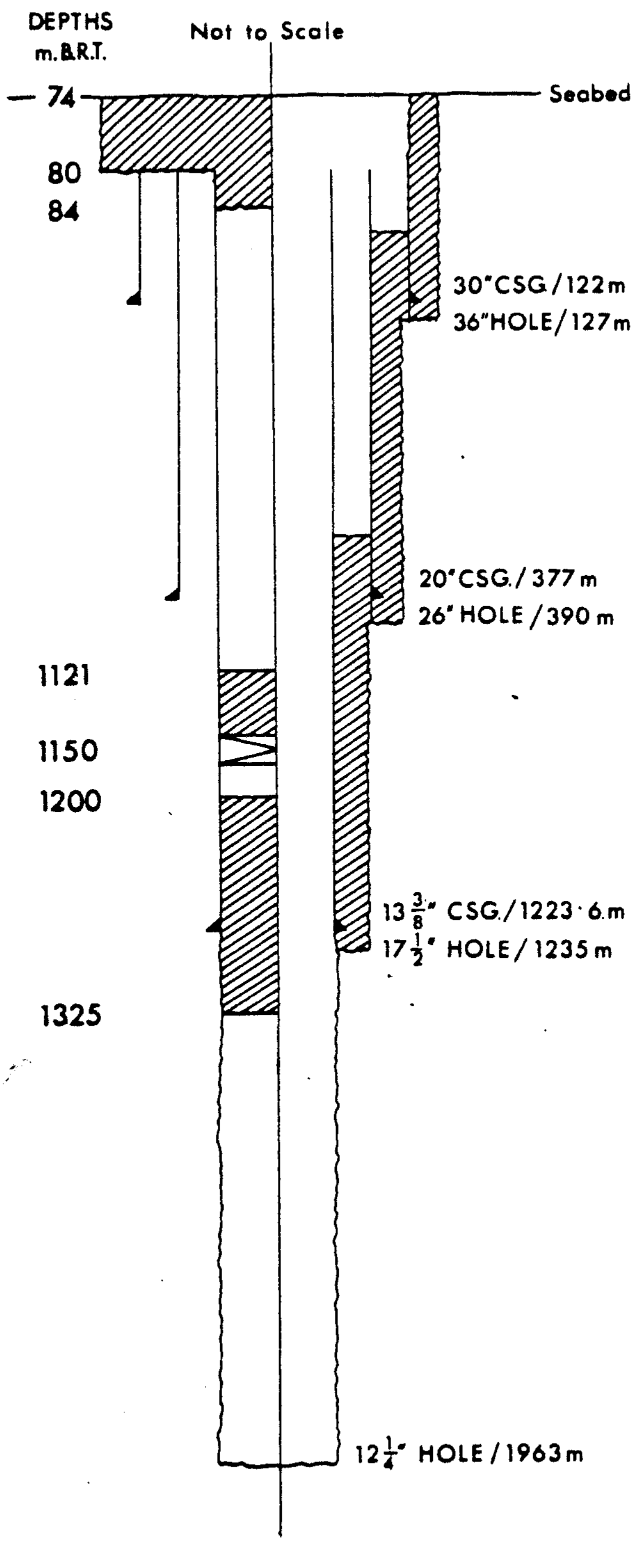
ABANDONMENT SCHEMATIC

RESOLUTION - 1

STATUS: Plugged & Abandoned 31st July, 1975. Seabed clear at mudline

WATER DEPTH: 64 m.

SEABED DEPTH: 74 m. B.R.T.



DETAILS

10. Temporary Guide Base recovered

9. 100 sax neat 'G' cement set from 84m to seabed (74 m)

8. Wellhead & Permanent Guide Base recovered

7 13 3/8", 20" & 30" Casings cut at 80m

6. Recovered B.O.P. stack

5. 70 sax neat 'G' cement set from 1150m to 1121m

4. Displaced mud to water above bridge-plug

3. Pressure tested bridge-plug to 1000 p.s.i.

2. Set bridge-plug on wireline at 1150m

1. 300 sax neat 'G' cement set from 1325m to 1200m

NOTE: After cutting the casing strings maximum allowable pulls failed to free the wellhead. A 50 lb. charge was set off 11m below the top of the wellhead after winching the rig over 300 ft. The wellhead could then be pulled freely with the permanent guide base.

AUG, 1975
DRG. NO. 38

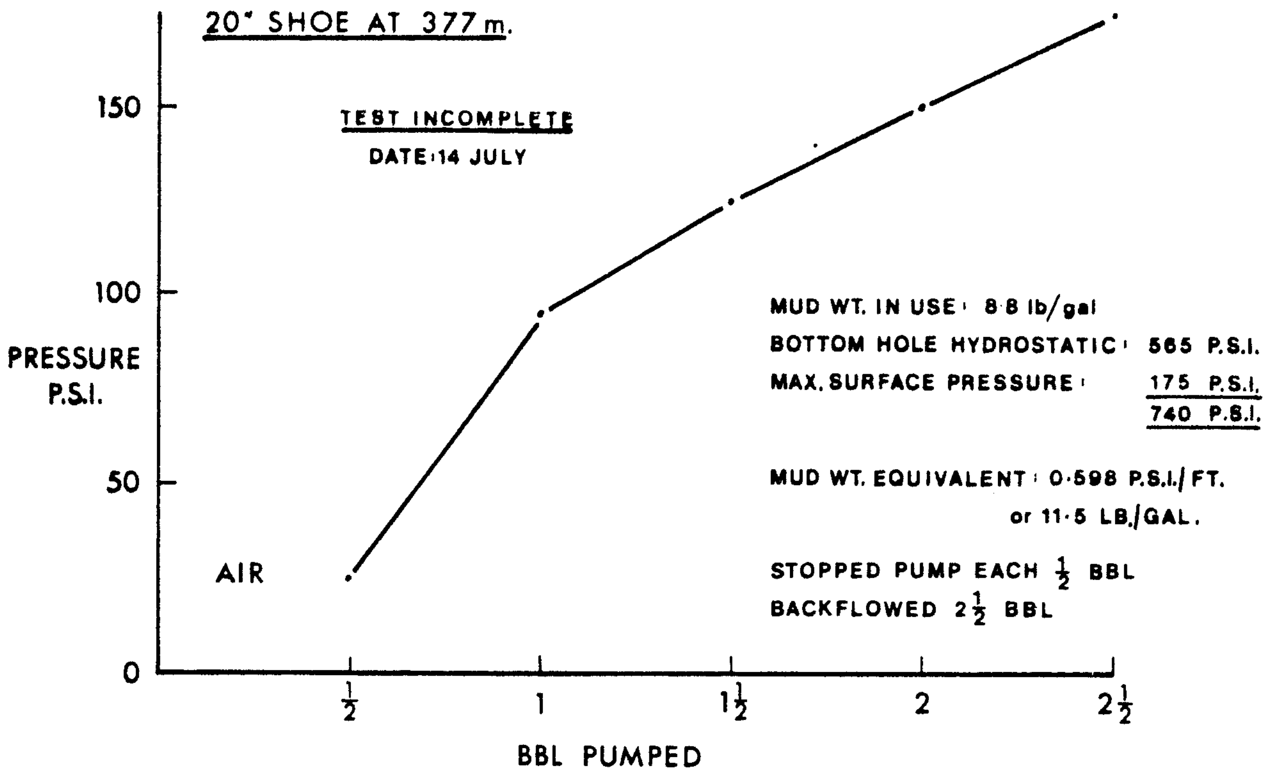
FIG. 5

1.9 ABANDONMENT

The well was permanently abandoned as a dry hole. A schematic of the abandoned well is given in Fig. 5.

One cement plug was set across the 13-3/8" casing shoe and a second one above a bridge plug at 1,150 m. The casing strings (13-3/8", 20" and 30") were cut at 10 m below seabed and the wellhead and guide bases recovered leaving the seabed clear. The 30" conductor stub proved to be firmly cemented in the seabed and an explosive charge was used to break the bond and permit recovery.

RESOLUTION - 1
FORMATION LEAK-OFF TESTS



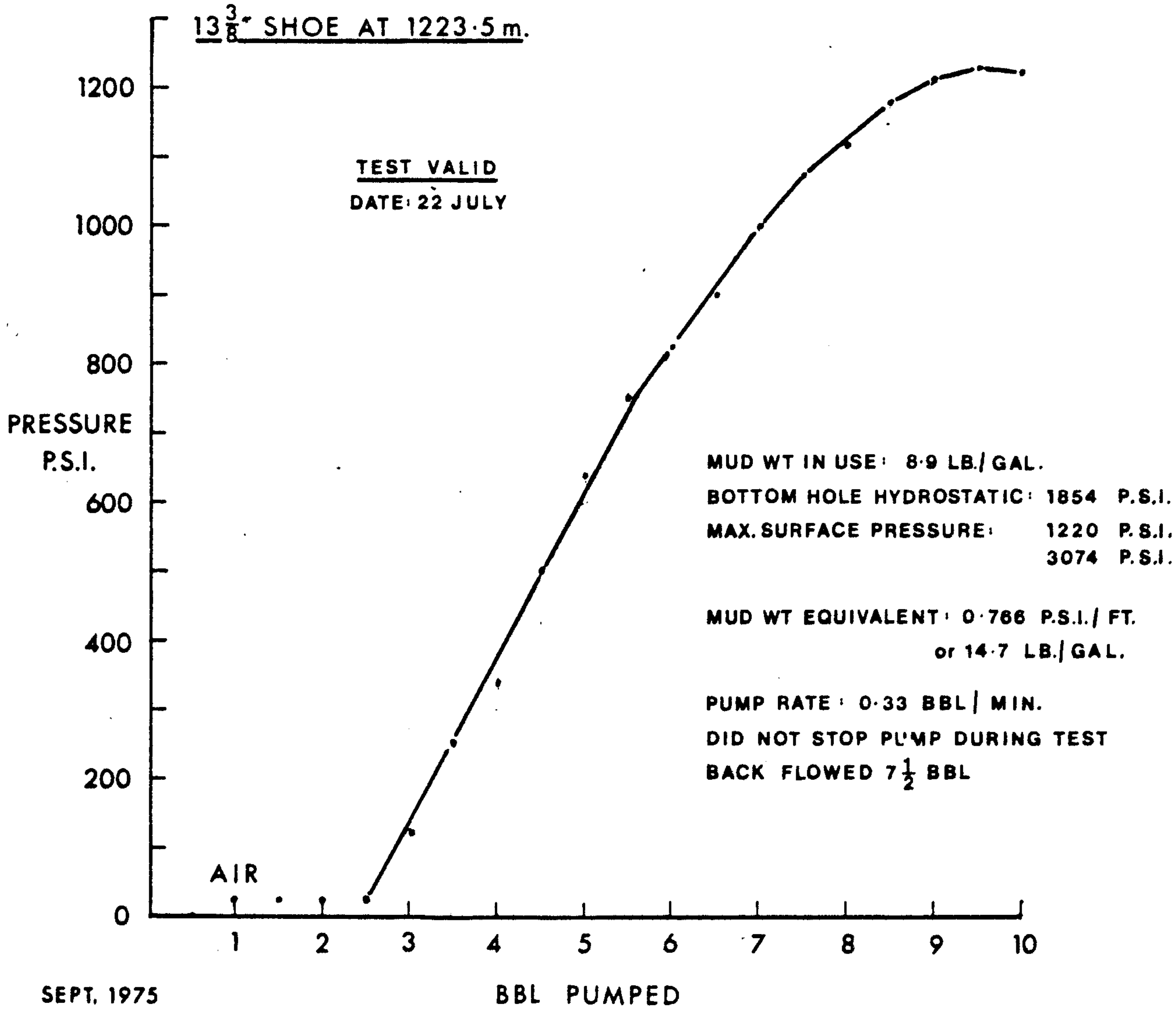


FIG. 6

SEPT. 1975
MRB. NIB. 41

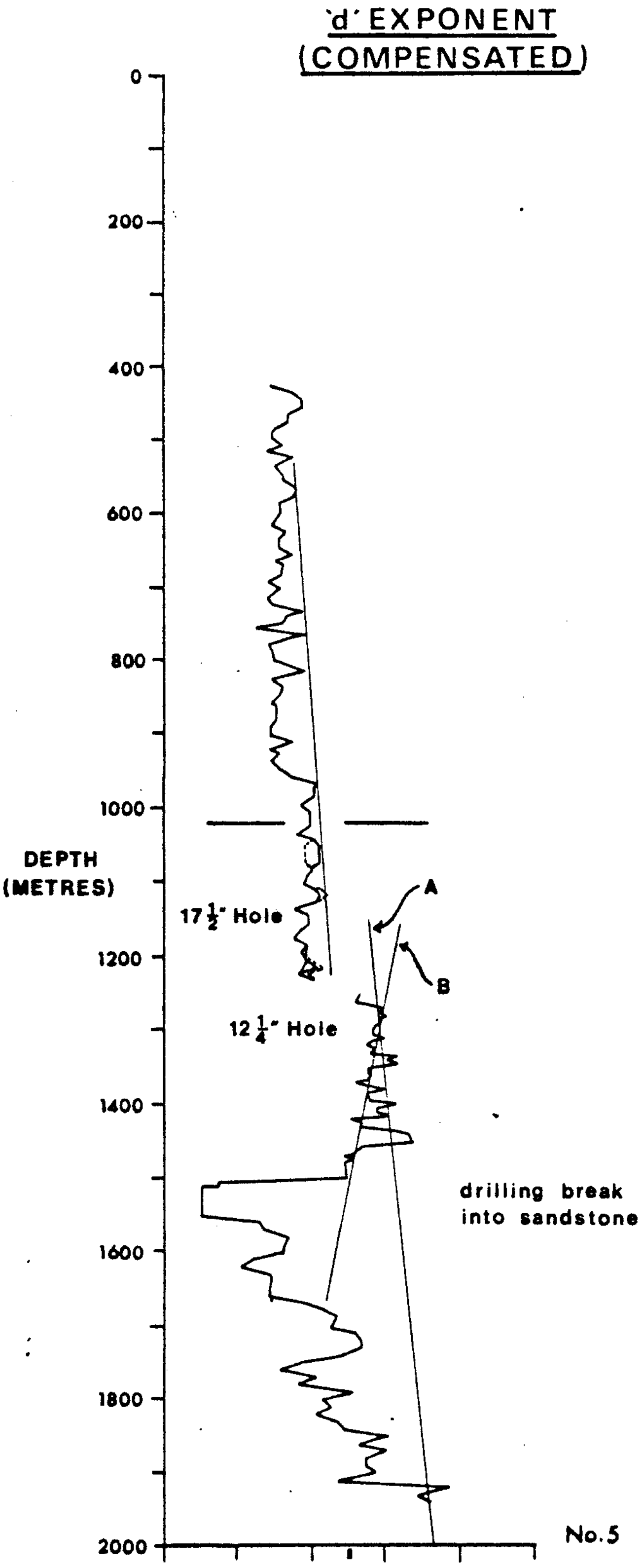
1.10 DRILLING ENGINEERING

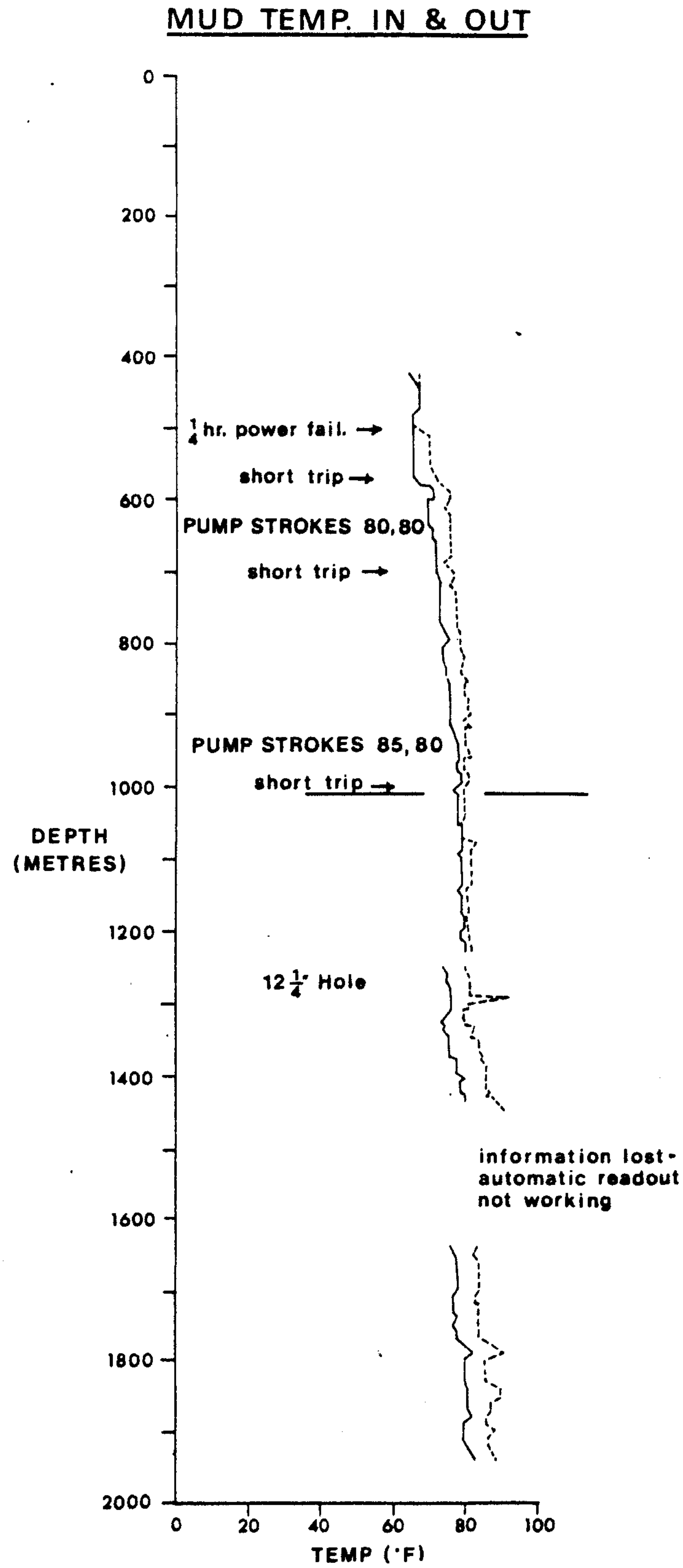
The concept of the well design was to drill 12¼" hole to T.D. and run the 9-5/8" casing as a test string or trouble string. In the event, it was not necessary to run the 9-5/8" string, the well being non-hydrocarbon bearing and essentially trouble free.

1.10.1 Formation Leak-off Tests (Fig. 6)

Leak-off tests were carried out below the 20" and 13-3/8" shoes. The breakdown of 0.598 psi/ft below the 20" shoe was invalid due to insufficient mud being pumped. The value of 0.766 psi/ft below the 13-3/8" shoe appears to be valid.

RESOLUTION No. 1





COMMENTS: Undercompacted nature of mudstone made curve relatively meaningless. Good shales are required to draw a trend line before deviation from the trend line can be detected

For example: if trend line A has been established, it would be possible to say that line B indicated increasing undercompaction giving warning of possible overpressure in sand at 1500 + metres

NB: This interpretation is not valid here because:

(a) shales need to be picked out

(b) the portion of hole 1250 - 1500 cannot give trend line and undercompaction at the same time

There are no significant points on these curves which could have indicated abnormal pressure horizons.

MUD LOGGING DATA

FIG. 7

1.10.2 Mud Logging (Fig. 7)

Core Laboratories provided an adequate mud logging service. A Hewlett Packard 9820 programmable calculator was added to the package as a tool to assist in the prediction of abnormal pressures. The operators required some time to become familiar with the use of this tool, particularly in pressure detection work. In the event there were no indications of abnormal pressures in the well, and it is probable that mud of 1.12 SG would have sufficed to T.D.

1.11 WEATHER

A chart of the weather and sea conditions is given in Enclosure 5.

The sea conditions during the drilling of the well were moderate and there was no shut-down because of weather. Some delays were experienced, however, during setting and recovery of moorings. These were the only occasions that sea or swell exceeded 10 ft. and winds exceeded 30 knots.

Based upon weather records for the area, a vessel heading of 225° was selected for Resolution-1. (The actual heading used was 215° in order to offer some protection to workboats when tied up on the port side). This heading proved to be correct for the prevailing swell in this area. Less frequent swells were experienced from the quarter 330° - 360°.

A current meter on loan from the D.S.I.R. was positioned over the side of the 'Glomar Tasman' for the duration of Resolution-1. The results were of doubtful value due to a malfunction of the tool.

1.12 SUPPORT SERVICES

1.12.1 Workboats

The 'Glomar Tasman' came to New Zealand waters with two associated workboats, the 'Lady Vilma' and the 'Sydney Tide'. The port of Nelson was selected as the main supply base for the wells to be drilled in New Zealand and the majority of supplies for Resolution-1 were obtained from Nelson. Some drill water was picked up in Lyttelton and a spare 20" casing string was held at this port. Lyttelton is conveniently located for PPL 682 and could be considered for a shore base in any future offshore work which may take place in this area.

The workboats performed satisfactorily and were able to keep the rig supplied from Nelson (28 hours sailing time) without difficulty for this shallow well. Both of the vessels encountered generator problems during the operation. The 'Lady Vilma' was used to set and recover anchors and performed creditably in rough sea conditions. The 'Sydney Tide' was found guilty of contributing to an oil spillage in Nelson Harbour on 22 June whilst transferring fuel to the 'Glomar Tasman'.

In view of the distance for the workboats to travel from Nelson to the location, it was considered preferable to use a special standby vessel. A small trawler (60 ft in length), 'M.F.V. Brothers' doubled as positioning and standy vessel. It performed satisfactorily theoughout the well.

A summary of workboat utilisation is given in Enclosure 6.

1.12.2 Helicopters

The helicopter contract called for two SA319B Alouette III aircraft. One machine did not in fact arrive until shortly before the well terminated. As an interim measure a Hughes 500 and a Bell 47J were positioned at Christchurch Airport.

The Alouette proved to be most reliable and the one Alouette and the Hughes were adequate for the operation. However, in the interests of having a back-up aircraft available, the policy of having two Alouettes is preferred. Flying time to the rig with either aircraft was 30 minutes.

Helicopter utilisation is given in Table 1.

The crews were ferried from Nelson to Christchurch by a contracted Cessna 402. The payload of this aircraft (8 pax) tied in well with the Alouette payload (6 pax). Crew changes took place 4 days eack week, two flights per day, and flying time Nelson/Christchurch was 1 hr.

TABLE 1

HELICOPTER UTILISATION

1.	Distance Base to Rig	43 N.M.
2.	Number of Flights	135
3.	Distance Flown	5,940 N.M. (1)
4.	Flying Times	Actual - 65.9 hr Total - 88.7 hr (2)
5.	Average Speeds	90.136 knots

6. Outward Flights

(a)	Number of passengers carried	240
(b)	Weight of passengers carried (180 lb each)	43,200 lb
(c)	Weight of freight carried	5,964 lb
(d)	Total weight carried	49,164 lb
(e)	Total capacity	74,400 lb
(f)	Utilisation	66%

7. Inward Flights

(a)	Number of passengers carried	229
(b)	Weight of passengers carried (180 lb each)	41,220 lb
(c)	Weight of freight carried	7,026 lb
(d)	Total weight carried	48,246 lb
(e)	Total capacity	74,400 lb
(f)	Utilisation	64.8%

8. Time Grounded

(a)	Weather	2.6 hr	
(b)	Technical	0.4 hr	
(c)	Maintenance	111.3 hr	
(d)	Total	114.3 hr	
(e)	Non-availability	$\frac{100d}{2 \times \text{daylight hours}}$	18.74% (3)

NOTES: (1) Includes additional mileage incurred during re-routing due to adverse weather conditions.

(2) Includes ground running.

(3) All maintenance was carried out during non-scheduled flying programmes and at no time would a special flight have been delayed.

1.12.3 Diving

The diving service provided by Ocean Systems Australasia proved to be less than satisfactory. The bell handling system was not properly rigged and the bell was only used on one dive from the rig, the first. In making a dive on 20 July to 63.7 m, one diver appeared to react adversely to the cold after the hot water line to his suit failed to operate and the heating system to the decompression chamber could not be activated. The diver in question had a history of not being suited to dives in cold water and has subsequently been replaced on this operation.

A total of 14 dives were made during the well, six of which were to the seabed and one of which was a training dive. The remaining seven dives were shallow.

Summary

Date	Dive No.	Time O.B. Mins.	Bell Used	Depth	Job
8.7.75	1	17	Yes	210'	Searched for lost skate - not found. Checked baseplate - level.
10.7.75	2	10	No	50'	Tied softline to 30" csg. to assist stab-in.
12.7.75	3	31	No	220'	Searched for BOP skate. Unsuccessful.
13.7.75	4	16	No	208'	Checked PGB (clear) and searched for BOP skate - unsuccessful.
14.7.75	5	41	No	208'	Inspected PGB and checked latching of 20" BOP stack to wellhead.
15.7.75	6	6	No	15'	Attached Schlumberger heave compensating line to slip joint.
20.7.75	9	29	No	209'	Freed fouled TV line and stabbed 13-5/8" stack to wellhead.
20.7.75	10	20	No	15'	Removed rope fouling BOP pod.
26.7.75	7	2	No	165'	Training dive. Familiarisation with Aquadyne DM5 and HeO_2.
26.7.75	8	10	No	15'	Attached Schlumberger heave compensating line to slip joint.
29.7.75	11	13	No	210'	Stabbed explosive charge in wellhead.
2.8.75	12	10	No	40'	Shackled tugger wire to No. 7 anchor pigtail.
3.8.75	13	5	No	20'	Shackled tugger wire to No. 2 anchor pigtail.
3.8.75	14	?	No	6'	Patched hole in aft chain locker.

1.13 LOST TIME OPERATIONS

This section highlights phases of the well where problems resulting in lost time were encountered. An explanation of the delays is given and, where possible, remedies are suggested.

1.13.1 Mooring and Unmooring Operations

Inclement weather caused considerable delays in the setting and recovery of moorings.

	HOURS				
	Working	W.O.W.	Total	Normal	Lost
Mooring	26¾	38¾	65½	18	47½
Unmooring	27¼	46½	73¾	18	55¾
Total	54	85¼	139¼	36	103¼

Total lost time over anticipated times for fair weather was thus 103¼ hours, or rather more than 4 days. Clearly this was unavoidable lost time. In fact, anchor handling was continued in seas up to 16 feet, which is well beyond the usual limit of 6-8 feet for moorings of this size. A diary of mooring and unmooring operations, including weather records, is included in Appendix 2.

1.13.2 Loss of BOP Skate

The BOP skate is a steel trolley upon which the BOP stacks can be set for transfer from their storage areas to a position over the moonpool. It is approximately 8 m long, 5 m wide, 1 m deep and weighs about 10 tonnes.

On 8 July, prior to spud, it was used to move the temporary guide base to the moonpool area. At the time the TGB was picked up, one weld, which had been run to restrain the TGB, had not been washed off and the skate was inadvertently picked up and lost through the moonpool.

Three dives were made to locate the skate on the seabed, without success. Visibility at the seabed was less than 1 m. Sweeps of up to 60 feet was made. Some delays were encountered in making the dives, and a small delay resulted through the replacement skate, fabricated in Nelson, not being available at the time of running the 20" stack. Total time lost was of the order of 12 hours.

Loss of the skate can be attributed to human error. The handling of subsea equipment on floating rigs is always a potentially hazardous operation. However in this instance, the loss may have been avoidable had there been a direct intercom between the moonpool area and the driller's position. Such a device could be useful when handling subsea equipment and may be worth considering for installation on the rig.

1.13.3 Delays in Testing 13-5/8" BOP Stack, etc.

Delays totalling some 24¾ hours were incurred at the time of changing out the BOP stacks and presure testing the 13-5/8" stack. These were due to a leaking slip joint element, leaking unions and a burst hose on the kill and choke lines, and a defective kelly cock. There were no leaks in the stack itself. It is evident that insufficient attention was given to surface equipment during the refit in Singapore.

1.13.4 Stuck Pipe at 1,322 m

Whilst carrying out a short trip in the 12-1/4" hole from 1,451 m, the pipe stuck with the bit at 1,322 m. Overpull, to 100,000 lb above hanging weight, failed to free the string. A 20 bbl Pipe Lax/diesel pill was spotted around the drill collars, but failed to free the string after 5 hours soaking. The string was then circulated with mud and the string came free at a time when the overpull had been increased to 125,000 lb.

At the time the pipe stuck, the mud SG was 1.10 and the water loss 18, considerably more than the figure of between 10 and 5 recommended in the programme. The reason for the high fluid loss was an influx of at least 250 bbl of sea water into the system when a valve from a salt water line to the mud pump sections was left open after BOP testing.

In hindsight, more strenuous efforts should have been made to reduce the water loss following this influx. Whether the pipe was stuck mechanically or differentially is a matter for conjecture. Constant movement of the string with the heave of the vessel would tend to reduce the chances of differential sticking, so hole condition could have been a major factor in this instance. Total time lost was 32½ hours from the pipe sticking to getting back to bottom. In this instance, 12 hours spent conditioning the mud to reduce fluid loss after the water influx could have prevented the stuck pipe and reduced the lost time.

1.13.5 Abandonment - Wellhead Recovery

Rather than use explosives to blow off the subsea wellhead, a set of casing cutting tools were procured for wellhead recovery. The 13-3/8", 20" and 30" strings were cut at 80 m BRT, 6 m below seabed. Time taken for the operation - three separate cuts were made - was 12 hours. However, upon latching into the 13-5/8" housing pulls up to 500,000 lb failed to free the wellhead. Presumably the 30" cementation was effective to the seabed and the cement bond held the conductor.

A 50 lb explosive charge was set at 80 m BRT and set off with the rig winched over 100 m. This proved effective in loosening the conductor cement bond, and the wellhead was recovered with a low overpull. The charge did, however, cause some damage to the 13-5/8" housing which is not reusable. Time spent in working the wellhead and setting the charge was 15¾ hours.

To preclude these delays in future wells, it is proposed to grease the exterior of the top 6 m of 30" conductors which should prevent the cement bonding to the casing. It should thus be possible to recover the wellhead after cutting without recourse to explosives. This system has apparently been used by Shell to some effect. If results do not prove satisfactory, it will be necessary to set the wellheads above the seabed so that casing cuts can be made below the housings at mudline level.

1.13.6 Damage Sustained in Recovering Anchors

This has been separated from the delays caused by seas in excess of the safe limits for handling moorings.

At some period during the storm on 1 and 2 August, damage was sustained which resulted in water entering No. 5 chain locker. This probably occurred whilst housing No. 5 anchor on 1 August during a

4 m swell. It was considered necessary to repair the hole before sailing for the next location and the 'Glomar Tasman' proceeded to sheltered water 16 miles east of Godley Head. Whilst carrying out the repairs, mooring gear and personnel were transferred from the Lady Vilma. The time breakdown for the repairs is as follows:

Last anchor stowed Resolution-1	0945 hr	3.8.75
Steaming to sheltered water	11¼ hr	SBPT a/c
Dropped anchor in sheltered water	2100 hr	3.8.75
Carried out repairs and transfers	17 hr	BPST(C)S a/c
Departed from anchorage	1445 hr	4.8.75
Underway to Kupe-1		SBPT a/c

During the storm on 1 and 2 August, some water was taken into the starboard pod room through a hatch which had been damaged by diving equipment which had broken free. This water, combined with heavy beam seas at a time when only three moorings were still out, resulted in a 9° list to starboard. In order to correct the list, 1,000 bbl of mud were dumped from the starboard reserve tanks. The pod room was subsequently pumped dry without problem and the hatch repaired.

PART 2.

PETROLEUM ENGINEERING

by

P. Threadgold

2.1 SCHLUMBERGER LOGS

The following Schlumberger logs were run in the well:

Log	Run No.	Date	Depth Interval (m)
BHC-GR	1A	17.7.75	379.0 - 1,207.3
	2B	28.7.75	1,212.0 - 1,956.5
DSL	1A	17.7.75	379.0 - 1,204.6
	2B	28.7.75	1,213.3 - 1,954.8
CAL	1A	17.7.75	379.0 - 1,204.6
HDT	2A	28.7.75	1,212.0 - 1,959.0

2.2 LOG INTERPRETATION

2.2.1 Logging Run 1 - Logged Interval 379 - 1,204.6 m

Logs Run:		
Dual Laterolog (simultaneous)-SP	:	Run 1A
BHC Sonic-Gamma	:	Run 1A
Caliper	:	Run 1A

The interval was predominantly poorly consolidated mudstone. The only cleaner zone was from 1,104 - 1,112 m. This has the characteristics of a poorly consolidated silt. It has high porosity and contains relatively fresh water of about 5,000 - 6,000 ppm NaCl equivalent.

2.2.2 Logging Run 2 - Logged Interval: 1,212 - 1,959 m

Logs Run:		
Dual Laterolog (simultaneous)-SP	:	Run 2B
BHC Sonic - Gamma - Caliper	:	Run 2B
High Resolution Dipmeter	:	Run 2A
CIS (Well Velocity Survey)	:	-
Core Sample Taker	:	Run 2A

(a) Interval 1,212 - 1,236.8 m

Uncompacted mudstones.

(b) Interval 1,236.8 - 1,332 m

More compacted mudstones with a transition to sandy limestone at about 1,287 m. A glauconitic sand is present towards the top characterised by the high gamma peak at 1,305 - 1,306 m. A further sand development occurs at the base of the limestone zone. The porous zones have porosities of the order of 23-26% and contain water of 9,000 - 12,000 ppm NaCl equivalent.

(c) Interval 1,332 - 1,480.5 m

Basically uncompacted mudstones, more silty and compacted towards the base. The small zones of lower travel time and higher resistivity could be glauconitic sands - possibly also pyritic. The most pronounced of these is at the base of the zone.

(d) Interval 1,480.5 - 1,663.5 m

This was the major target zone of interest. It is a high porosity sand. The porosity ranges from 35 to 45% and higher on log evidence. The majority of the sand is clean. Again pyritic/glauconitic zones are apparently present, evidenced by the reduction in sonic transit time (reduction in porosity), and high gamma activity.

On SP evidence the water resistivity is greater than that of the mud filtrate and is of the order of 0.35 - 0.45 ohm-m at BHT (142°F). The plot of sonic transit time versus reciprocal root resistivity confirms these values and also the high porosities. It also indicates substantial filtrate invasion by the lower resistivity filtrate.

(e) Interval 1,663.5 - 1,911.5 m

Argillaceous sandstone and siltstone are predominant in this interval which also has evidence of pyrite and glauconite zones. A clean sandstone development occurs between 1,756 and 1,788 m, having a porosity of 30 - 35% and containing water of the same salinity as of the major sand.

From 1,899 m to the top of the intrusive at 1,911.5 m, there are four sand developments which have lower porosities 15 - 20% but contain the same salinity water as in the higher sands.

(f) Interval 1,911.5 - 1,959 m

This is an igneous intrusive. The lower resistivity zones appear to indicate some low porosity development ($<$ 10%).

PART 3.

GEOLOGY

by

A.D. Milne

3.1 INTRODUCTION

Resolution-1 was the second exploration well drilled in the PPL 685 area. Previous exploration activities in this licence area comprise seven seismic surveys and one exploration well, Endeavour-1, which was drilled in 1970 to 2,741 m.

The geological interpretation of the stratigraphy of Resolution-1 is based on cuttings collected at 5 or 10 m intervals below 385 m, and 56 sidewall cores and one terminal core taken below 1,225 m, together with Schlumberger log data (Enclosures 7 - 9). These geological samples are stored with the N.Z. Geological Survey in Lower Hutt.

Specialist services were provided by staff of the Department of Scientific and Industrial Research based in Wellington or Lower Hutt as follows:

(a) Biostratigraphy (Appendix 4) - Dr. N. de B. Hornibrook et al, N.Z. Geological Survey

(b) Petrology (Appendix 5) - Dr. G.A. Challis, N.Z. Geological Survey

(c) Radiometric Dating (Appendix 6) - Dr. C.J.D. Adams, N.Z. Institute of Nuclear Sciences

(d) Magnetic Susceptibility (Appendix 7) - Mr. T.C. Mumme, Geophysics Division.

We wish to thank the above staff of the DSIR for their co-operation and technical assistance.

3.2 LITHOSTRATIGRAPHY

75-685 m

Plio-Pleistocene (Hawera-Wanganui Series)

No ditch samples were obtained above 385 m. Below 385 m, the dominant lithology is a shelly clay, consisting of lamellibranch and gasteropod shells in a grey silty clay matrix. From 524.5 - 569.5 m, there occurs an interval of grey, very fine grained, glauconite sandstone with medium porosity. Below 55 m there occur occasional 1-2 m thick beds of dark brown, fibrous lignite.

The tops of the stages within this interval marked on the composite log are the palaeontological top depths corrected upward for sample lag.

685-1,220 m

Upper Miocene (Taranaki Series)

From 685-860 m, the dominant lithology is a light grey silty clay. Subordinate intervals of light grey, very fine grained glauconitic sandstone and occasional thin beds of lignite also occur. Below 860 m, the major lithology is light grey, argillaceous silt. From 1,104-1,112 m and 1,133.5-1,134.5 m there occur intervals of grey and red-brown tuff.

1,220-1,280 m

Middle Miocene (Southland Series)

From 1,220-1,236.5 m, the rock is still light grey silty clay. From 1,236.5-1,280 m, a light grey, calcareous, microfossiliferous, silty mudstone occurs. Below 1,248 m, the ageing of the interval depends on data based on cuttings only, so the top of the Altonian Stage (Lower Miocene) is uncertain.

1,280-1,306 m

Lower Miocene (Pareora Series)

From 1,280-1,286.5 m, the rock is light grey silty mudstone. From 1,286.5-1,306 m, a sandy limestone occurs. This is a white, very fine to fine grained grainstone with a significant quartz content and high porosity. The base of the limestone is highly glauconitic. The limestone is of Altonian age and overlies a major unconformity which represents much of the Lower Miocene and Oligocene.

1,306-1,328 m

Oligocene (Landon Series)

This interval consists of sandy, glauconitic limestone with wackestone texture. It is of Whaingaroan age.

1,328-1,413.5 m

Upper and Middle Eocene (Arnold Series)

From 1,328-1,355 m, the section consists of light grey, silty calcareous mudstone. Below 1,355 m, the rock is light brown, calcarerous, glauconitic, silty mudstone. The Stage tops within this interval are accurately bracketed by sidewall cores, except for the top of the Upper Bortonian which is picked at a convenient log marker.

1,413.5-1,480.5 m

Middle Eocene to Palaeocene (Dannevirke Series)

The dominant lithology is light brown, calcareous, glauconitic silty mudstone. In the lower part of the interval there are a few beds of dark grey and green, fine grained basaltic tuff consisting of angular shards of devitrified volcanic glass. The topmost Stage in this Series, the Porangan is either absent or was not identified.

1,480.5-1,663.5 m

?Upper Cretaceous (?Mata Series)

In this interval the predominant rock is a pale coloured, very fine to coarse grained sandstone which is locally glauconitic, carries rare fragments of volcanic rock and is highly porous. In the interval 1,557.5-1,571 m, the sandstone is dark grey and tuffaceous. The whole interval is palaeontologically barren.

1,663.5-1,911.5 m

Upper Cretaceous (Mata Series)

From 1,663.5-1,783.5 m, the rock is a pale coloured, very fine grained sandstone which is locally glauconitic, carries fragments of volcanic rock and is highly porous. From 1,783.5-1,885 m, the rock is a grey, very fine to silt grade, tight, argillaceous sandstone. Near the base of this interval are several thin beds of lignite. From 1,885-1,911.5 m the dominant lithology is dark grey, sandy siltstone. A white, fine grained tight sandstone containing secondary zeolite also occurs, and at the base of the interval it is interbedded with gravel. The whole interval is well dated from sidewall core data as Haumurian. There was no indication of pre-Haumurian strata in the well.

1,911.5-1,963 m

Igneous Intrusive (Miocene)

This is a medium to coarse grained basic igneous rock ranging in composition between quartz syenogabbro and teschenite. The presence of contact metasomatism in the overlying sediments and the low radiometric age of the igneous rock indicates that it is intrusive.

3.3 HYDROCARBON SHOWS

1. Cuttings and Sidewall Cores

No hydrocarbon stain, fluorescence or cut was observed.

2. Schlumberger Logs

No low water saturations occurred.

3. Gas Shows

(a) 17½" Hole (to 1,235m BRT)

A continuous low background of 5-10 hotwire units of gas occurred in this silt/clay interval. This gas consisted of methane only and clearly was 'shale gas'. In the show of trip gas following drilling out the 13-3/8" casing shoe, one chromatograph unit of ethane was registered.

(b) 12¼" Hole (to 1,963 m BRT)

Down to 1,575 m background gas is virtually absent. Below 1,575 m the background level is 5-10 hotwire units. This background consists predominantly of methane, but below 1,740 m heavier hydrocarbon gases appear (C_2-C_6). These gases are almost certainly related to the addition to the mud of Pipe Lax plus diesel to free stuck pipe. Pilot tests conducted on board by Core Lab, using mixtures of these materials, shows that C_1 to C_6 could readily be evolved by heating to formation temperatures (120° - 140°F).

In view of the sandy nature of the section, and the absence of indications in samples or on Schlumberger logs, the gases recorded in the 12¼" hole are almost certainly derived solely from mud additives.

TENTATIVE

GEOLOGICAL INTERPRETATION

OF SEISMIC LINE 74 - 04

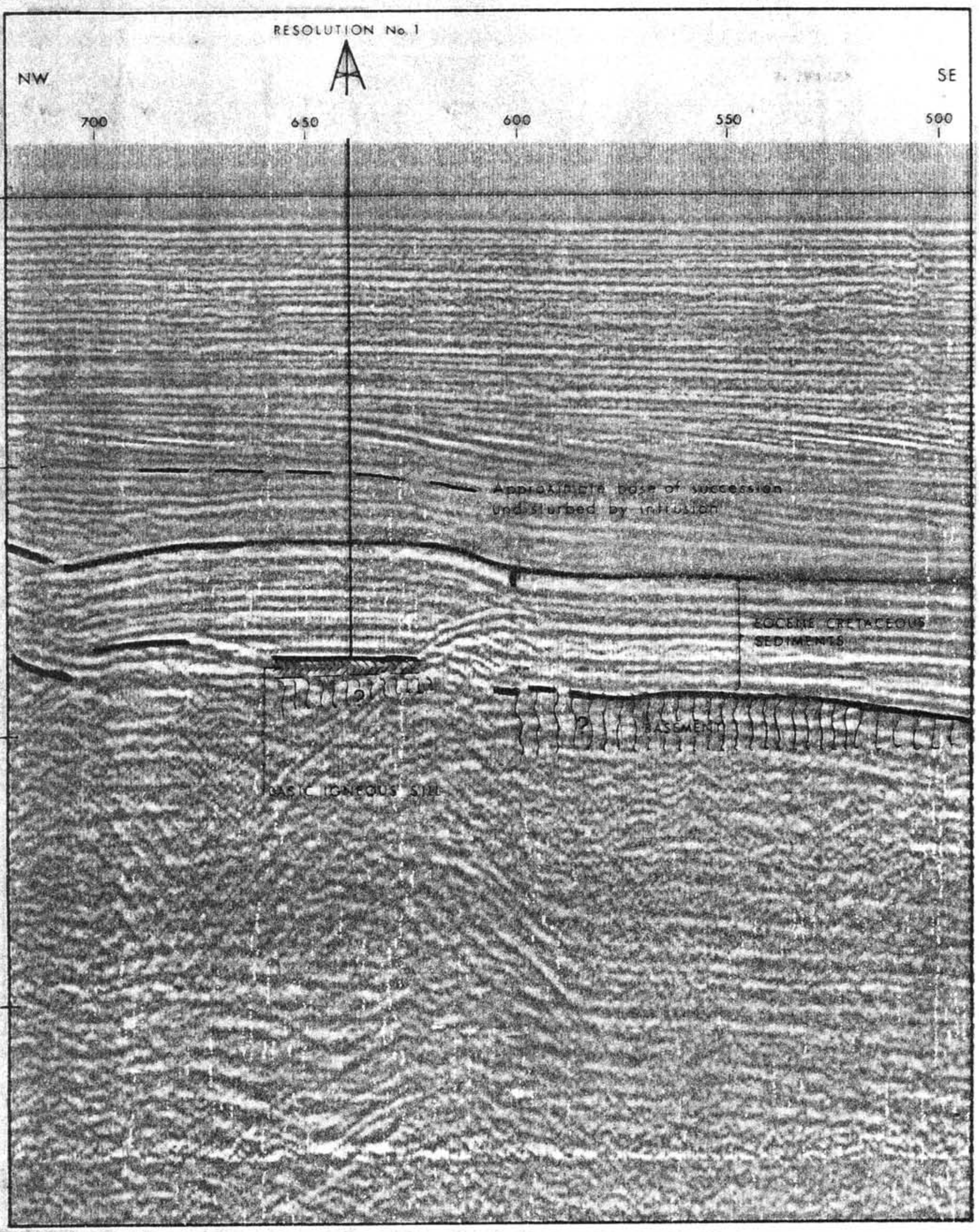


FIG. 8

AUGUST, 1975
DRG. NO. 41

3.4 FORMATION AT TOTAL DEPTH

Resolution-1 was terminated after drilling and coring 51.5 metres of a coarse, mesocratic igneous rock of plutonic aspect. Binocular microscope work on the rig positively identified plagioclase feldsapr, pyroxene, amphibole, biotite, apatite and quartz. In view of the mineralogy and mode, the rock was provisionally called a granodiorite. Further, the velocity shoot confirmed that the top of the igneous rock was the Seismic Red Horizon, presumed to be the top of Torlesse basement. Therefore, on the grounds of lithology, absence of apparent marginal chilling, and the velocity data, the rock was regarded as basement and the well was abandoned.

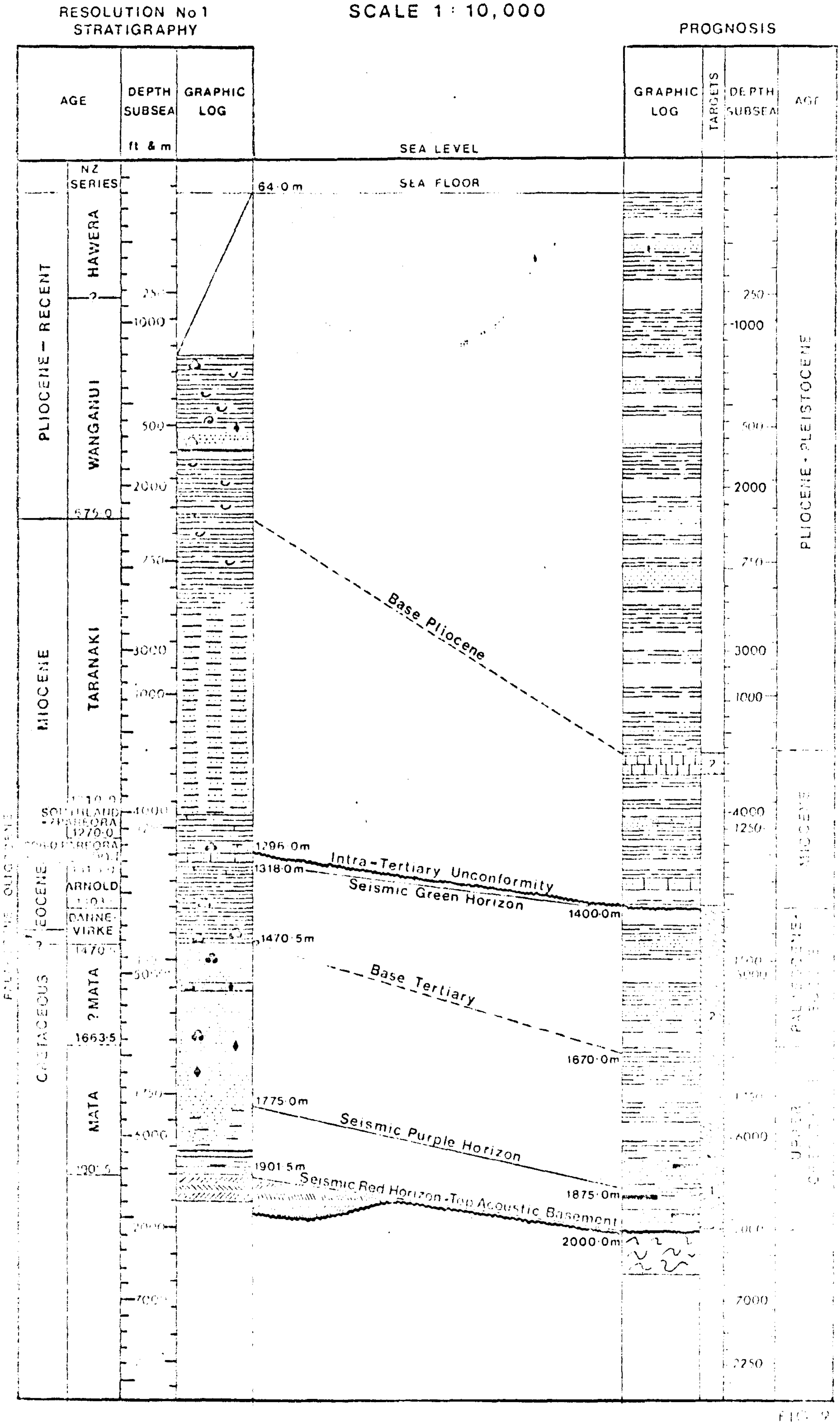
Subsequent petrological work indicated that the rock was in fact a teschenite, an alkaline basic igneous rock, and that the zeolite mineral thomsonite occurs in sidewall cores in the overlying sandstones indicating contact metasomatism (Appendix 5). This evidence, together with a K-Ar radiometric dating of c. 12 ± 2 m.y. (Appendix 6) clearly indicates that the igneous rock was intrusive, and that the well did not terminate in basement. However, there is little definition on the seismic sections in the area to suggest a bedded sedimentary succession below the Red Horizon which had been mapped as the top of basement. It is possible that the path of intrusion was between the harder indurated basement rocks and the softer, less dense, overlying sediments as indicated in Fig. 8. In the absence of well information concerning the true nature of the rock below the sill, this interpretation must be regarded as tentative.

In any event the well was a valid test of the structure and there is no evidence of closure below the sill to give any possibility of hydrocarbon trapping at this level.

648 52

COMPARISON OF RESOLUTION No.1 STRATIGRAPHY WITH PROGNOSIS

SCALE 1 : 10,000



SEPT 1975
DWG NO 48

3.5 COMPARISON WITH PROGNOSIS

Fig. 9 illustrates how the stratigraphy of Resolution-1 compares with the prognosis (Hill, 1975) and Table 2 compares the seismic predictions with the well data. In general, the comparison is good. The principal differences are:

1. The well section was more sandy and silty than had been expected.

2. The Plio-Pleistocene section was thinner and the Miocene section was thicker than had been anticipated.

3. There were no limestones in the Miocene section.

4. The coal beds which characterise the basal part of the sedimentary sequence onshore were only thinly developed in the well (three beds, aggregate thickness 2 m).

5. The Seismic Green Horizon was identified with the major velocity change at the base of the Landon limestone, and not in this case with the 'intra Tertiary unconformity' suggested by Fisher (1974).

6. Tuff beds occurred in the well, in the Tongaporutuan and Teurian sections. Other volcanogenic debris occurred in minor amounts through much of the well section (Encl. 7).

7. The well encountered a thick basic igneous sill, in which it was terminated.

TABLE 2

COMPARISON OF PREDICTED VELOCITIES AND DEPTHS WITH WELL DATA

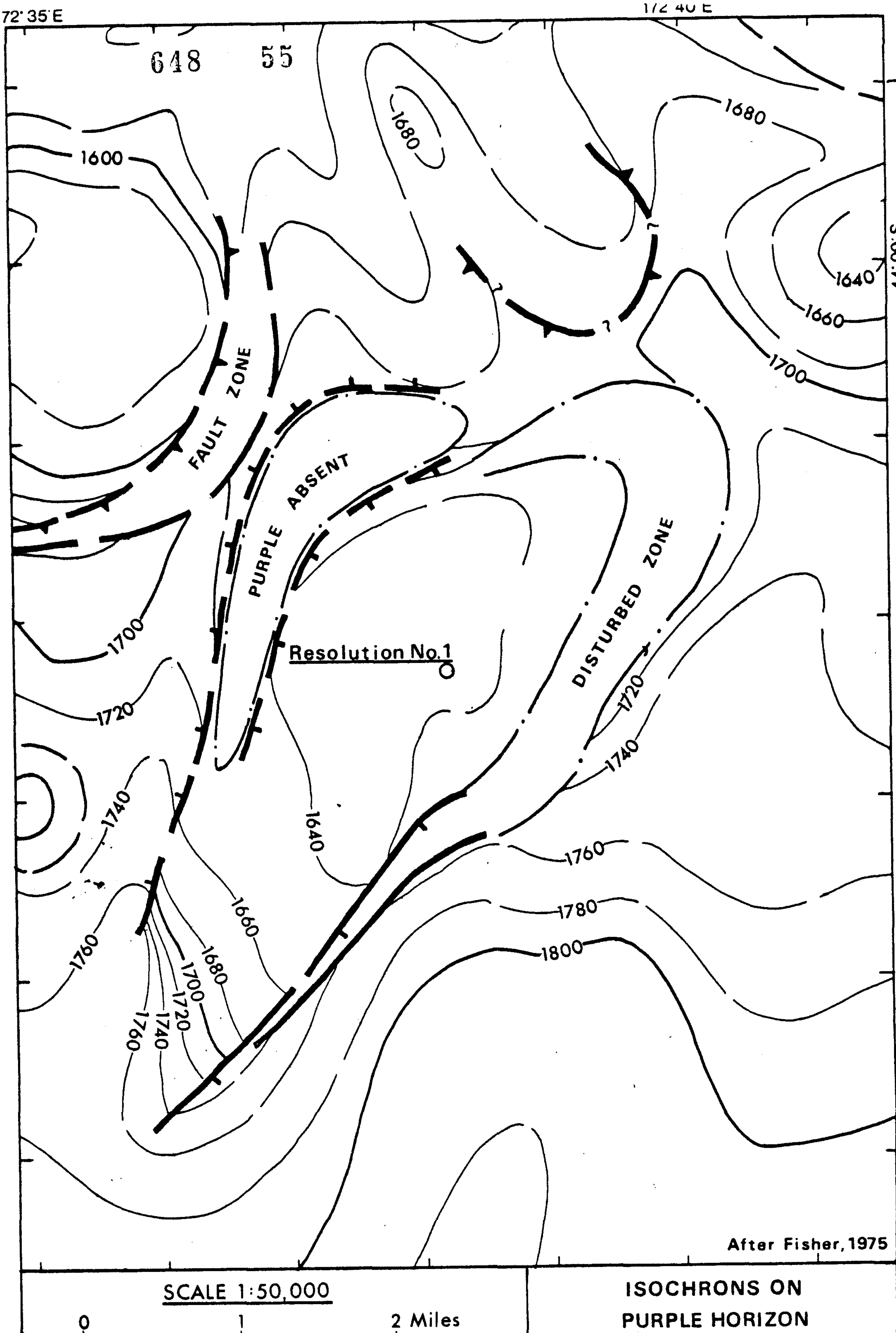
SEISMIC HORIZON	TWT (from seismic) (msec)	ASSUMED LAG (msec)	PREDICTED AVERAGE VELOCITY (m/sec)	PREDICTED DEPTH (m ss)	GEOLOGICAL MARKER	ACTUAL DEPTH (m ss)	TWT (from calibrated Sonic Log (msec)	DETERMINED LAG (msec)	TRUE AVERAGE VELOCITY (m/sec)
GREEN	1285	0	2170	1400	Base Landon Limestone	1320	1255	30	2105
PURPLE	1625	0	2300	1875	Within Mata Sandstone	1785	1590	35	2245
RED	1695	0	2360	2000	Top Intrusive	1901	1660	35	2290

NOTES:

1. Source of velocity data used in prediction: Stacking velocities from detail seismic work.

2. Nature of calibration data: Provisional.

3. Date of computation: August 28, 1975.



SCALE 1:50,000

0 1 2 Miles

0 1 2 3 Kilometres

ISOCHRONS ON PURPLE HORIZON

C.I. = 20 millisecs.

SEPT. 1975

FIG. 10

3.6 RESULTS AT TARGET HORIZONS

3.6.1 Primary Target

Sandstones in a basal, coal-bearing sequence of Upper Cretaceous age were the primary target of Resolution-1 (Fig. 9). Sandstones do occur at this level, but are in large part argillaceous, silty and tight. These rocks gave no indication of oil stain or fluorescence, or any significant gas shows, and according to Schlumberger logs, are freshwater-bearing.

An accumulation of hydrocarbons is not possible here because of a lack of a trap. Although an apparently closed anticline occurs at this level (Fig. 10), the sequence is overlain by porous sands which could not act as a seal (Fig. 9).

3.6.2 Secondary Target

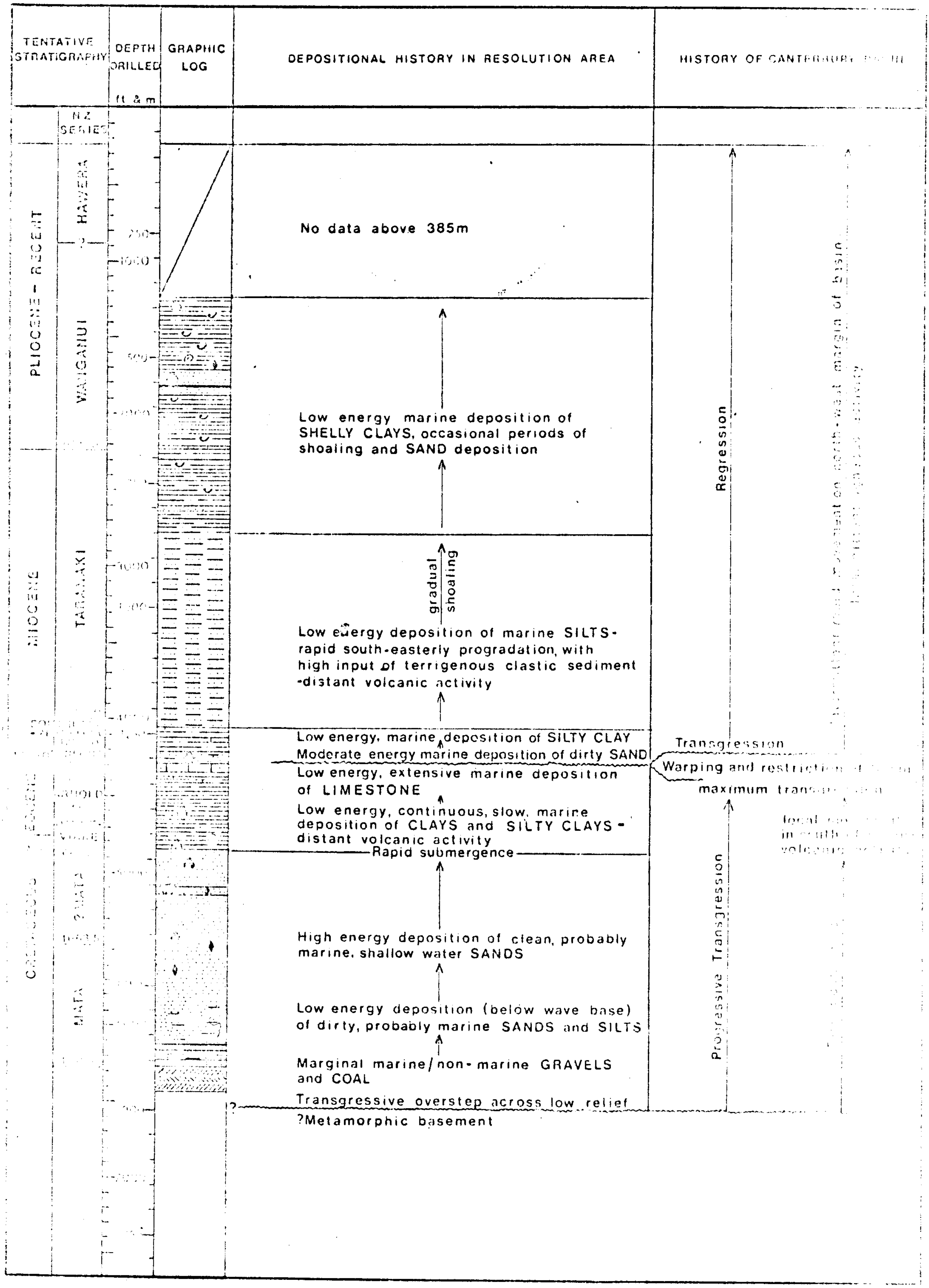
The main secondary target was a predicted sand-shale sequence of Upper Cretaceous/Eocene age (Fig. 9). In the well, a thick section of massive sands of inferred Upper Cretaceous age was found beneath a thick section of massive mudstones. These sandstones are excellent potential reservoirs since they are clean and have sonic log porosities of over 35%. However, there were no hydrocarbon indications, and electric logs indicate that the sandstones are freshwater bearing.

The topmost part of this porous sandstone is apparently trapped since it is anticlinally folded (Encl. 10) and is sealed by the overlying thick mudstone. If the structure ever did hold gas, this has been displaced by hydrodynamic flushing. The absence of residual oil indications means that the structure never held oil.

648 57

SYNOPTIC GEOLOGICAL HISTORY NORTH CANTERBURY BASIN

SCALE 1:10,000



3.7 DISCUSSION OF RESULTS IN RELATION TO REGIONAL GEOLOGY

3.7.1 Stratigraphical

3.7.1.1 Correlation

Enclosure 11 illustrates the correlation of the Resolution-1 section with the onshore stratigraphy of North Canterbury some 120 km to the north, the nearest area to the well where a fairly complete sedimentary succession occurs. Some apsects of the correlation are discussed below.

3.7.1.2 Reservoirs

In addition to the sandstones of the Mata Series which were anticipated in the well prognosis, two other potential reservoir sections, albeit relatively thinly developed, were encountered. The first occurs at 1,306-1,326.5 m BRT, and is a sandy, glauconitic limestone with wackestone texture and of Oligocene age. The sonic log porosity of this unit is over 25%. The limestone is the time equivalent of the Amberley Limestone onshore in North Canterbury (Encl. 11). It is the expression of maximum marine transgression (Fig. 11) and hence is probably widely developed offshore in the northern part of the basin.

The second potential reservoir section occurs at 1,287-1,306 m BRT, and is a sandy glauconitic limestone with grainstone texture and of Miocene age. The average sonic log porosity of the rock is over 30%. The unit unconformably overlies the Oligocene limestone discussed above. It is a basal deposit laid down during the transgression that followed the Oligocene hiatus (Fig. 11) and is probably areally extensive. It is of similar facies to, and homotaxial with the Weka Pass Stone (Encl. 11) but is much younger.

3.7.1.3 Unconformities

The only unconformity that can be positively identified in the Resolution-1 succession occurs at 1,306 m BRT, at the base of the Miocene, where Southland Series limestones overlie basal Landon Series limestones. This unconformity represents a major stratigraphic break (three New Zealand stages cf. Encl. 11), but is not noticeably angular, either in the well, from dipmeter log evidence, or areally, on seismic.

3.7.1.4 Depositional Environments

Figure 11 illustrates an interpretation of the depositional environments represented in the Resolution-1 section.

The well section was sandier than was expected in the ?Mata interval. This probably results from the Resolution area remaining high relative to onshore Canterbury during the initial transgression. If this were the case, condensed deposition and stratigraphic breaks would occur, thus helping to explain the abundance of glauconite in the well (McRae, 1972).

3.7.1.5 Identity of the Seismic Red Horizon

Resolution-1 penetrated the Red Horizon, the top of acoustic basement. However the well terminated in an igneous intrusive body and therefore failed to identify what regionally is acoustic basement. Further, the Endeavour-1 well 160 km to the south-west, possibly failed to reach the Red Horizon (Fisher, 1974), so the identity of the horizon remains uncertain.

The Red Horizon is a south-easterly dipping horizon, which is overstepped by overlying reflections (Encl. 12). Clearly it represents a fairly major regional unconformity. In view of the observed degree of overstep and the lack of consistent, deeper reflections indicative of a bedded sedimentary sequence, the Red Horizon most probably represents the top of metamorphic basement.

3.7.1.6 Age of Igneous Activity

In Resolution-1, thin tuff beds occurred in the Tongaporutuan and Teurian sections, indicating volcanic activity in late Miocene and Palaeocene times respectively. The Tongaporutuan tuffs are very probably derived from one of the Banks

Peninsula vents (Table 3). The Teurian tuffs may be related to the 'Brookside Volcanic Formation' encountered in the onshore well Leeston No. 1, but the precise age of this unit is uncertain (Katz, 1971).

The basic intrusive in which the well was terminated has been radiometrically dated at 12±2 m.y. (Appendix 6). It is therefore of Miocene age and is apparently contemporaneous with the Lyttleton episode of the Banks Peninsula volcanic complex.

3.7.2 Structural

3.7.2.1 Origin of the Structure

The Resolution-1 structure is a simple domal feature across which the strata maintain a constant thickness (Encl. 13). It involves reflections as high as 1 sec. on seismic sections corresponding to strata as high as Tongaporutuan in the well. Clearly therefore the feature was generated by doming in Miocene times. This age corresponds with the radiometric dating obtained from the igneous intrusive at the base of the Resolution-1 section. Hence it is reasonable to suggest that doming was caused by the emplacement of the igneous intrusive. If this is so, by corollary, the area and thickness of the intrusive body must approximate the area and relief of the structure in the overlying strata.

3.7.2.2 Other Structures

In the immediate area south of Banks Peninsula, Fisher (1975, Encl. 16) has mapped several structures at Seismic Purple and Green levels, as well as some inferred volcanic plugs which breach the Green Horizon. In view of the very similar structural style and age of these structures to the Resolution feature, probably these too were created by doming over Miocene igneous intrusions emplaced low in the succession.

TABLE 3

AGE OF VOLCANIC ROCKS IN NORTH CANTERBURY

Volcanic event/unit		Radiometric Dating	Age
Banks Peninsula *	(Diamond Harbour Gp (Akaroa Volcano (Lyttelton Volcano	5.8-8.2 m y 8-9 m y 10-12 m y	Late Miocene-Pliocene
Brookside Volcanics		undated	Palaeocene-Miocene
Mount Somers Gp **		81 m y	Late Cretaceous

Data Sources

*	Stipp and McDougall	(1968)
**	Hulston and McCabe	(1972)

3.8 HYDROCARBON POTENTIAL OF PPL 685

3.8.1 Traps

All potential reservoirs in the Resolution-1 section have been hydrodynamically flushed. The other anticlinal features immediately south of Banks Peninsula, all of which lie landward of Resolution-1, can be expected to have been similarly flushed, and hence are very poor prospects.

A very large wedgeout feature some 70 km south-west of Resolution-1 has been mapped by Fisher (1974, Encl. 16). This is defined by the truncation of the Seismic Purple Horizon against Seismic Red, reflecting onlap across an unconformity surface. However in Resolution-1, the Purple Horizon is overlain by over 300 m of sandstone. Assuming a similar succession in the vicinity of the wedge-out, the feature would be open to the north-west.

Possibly the most promising prospective area remaining in the licence area lies basinward of Resolution-1 (Encl. 14). Here, overstep of Mata and pre-Mata strata across the Red Horizon (?top basement) unconformity could give rise to wedgeout traps in basal sands. These traps should have been protected from the effects of flushing.

3.8.2 Source Potential

Full evaluation of the source potential of the Resolution-1 section must await the results of geochemical studies presently in hand. However, the generally sandy/silty nature of the well section is discouraging. Nevertheless, seismic sections show that:

(a) because of the overstepping nature of the basal part of the sequence, older sediments occur basinwards of Resolution-1 that were not tested by the well. The source potential of these older strata remains unknown.

(b) in the Red-Green interval, the character of seismic reflections becomes less distinct basinwards (Encl. 13), e.g. the Purple Horizon dies out completely (Encl. 12). This character change may reflect a seaward transition to a more shaly sequence with better source rock potential.

3.8.3 Future Prospects

As mentioned previously, the most promising prospects remaining in PPL 685 are potential wedgeout traps at Mata and pre-Mata levels, lying basinward of Resolution-1. A review of the hydrocarbon potential and prospects of the Canterbury Basin is presently being undertaken. Recommendations for further work will depend on the results of the review.

3.9 CONCLUSIONS

1. The Resolution-1 succession compared well with the prognosis. The main departure was that the section was sandier than expected.

2. No significant gas or oil indications occurred.

3. Reservoir quality sandstones and limestones were well developed, but all were freshwater-bearing, very probably due to hydrodynamic flushing.

4. Evaluation of the hydrocarbon source potential of the Resolution-1 section awaits the results of geochemical studies presently in hand. However, the sandy character of the well section is discouraging, but shales with source potential probably occur basinward of the well.

5. The Resolution structure was probably created by updoming of the sedimentary cover over a Miocene basic igneous intrusion. The other anticlines in the area immediately south of Banks Peninsula are probably of similar origin and age.

6. The Seismic Red Horizon is a regional unconformity which is extensively overstepped. It most probably represents the top of basement.

7. The other anticlinal prospects adjacent to the Resolution structure have very probably been hydrodynamically flushed. Hence they are very poor prospects.

8. The major depositional wedgeout 70 kms south-west of Resolution-1 is probably not sealed.

9. The most promising prospects remaining in PPL 685 are Mata and pre-Mata depositional wedgeouts located close to the seaward boundary of the licence area. A review of the hydrocarbon potential and prospects of the Canterbury Basin is presently being undertaken and further work will depend on the results of this review.

3.10 REFERENCES

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APPENDIX I

DRILLING DIARY

DRILLING DIARY

Date	Depth m	
23/5/75	-	Glomar Tasman left Jurong Dockside (Singapore) at 1000 hr. Loading fuel.
25/5/75	-	Glomar Tasman departed Singapore 0001 hr tow assisted by Lady Vilma.
19/6/75	-	Arrived Tasman Bay at 0800 hr. Alongside at Nelson 1640 hr for loading equipment.
20/6/75	-	Contract suspended at 1400 hr for electrical repairs.
2/7/75	-	Glomar Tasman departed Nelson. Contract resumed at 1330 hr at release of pilot. Lady Vilma tow-assisting to location.
5/7/75	-	Arrived on location. Set first anchor at 2100 hr.
6/7/75	-	Setting anchors, 3 out. WOW.
7/7/75	-	WOW. Set 2 further anchors.
8/7/75	-	Completed setting anchors and tensioned up. Confirmed rig position, 11 yds west and 25 yds north of intended location. Checked water depth (64 m) and seabed competence. Lost BOP skate in handling TGB. Divers unable to locate. Ran Temporary Guide Base.
9/7/75	109	Made up tools. Spudded Resolution-1 1700 hr. Drilling 36" hole.
10/7/75	127	Drilled to 127 m. POH and ran 4 joints 30" casing to 122 m with Permanent Guide Base. Cemented with neat cement.
11/7/75	313	Made up 26" bit. Tagged cement at 111 m. Drilled out shoe. Drilling 26" hole.

Date	Depth m	
12/7/75	390	Drilled to 390 m. Made wiper trip and spotted viscous mud. Running 20" casing.
13/7/75	390	Ran 20" casing to 377 m. Cemented with gel followed by neat cement. Transferred and ran 20" BOP stack.
14/7/75	397	Latched and tested 20" stack. Ran 17½" tools. Drilled out cement and shoe. Drilled to 397 m and carried out formation leak-off test, equivalent to 11.3 lb/gal.
15/7/75	926	Drilling 17½" hole with wiper trips.
16/7/75	1235	Drilled to 1,235 m with wiper trips. POH.
17/7/75	1235	Logged. Made wiper trip. POH.
18/7/75	1235	Pulled bore protector. Ran 97 joints 13-3/8" casing to 1,223.6 m in rough seas.
19/7/75	1235	Cemented with gel followed by neat cement. Pulled 20" BOP stack.
20/7/75	1235	Ran 13-5/8" stack. Testing and repairing lines.
21/7/75	1235	Tested stack and cured leaks. Made up 12¼" tools.
22/7/75	1451	Tagged cement at 1,199 m. Drilled out shoe and carried out formation leak-off test, equivalent to 14.7 lb/gal. Drilling. Pipe stuck with bit at 1,322 m on short trip.
23/7/75	1451	Spotted Pipe lax and worked pipe. Increased over-pull and circulated mud. POH and RIH new bit.
24/7/75	1729	RIH. Conditioned mud and hole. Drilling.
25/7/75	1911	Drilled to 1,851 m. POH and RIH new bit. Drilling.
26/7/75	1958	Drilled 12¼" hole to 1,958 m. POH and ran 8-7/16" core head on 6¾" barrel.

Date	Depth m	
27/7/75	1963	Took core No. 1, 1,958 m to 1,963 m. Progress ceased. POH, 100% recovery. RIH 12¼" bit and reamed rat hole. POH. Logging.
28/7/75	Plugged Back	Completed logging. Ran open-ended drill pipe and set cement plug across 13-3/8" shoe. Set bridge plug at 1,150 m.
29/7/75	-	Set cement plug on bridge plug. Recovered 13-5/8" BOP stack on 22" riser. Cut 13-3/8" and 20" casing at 80 m BRT.
30/7/75	-	Cut 30" casing. Attempted unsuccessfully to pull wellhead housings. Ran and set off explosive charge in wellhead with rig 100 m off location. Moved back over and recovered wellhead and PGB.
31/7/75	-	Set surface cement plug 84 m BRT to seabed (74 m). Recovered TGB. Seabed clear. Well abandoned 0800 hr. Commenced lifting anchors 0800 hr. Recovered 2 anchors. WOW.
1/8/75	-	WOW, 18' seas and 60 knot winds. Dumped mud to correct list caused by leaking hatch. Recovered 2 further anchors.
2/8/75	-	WOW.
3/8/75	-	Recovered remaining anchors. Last anchor housed and rig released 0945 hr. Under way 1015 hr. Set anchor off Godley Head at 2100 hr to carry out repairs to hull caused by No. 5 anchor being housed.
4/8/75	-	Completed repairs. Under way to SBPT location 'D' in South Taranaki Bight 1445 hr.

NOTE: The adjusted release time to allow for repair time off Godley Head was 0330 hr 4 August 1975.

APPENDIX 2.

MOORING AND UNMOORING

by Captain L. Watkins

BOCAL Pty. Limited.

MOORING AND UNMOORING

MOORING 5 JULY 1975 - 8 JULY 1975

5 July 1975

1805	Streamed #5 buoy, rig to proceed to location.
2100	Set #5 anchor at marker.
2220	Run and set #1 with Lady Vilma.
	Rig held with #5 and #1. #7 dropped underfoot to hold rig heading.
2300	Discussed with Master Lady Vilma conditions deteriorated now considered unsafe to continue.
	wx Barometer 1018.0 Wind 200° x 30 knots Sea Ht. and Direction 200° x 5 feet Swell Ht. and Direction 200° x 18 feet

6 July 1975

1600	Weather moderating slightly. Lady Vilma ordered to #8 to attempt to run.
1700	Lady Vilma at #8.
1745	#8 run and set. Lady Vilma to attempt transfer of personnel via crane, attempt aborted, unsafe. Too dangerous to attempt transfer of personnel or equipment.
2045	Lady Vilma to #4 anchor.
2215	#4 anchor set. Weather deteriorated, anchor work discontinued.
	wx Barometer 1016.9 Wind 220° x 30 knots Sea Ht. and Direction 220° x 5 feet Swell Ht. and Direction 220° x 16 feet

7 July 1975

1930	Weather improves Lady Vilma ordered to rig.
2145	Lady Vilma runs and sets #2 anchor to prepare for #3.
2355	#3 run and set. Lady Vilma to prepare for #7.

8 July 1975

0400	#7 run and set. Lady Vilma to reset #1 and pull rig into tolerance zone.
0530	#1 reset. Heaving rig into zone with anchors.
0700	Lady Vilma in for #6.

MOORING

8 July 1975 (cont'd)

0900	#6 run and set. All anchors run.
	Position rig within tolerance zone as directed by M.V. Brothers.
1145	Reset #7 anchor scope of chain too little due to moving of rig.
1345	Reset #8 anchor scope of chain too little due to moving of rig.
1410	Position of rig accepted, mooring system tensioned to 150,000 lbs. Final Heading 215^o (T).

WEATHER LOG — 5 JULY 1975 - 8 JULY 1975

5 July 1975

2000 — Bar 1019.1 Wind 200° x 30 k Sea 200° x 4 feet
Swell 200° x 15 feet

2400 — Bar 1018.2 Wind 200° x 35 k Sea 200° x 5 feet

6 July 1975

0400 — Bar 1020.0 Wind 200° x 30 k Sea 200° x 4 feet
Swell 200° x 16 feet

0800 — Bar 1020.3 Wind 200° x 30 k Sea 200° x 4 feet
Swell 200° x 16 feet

1200 — Bar 1020.0 Wind 220° x 30-35 k Sea 220° x 5.6 feet
Swell 220° x 16 feet

1600 — Bar 1017.2 Wind 220° x 20-25 k Sea 220° x 5 feet
Swell 220° x 16-18 feet

2000 — Bar 1017.0 Wind 220° x 25 k Sea 220° x 5 feet
Swell 220° x 16 feet

2400 — Bar 1016.1 Wind 220° x 25 k Sea 220° x 5 feet
Swell 220° x 16-18 feet

7 July 1975

0400 — Bar 1013.8 Wind 225° x 25-30 k Sea 225° x 4 feet
Swell 230° x 18 feet

0800 — Bar 1015.2 Wind 230° x 30 k Sea 230° x 5 feet
Swell 230° x 16 feet

1200 — Bar 1014.7 Wind 230° x 30 k Sea 230° x 5 feet
Swell 230° x 18 feet

1600 — Bar 1015.9 Wind 230° x 30 k Sea 230° x 5 feet
Swell 230° x 18 feet

2000 — Bar 1016.9 Wind 230° x 25 k Sea 230° x 4 feet
Swell 230° x 16 feet

2400 — Bar 1017.5 Wind 215° x 20 k Sea 215° x 2 feet
Swell 225° x 14 feet

8 July 1975

0400 — Bar 1017.9 Wind 180° x 15-25 k Sea 180° x 2 feet
Swell 220° x 12-14 feet

0800 — Bar 1017.6 Wind 180° x 15 k Sea 180° x 2 feet
Swell 215° x 12 feet

1200 — Bar 1017.2 Wind 180° x 10 k Sea 180° x 1 foot
Swell 210° x 10-12 feet

UNMOORING — 31 JULY 1975 - 3 AUGUST 1975

31 July 1975

0645	Lady Vilma placed on standby for anchor work.
0745	Lady Vilma reports #7 buoy not visible (presumed sunk, had been observed on previous day).
	Lady Vilma to proceed to #2.
0900	Commenced heaving in #2.
0920	#2 released by Lady Vilma. Lady Vilma to proceed with #6.
1145	#6 racked. Lady Vilma to #3.
1200	Lady Vilma attempted to retrieved #3 unsuccessful due to deteriorating weather.
	wx Barometer 1009.5 Wind 320° x 35/45 knots Sea 320° x 6-7 feet Swell 320° x 8 ft.
1500	Weather moderates slightly. Lady Vilma to #3.
1530	Commenced heaving #3.
1710	#3 racked. Lady Vilma to proceed to #5.
1930	After repeated attempts Lady Vilma unable to work at #5; anchor work suspended.

1 August 1975

0230	Lady Vilma requested to attempt #5.
0330	Wind increases to 45-60 knots, attempt aborted.
1200	Weather moderating attempting to heave #7 in without workboat assistance.
1600	Lady Vilma to procced to #5.
1630	#7 racked sunken buoy on bottom connected by pendant line.
1900	#5 anchor decked and cleared on Lady Vilma commenced heaving in. Rigging up to retrieve #7 crown wire and buoy.
2200	#5 racked. Lady Vilma to #8.
2330	#8 racked. Weather deteriorating.
	wx Barometer 995.5 Wind 205° x 35-40 knots Sea 215° x 6 feet Swell 215° x 12 feet

UNMOORING

2 August 1975

0545	Lady Vilma ordered to #4 to attempt recovery of buoy; attempt aborted. Rig to heave #4 chain short.
0630	Bitter end of #4 chain at fairlead, chain must have parted during storm of 1.8.75 (subsequently found to have parted at Kenter link approximately 1500 ft. from anchor).
0700	Lady Vilma to pick up #7 crown wire and buoy. Lady Vilma unable to approach close enough to rig. Rig to recover crown wire and buoy.
1330	#7 buoy recovered. Rig to attempt pull #1 anchor and leave Lady Vilma at location to pick up #4 when weather moderates.
1530	Abandoned attempt to recover #1 anchor, swells too heavy.

3 August 1975

0530	Lady Vilma to attempt recovery of #4 anchor and chain.
0700	#4 anchor on deck of Lady Vilma.
0830	Commenced heaving #1 chain.
0945	#1 anchor off bottom.
1015	Recovered #1 anchor buoy. Departed Resolution-1.

WEATHER LOG 31 JULY 1975 - 3 AUGUST 1975

31 July 1975

1200	Baro 1009.5 Wind 320° x 35-45 knots Sea 320° x 6-7 ft. Swell 320° x 8 ft.
1600	Baro 1007.0 Wind 320° x 30-40 knots Sea 320° x 6-7 ft. Swell 320° x 8 ft.
2000	Baro 1003.5 Wind 325° x 30-40 knots Sea 325° x 8 ft. Swell 320° x 8 ft.
2400	Baro 990.0 Wind 325° x 40-50 knots Sea 325° x 10 ft. Swell 325° x 8 ft.

1 August 1975

0400	Baro 994.0 Wind 345°x 25 knots Sea 345° x 6 ft. Swell 345° x 8 ft.
0800	Baro 992.5 Wind 315° x 60-85 knots Sea 315° x 10 ft. Swell 315° x 10 ft.
1200	Baro 988.0 Wind 315° x 40-50 knots Sea 315° x 8 ft. Swell 315° x 10 ft.
1600	Baro 988.0 Wind 325° x 20 knots Sea 325° x 5 ft. Swell 325° x 8 ft.
2000	Baro 992.2 Wind 215° x 35 knots Sea 215° x 5 ft. Swell 215° x 12 ft.
2400	Baro 995.5 Wind 215° x 35-40 knots Sea 215° x 6 ft. Swell 215° x 12 ft.

2 August 1975

0400	Baro 998.5 Wind 225° x 30-40 knots Sea 225° x 6 ft. Swell 225° x 12 ft.
0800	Baro 1002.0 Wind 225° x 30-45 knots Sea 225° x 6 ft. Swell 225° x 12 ft.
1200	Baro 1006.3 Wind 220° x 40-50 knots Sea 220° x 8 ft. Swell 220° x 12 ft.
1600	Baro 1010.0 Wind 220° x 35-45 knots Sea 220° x 8 ft. Swell 220° x 14 ft.
2000	Baro 1016.5 Wind 210° x 25-30 knots Sea 220° x 6 ft. Swell 220° x 12-14 ft.
2400	Baro 1019.9 Wind 210° x 25-30 knots Sea 210° x 5 ft. Swell 210° x 12 ft.

WEATHER LOG

3 August 1975

0400	Baro 1023.0 Wind 205° x 20 knots Sea 205° x 3 ft. Swell 210° x 10 ft.
0800	Baro 1024.8 Wind 205° x 12 knots Sea 205° x 1 ft. Swell 210° x 10 ft.

APPENDIX 3.

SIDEWALL CORE DESCRIPTIONS

SIDEWALL CORE DESCRIPTIONS

Sidewall core depths refer to the Run 2B Gamma Ray Log. This log was accidentally run 1.3 m higher than the Run 2B Sonic Log.

Core No.	Depth (m BDF)	Description
1	1908.5	SANDSTONE: white, very fine to fine grained, occasional coarse grains, subangular to subrounded, poorly sorted grains, firm, argillaceous, slightly calcareous, tight. Contains secondary fibrous zeolite (thomsonite).
2	1893.5	No recovery.
3	1877.5	ARGILLACEOUS SANDSTONE: medium grey, very fine to silt grade, subangular to subrounded, poorly sorted grains, firm, slightly calcareous, pyritic, micaceous, tight. Vein of massive dolomite mineral.
4	1797.5	ARGILLACEOUS SANDSTONE: as for core 3, but light grey, slightly cleaner.
5	1776.0	SANDSTONE: light grey, very fine grained, subrounded, well sorted grains, firm, non-calcareous, slightly argillaceous, glauconitic, high porosity.
6	1772.0	SANDSTONE: as for core 5, but calcareous and slightly micaceous.
7 8	1758.5) 1740.0)	SANDSTONE: as for core 5, but buff coloured.
9	1704.5	SANDSTONE: as for core 5, but buff coloured and with occasional fragments of lignite and some grains of crystalline quartz.
10	1685.0	SANDSTONE: as for core 5, with occasional fragments of lignite.
11	1668.0	SANDSTONE: light brown, very fine grained, subangular to subrounded, poorly sorted grains, firm, non-calcareous, pyritic, glauconitic, high porosity.
12 13	1660.0) 1640.0)	SANDSTONE: buff, very fine to fine grained, subrounded to rounded, moderately sorted grains, soft, clean, high porosity.
14 15	1610.0) 1590.0)	SANDSTONE: white, very fine to fine, occasionally medium grained, rounded, moderately sorted grains, soft, clean, high porosity.
16	1581.0	SANDSTONE: as for core 14, but medium, occasionally coarse grained.
17	1577.0	No recovery.

18	1574.5	SANDSTONE: light grey, very fine to fine grained, subangular to subrounded, poorly sorted grains, soft, silty matrix, medium porosity.
19	1572.0	SANDSTONE: buff, very fine to fine grained, subrounded, moderately sorted grains, soft, silty matrix, high porosity.
20	1567.5)	SANDSTONE: dark grey and green, fine to very fine grained, subangular to subrounded, poorly sorted grains, hard, pyritic, glauconitic, porosity variable, locally very high. Some organic carbonate, feldspar, magnetite, epidote, zircon, glauconite, volcanic glass and palagonite tuff.
21	1566.0)	
22	1562.0)	
23	1560.0)	
24	1557.0)	SANDSTONE: light grey, very fine to fine grained, rounded, well sorted grains, soft, non-calcareous, very high porosity. Minor glauconite in cores 26, 28 and 30.
25	1546.5)	
26	1534.0)	
27	1532.0)	
28	1528.5)	
29	1525.0)	
30	1510.0)	
31	1508.5	No recovery.
32	1480.0)	BASALTIC TUFF: dark grey and green, fine grained, angular shards of devitrified volcanic glass. Numerous crystals of magnetite and pyrite. Rare feldspar and augite. Rare carbonate and glauconite, possibly contamination.
33	1478.0)	
34	1474.5	MUDSTONE: dark grey, firm, non-calcareous, sandy, slightly glauconitic, pyritic.
35	1462.4)	MUDSTONE: medium grey, firm, non-calcareous, slightly glauconitic.
36	1450.0)	
37	1443.0	MUDSTONE: medium grey, firm, non-calcareous, sandy, highly glauconitic.
38	1428.0)	MUDSTONE: brown, firm, silty, glauconitic, calcareous.
39	1396.5)	
40	1387.0)	SILTY MUDSTONE: brown, firm, calcareous.
41	1380.0)	
42	1348.0)	
43	1338.0)	
44	1335.0)	SILTY MUDSTONE: light grey, fine, calcareous.
45	1332.0)	
46	1330.0)	

47	1328.0	SANDY LIMESTONE: light grey, very fine grained, grainstone texture. Quartz grains are rounded. Minor glauconite, feldspar, pyroxene, magnetite and pyrite. Minor tuffaceous material. Medium porosity.
48	1323.0)	LIMESTONE: white, wackestone, firm sandy, no visible porosity. Pinpoints of glauconite in cores 48 and 51.
49	1320.0)	
50	1318.5)	
51	1312.5)	
52	1308.5)	
53	1306.5	SANDY LIMESTONE: white, fine grained, grainstone texture, highly glauconitic. Grains consist of shell fragments, microfossils, glauconite, quartz, feldspar and a quartz-rich, medium grained igneous rock. Quartz is largely angular. Rare titanaugite and zeolite.
54	1299.0)	SANDY LIMESTONE: white to light grey, very fine to fine grained, grainstone texture, high porosity. Grains consist predominantly of shell fragments and microfossils. Subordinate quartz, rounded clouded and pitted. Very rare fragments of zeolitized volcanic glass.
55	1292.0)	
56	1285.0	SILTY MUDSTONE: medium grey, firm, sandy, calcareous.
57	1247.0	SILTY MUDSTONE: medium grey, firm, sandy, calcareous, very glauconitic.
58	1229.0)	SILTY MUDSTONE: light grey, soft, calcareous.
59	1225.0)	
60	1221.5	No recovery.

APPENDIX 4.

BIOSTRATIGRAPHY

by Dr. N. de B. Hornibrook et al,

N.Z. Geological Survey, D.S.I.R.

(Biostratigraphic data sheets are enclosed as Enclosure 15).

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CONFIDENTIAL

REPORT ON THE BIOSTRATIGRAPHY OF RESOLUTION No. 1 OFFSHORE WELL

By N. de B. Hornibrook,
J.I. Raine and G.T. Wilson

DATE: August 1975

David Kear
Director

NEW ZEALAND GEOLOGICAL SURVEY

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Refer to this report as:
N.Z.G.S. UNPUBLISHED REPORT

Introduction

Resolution No. 1 Well was drilled by BP Shell Todd (Canterbury) Services Ltd. at Long. 172 deg. 38 min. 10.8 sec E, Lat. 44 deg. 11 min, 16.94 sec S, south of Banks Peninsula, in July 1975, using the 'Glomar Tasman'.

The New Zealand Geological Survey examined and reported on the microfossils from cuttings during drilling so as to provide day to day information on progress. This report summarises the information from all the cuttings and sidewall samples examined.

N. de B. Hornibrook dealt with the foraminifera, assisted by Dr C.P. Strong, Mr A. Trask and Miss E.D. Souter. Dr A.G. Beu provided notes on the mollusca. J.I. Raine, and G.T. Wilson, assisted by Miss Y. Crosbie, dealt with the palynofloras and dinoflagellates.

No samples were taken above 380 m. All foraminiferal samples were washed over a 200 mesh sieve.

Ages are given in New Zealand Stages (Table 1).

Ed. Note

Geographical co-ordinates of Resolution-1 are:

Latitude: 44° 11' 16.20" S

Longitude: 172° 36' 09.69" E

Foraminifera. (N. de B. Hornibrook) (See log sheets 1-10 in pocket).

395 m - 445? m

Foraminifera: Haeuserella parri, H. finlayi, Siphotextularia mestayeri, Robulus calcar, Pseudopolymorphina sp., Pseudonodosaria aperta, Quinqueloculina sp., Biloculina sp., Bulimina aculeata, Bolivina wanganuiensis, B. parri s.l., Bolivinita pliozea, Euuvigerina pliozea, Rectobolivina striatula, Cassidulina carinata, Nonionellina flemingi, Astrononion parki, Anomalinoides parvumbilia, Notorotalia zelandica (abundant), N. finlayi, Cibicides deliquatus.

This general assemblage is characteristic of the Nukumaruan Stage in a fairly shallow water environment (less than 50 m?).

Mollusca (395-400 m by A.G. Beu); notes from fragments.

Bivalvia: Chlamys sp., interspace between 1 pr. of ribs only, large specimen originally - indet.
?Lima sp., ribbing like waipipiensis group.
Nemocardium (Pratulum) pulchellum (Gray), frags abundant definitely coarser than quinarium, i.e. post-Wp.
?Dosina sp. - shell and hinge frags of a large venerid common, prominent thin concentric ribs.

Gastropoda: Zeacolpus (Stiracolpus) symmetricus (Hutton), several; one a fairly complete juvenile. Agree with Marwick's figs. closely. Age is "Waitotaran" to Hawera in North Canterbury (probably Wp-H).

Barnacle plates abundant (mostly broken but fresh), echinoid spines and plates sparse, bryozoans sparse.

Age: Wm-H or younger; a Nukumaruan age seems quite compatible. Chlamys is just as likely to be gemmulata as delicatula.

445 m - 640 m

Foraminifera: Haueslerella morgani, Quinqueloculina sp.*, Biloculina sp.*, Robulus calcar, Bulimina aculeata, Euuvigerina pliozea, Nonionellina flemingi, Bolivinita pliozea, Astrononion parki, Sphaeroidina bulloides, Bolivina fyfei (595-600 m), Notorotalia finlayi*, N. kingmai, N. taranakia, N. hurupiensis (595-600 m), N. zelandica*, Cibicides molestus (common), C. deliquatus.

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* Species with an asterisk are considered contamination.

The Notorotalia assemblage, together with Cibicides molestus, indicates Waipipian or Opoitian age; there seems no way of being certain of which in this very shallow water facies. The Mangapanian is apparently missing.

640 m - 700 m

Only a few foraminifera, of the same species as occur in the overlying interval were found. The cuttings are mainly shell grit and indicative of a very shallow, nearly littoral facies, probably lacking autochthonous foraminifera.

700 m - 1220 m

Textularia miozea indicating Tongaporutuan age is in cuttings from 700-710 m, accompanied by a shallow water, inner shelf assemblage: Quinqueloculina sp., Biloculina sp., Pyrgo sp., Robulus calcar, Euuvigerina costate sp., Nonionellina flemingi, Cornuspira sp. and Notorotalia pristina (large and abundant).

Below this level the microfaunas indicate a steadily increasing depth of deposition. Planktonics are scarce at 790-800 m (only a few Globigerina bulloides and G. decoraperta) and they gradually increase in numbers downwards. The first Globorotalias occur between 1100 and 1200 m and gradually increase in numbers, suggesting a transition from depths equivalent to a mid shelf to an outer shelf location. The numbers of species of benthic foraminifera increase downwards. Globorotalia miozea s.l. appears fairly commonly at around 1200 m and is suggestive of depths equivalent to at least an outer shelf location. The total assemblage of the interval is as follows: Haeuslerella morgani, Textularia miozea, Siphotextularia subcylindrica, Martinottiella communis, Karreriella cylindrica, K. bradyi (1100-1110 m), Cyclammina medwayensis (1140-1150 m), Sigmoilopsis schlumbergeri (1140-1150 m), Robulus calcar, R. loculosus, R. echinatus, Lenticulina mamilligera, Saracenaria italica, Amphicoryne hirsuta, Dentalina spp., Nodosaria spp., Vaginulinopsis recta, Lingulina avellanoides, Bolivina lapsus, B. affiliata, B. barnwelli, B. albatrossi, B. watti, Rectobolivina maoria, Bolivinita pohana (990-1000 m), B. quadrilatera (1100-1110 m), Euuvigerina rodleyi, E. aff. paeniteres, E. hispid sp., Siphouvigerina eketahuna, Plectofrondicularia pohana, Ehrenbergina osbornei, Evolvocassidulina orientalis, Cassidulina carinata, Bulimina cf. aculeata, Astrononion parki, Notorotalia taranakia, N. hurupiensis, N. pristina, Anomalinoides parvumbilia, A. sphericus, A. subnonionoides, *A. miosuturalis*, *A. vitrinodus*, *Gyroidinoides zelandicus*, *G. altispira*, *Pullenia bulloides*, *Hoeglundina elegans*, *Laticarinina pauperata*, *Siphonina australis*, *Cibicides molestus*, *C. deliquatus*, *C. thiaracuta*, *C. finlayi*, *C. amoenus*, *C. robertsonianus*, *Globigerina decoraperta*, *G. bulloides*, *Globorotalia mayeri continuosa* (1100-1110), *G. miozea* s.l. (1140-1150 m).

1220 m - 1237 m

The foraminifera of this interval differ from those of the basal part of the overlying interval only in the presence of *Globorotalia mayeri mayeri* (SWS 1225 m) which is diagnostic of Waiauan age.

1237 m - 1300 m

The side wall sample at 1247 m is strongly glauconitic and contains the following assemblage: *Haeuslerella pukeuriensis*, *Karreriella cushmani*, *K. bradyi*, *Sigmoilopsis schlumbergeri*, *Martinottiella communis*, *Robulus foliatus*, *R. coloratus*, *Nodosaria* spp., *Lingulina bartrumi*, *Globocassidulina cuneata*, *Trifarina bradyi*, *Euuvigerina miozea*, *Melonis maorica*, *Gyroidinoides neosoldanii*, *Anomalinoides macraglabra*, *A. vitrinoda*, *Cibicides perforatus*, *C. semithiara*, *C. molestus*, *Globigerina woodi*, *Globorotalia barisanensis*, *G. miozea*, *G. praescitula*, *Orbulina suturalis* (early form). It is lower Lillburnian, probably not very different in depositional environment from the overlying upper Waiauan. Most of the Waiauan and Lillburnian are either missing or highly condensed in this glauconitic sequence.

Cuttings from 1265 - 1270 m contain a very similar assemblage to those above but have *Globigerinoides glomerosus*, indicating Clifdenian age.

The side wall sample at 1285 m contains the same general assemblage plus *Hanzawaia turgida*, but without *G. glomerosus*. Cuttings from 1295 - 1300 m also have the same fauna, plus *Notorotalia wilsoni* and two specimens of *G. glomerosus*, considered to be from cavings. The interval between 1265 m and 1285 m is therefore assigned an Altonian age.

The abundance of planktonic foraminifera, together with the benthic assemblage, indicates a depth of deposition equivalent to at least outer shelf.

The underlying limestone is Lower Whaingaroan age and separated from the Altonian by a considerable age gap with no sediments of Upper Whaingaroan to Otaian age (about 10 m.y.), i.e. the equivalent of the Kokoamu Greensand, Otekaike and Weka Pass Stone and Gee Greensand or Lower Grey Marls are missing.

1300 m - 1330 m

Six side wall samples from white chalky limestone in this interval contain a foraminiferal assemblage of Lower Whaingaroan age (G. angiporoides angiporoides - Zone of Jenkins) including:: Arenodosaria antipoda, Karreriella bradyi, Vulvulina granulosa, Bolivinopsis cubensis, Vaginulinopsis hochstetteri, Rectuvigerina striatissima, Melonis maorica, Sphaeroidina bulloides, Globocassidulina cf. subglobosa, Pullenia quinqueloba, Anomalinoides orbiculus, Cibicides collinsi, C. cf. perforatus, C. robertsonianus, C. pro-novozelandicus, Rotoliatina sulcigera, Chiloguembelina cubensis, and abundant Globigerina angiporoides. The depositional environment of this limestone was probably fairly deep, equivalent to outer shelf or beyond. It can be correlated with the Amberley Limestone of North Canterbury and the MacDonald Limestone of North Otago.

1330 m - 1380 m

The side wall samples at 1332 m contain the following foraminifera of Runangan age: Bathysiphon sp., Textularia cuspis, Schenckiella levis, Vaginulinopsis hochstetteri, Bolivina pontis, Euuvigerina bortotara, Rectuvigerina post-prandia, Globocassidulina cf. subglobosa, Oridorsalis umbonatus, Cibicides cf. perforatus, C. parki, Globanomalina micra, Globigerina angiporoides, and Globigerapsis index. The Runangan index sp. Bolivina pontis was not found in the side wall sample at 1335 m which contains additionally, Candeina zeocenica and Globanomalina micra and is either Runangan or Kaiatan age.

The side wall sample at 1338 m is considered to be Kaiatan age principally because it contains Sphaeroidina variabilis and Gaudryina reussi and the following assemblage: Arenodosaria antipoda, Cyclammina incisa, Ammodiscus incertus, Plectofrondicularia whaingaroica, Bulimina truncanella, Euuvigerina bortotara, Cibicides parki, C. semithiara, Anomalinoides orbiculus, Globorotalia aculeata, G. nana, Globigerina angiporoides minima, G. linaperta, Globigerapsis index. The typically Kaiatan species, Bolivina cf. moodyensis occurs in the next side wall sample at 1348 m. The underlying interval down to the first appearance of Bortonian species is correlated with the Kaiatan.

Planktonic species are small and not particularly abundant and the benthic assemblage suggests a depth of deposition equivalent to about outer shelf.

1380 m - 1415 m

The side wall core at 1380 m yielded the following Upper Bortonian microfauna: Bathysiphon sp., Cyclammina incisa, Robulus hampdenensis, Nodosaria spp., Guttulina sp., Vaginulinopsis hochstetteri, Plectofrondicularia whaingaroica, Euuvigerina bortotara, Rectuvigerina prisca, Bulimina bortonica, B. pupula, Anomalinoides semiteres, Cibicides parki, C. hampdenensis, Pseudogloboquadrina primitiva, Truncorotaloides collactea, Globigerina linaperta, Globigerapsis index, Zeauvigerina zelandica, Z. parri. The Bortonian index species Gaudryina proreussi appears in cuttings from 1380-1385 m and remains common thereafter. The Bortonian species Plectina aggrestior is present in cuttings from 1400-1405 m and 1410-1415 m (with Marginulinopsis spinobesa). Lower Bortonian, with Euuvigerina wanzea, is present between 1396 m and 1415 m but Porangan is either missing or unrecognized.

1415 m - 1465 m

Cuttings from this interval contain mostly Bortonian foraminifera from cavings but the appearance of Elphidium hampdenense in a sample from 1410-1415 m definitely indicates Heretaungan age. Elphidium hampdenense is also present in side wall samples from 1428 m and 1443 m, and Globorotalia crater (Dm-Dh) is also present at 1443 m. Below 1443 m the age was not able to be determined exactly. The side wall sample at 1450 m is mostly drilling mud with minor glauconite. Calcareous foraminifera become progressively less common and the side wall sample from 1462.5 m contains an assemblage of agglutinated foraminifera, indicative of shallow water but undiagnostic of age.

1465 m - 1490 m

The side wall sample from 1474.5 m is a non-calcareous glauconitic sandstone containing a shallow water assemblage of agglutinated foraminifera. The association of Bolivinopsis compta and B. spectabilis indicates Teurian age and correlation with the Waipara Greensand.

1490 m - 1675 m

The white quartzose sands in this interval yielded no foraminifera and are either non-marine or very marginally marine.

1675 m - 1900 m

Only the following three species of foraminifera found in the cuttings from this interval are autochthonous: *Cyclammina elegans*, *Gaudryina healyi* and *Bathysiphon* sp. *Gaudryina healyi* is diagnostic of Haumurian age and occurs only in cuttings from 1695-1700 m.

This assemblage is typical of shallow facies of Haumurian age, the same species being present in the Haumurian Laidmore Formation (Saurian Sands) in North Canterbury.

Palynology (J.I.Raine & G.J.Wilson)
Three side-wall cores were prepared for palynological Study: after careful washing and scraping to remove drilling mud, a standard HF/HCl/flotation/Schulze oxidation technique was used, residues being mounted in glycerine jelly.

The best preserved microflora was obtained from 1740m (L7130), the sample from 1685 m (L7129) was slightly more poorly preserved, while the highest sample, from 1478 m (L7128) was very poor. It is not clear whether this variation in preservation is due to pre-depositional corrosion or diagenesis: in all three samples miospores and microplankton are yellow-brown or brown in colour.

Miospores and microplankton are listed in Table 2. Reference sections for miospore material of this age are the Waipara River, Waipawa and Te Uri Stream sections studied by Couper (1960) in N.Z.Geological Survey Pal.Bull.32.

Side-wall core 1478 m (L7128)
This sample yielded a very poor assemblage which differed markedly from the lower two samples in the presence of *Nothofagus waipawaensis* and *Triorites minor*. *T.minor* is a long-ranging form which appears to be more frequent in the Dannevirke Series than in the Haumurian, while the former species has been regarded as a Teurian index form, with apparently consistent results.

The sparse dinoflagellate cysts in this sample are not diagnostic.

Side-wall core 1685 m (L7129)
The miospore assemblage from this sample closely resembles that from 1740 m. Although fewer stratigraphically useful species were recorded, the occurrence together of *Nothofagus Kaitangata* and *Caryophyllidites polyoratus*, together with the absence of *Triorites harrisii* and Myrtaceae suggests a Haumurian age.

The association of *Deflandrea acutula* and *Cribroperidinium* cf. *edwardsi* indicate a Maastrichtian age and the presence of predominantly Danian form, *Cassidium fragilis*, confirms an age very close the the Mh/Dt boundary.

Side-wall core 1740m (L7130)
This sample contained a microflora of miospores and dinoflagellate cysts dominated by *Microcachryidites antarcticus*, *Phyllocladidites mawsonii*, *Nothofagus Kaitangata*, *Tricolpites* spp, lycopods, and the dinoflagellate *Deflandrea cretacea*

The assemblage is not younger than Haumurian on the basis of *Camarozonosporites ohaiensis*, *Nothofagus Kaitangata* and *Tricolpites lillei*, and the absence of Tertiary forms such as *Haloragacidites harrisii* and Myrtaceae. The presence of abundant *Proteacidites* and *Tricolpites* spp. and the forms of *Proteacidites parvus* and *Caryophyllidites polyoratus* which appear in the Haumurian of the Waipara section and range into the Tertiary, suggest a Haumurian age for the sample. *Tricolpites waiparaensis* was recorded by Couper in the Waipara section only in the upper part of the 'Saurian Sands', and the assemblage is in general very similar to those from this formation.

The association of the dinoflagellates _Deflandrea cretacea_ and _Cribroperidinium_ cf. _edwardsi_ indicate a late Senonian age (probably Mh) and both species have been reported from the uppermost Cretaceous of the Campbell Plateau.

TABLE 1 NEW ZEALAND CRETACEOUS AND TERTIARY SERIES AND STAGES.

SERIES	STAGES		MAP SYMBOL		INTERNATIONAL	
Hawera						
Wanganui	Putikian	Castlecliffian	Wu	Wc	Quaternary	L
	Okehuan		Wk			
	Marahauan	Nukumaruan	Wa	Wn		E
	Hautawan		Wh			
	Mangapanian	Waitotaran	Wm	Ww	Pliocene	L
	Waipipian		Wp			M
	Opoitian			Wo		E
Taranaki	Kapitean			Tk	Miocene	L
	Tongaporutuan			Tt		
Southland	Waiauan			Sw		M
	Lillburnian			Sl		
	Clifdenian			Sc		
Pareora	Altonian			Pl		E
	Otaian			Po		
Landon	Waitakian			Lw	Oligocene	
	Duntroonian			Ld		
	Whaingaroan			Lwh		
Arnold	Runangan			Ar	Eocene	L
	Kaiatan			Ak		
	Bortonian			Ab		M
Dannevirke	Porangan			Dp		
	Heretaungan			Dh		
	Mangaorapan			Dm		E
	Waipawan			Dw		
	Teurian			Dt	Paleocene	
Mata	Haumurian	*Inoceramus matotorus*		Mh	Maastrichtian	
	Piripauan	*I. australis, pacificus*		Mp	Campanian	
Raukumara	Teratan	*I. nukeus, opetius*		Rt	Santonian	approximate
	Mangaotanean	*I. bicorrugatus*		Rm	Coniacian	
	Arowhanan	*I. rangitira*		Ra	Turonian	
Clarence	Ngaterian	*I. fyfei, tawhanus, hakarius*		Cn	Cenomanian	
	Motuan	*I. ipuanus, urius*		Cm	Albian	
	Urutawan	*I. kapuus*		Cu		
Taitai	Korangan	*Maccoyella*		Uk	Aptian	

TABLE 2, Taxonomic list for Palynologic Samples

	1740m L7130	1685m L7129	1478m L7128
BRYOPHYTA:			
Annulispora sp.	x		
Cingutriletes clavus (Balme) Dettm.	x		
Stereisporites cf.antiquasporites (Wilson & Webster) Dettm.	x		
Stereisporites sp	x		
PTERIDOPHYTA:			
Baculatisporites comaumensis (Cooks.) Pot.	x	x	
Blechnum sp.	x	x	
Camarozonosporites ohaensis (Couper) Dettm. & Playford	x		
Ceratosporites cf.equalis Cooks.& Dettm.	x	x	
Cyathidites minor Couper		x	
Ischyosporites gremius Stover		x	
Lycopodiacidites sp.	x		
Lycopodiumsporites sp.A	x	x	
Lycopodiumsporites sp.B		x	
Osmundacidites sp.	x		
Dictyophyllidites concavus Harris	x		
Gleicheniidites cf.circinidites (Cooks.) Dettm.	x		
GYMNOSPERMAE:			
Cupressaceae	x	x	
Dacrydium sp.	x	x	
Phyllocladidites mawsonii Cooks.	x	x	
Microcachryidites antarcticus Cooks.	x	x	x
Podocarpidites cf.marwickii Couper	x		x
Podocarpidites spp.	x	x	x
Zonalapollenites sp.	x		
ANGIOSPERMAE:			
Caryophyllidites polyoratus Couper	x	x	
Liliacidites spp.	x		
Nothofagus kaitangata Te Punga	x	x	
N.waipawaensis Couper			x
Proteacidites minimus Couper	x	x	
P.parvus Cooks.	x	x	
P.subpalisadus Couper.	x	x	
P.cf.subscabratus Couper	x		
Proteacidites sp. D	x	x	
Proteacidites sp. indet.			x
cf.Tetracolporites sphericus Couper	x		
Tricolpites gillii Cooks.	x	x	x
T.lilliei Couper	x		
T.waiparaensis Couper	x		
Tricolpites spp.	x	x	
Tricolporites sp.	x		x
Triorites cf fragilis Couper	x		
T.minor Couper			x
DINOPHYCEAE:			
Cassidium fragilis (Harris) Drugg		x	
Cleistosphaeridium sp.1			x
Clesitosphaeridium sp.2			x
Cribroperidinium cf.edwardsii (Cooks.& Eis.) Davey	x	x	
Deflandrea acutula Wilson		x	
Deflandrea cretacea Cookson	x		
Deflandrea sp.			
Spiniferites cingulatus (O.Wetz.) Sarjeant	x	x	

APPENDIX 5.

PETROLOGY

by Dr. G.A. Challis,

N.Z. Geological Survey.

RESOLUTION I. PETROLOGICAL EXAMINATION OF CUTTINGS 1900m-1958m

1910m Chips of siltstone scarce. The bulk of the sample consists of loose grains and small aggregates of rounded quartz. Radiating, fibrous aggregates of the zeolite thomsonite, are plentiful. Heavy minerals are rare and no igneous fragments were noted.

1910-1920m. Sedimentary chips and grains are similar to 1910m, and make up approximately 80 percent of the sample. However, some of the quartz grains could come from a coarse-grained igneous rock, and chips of a plagioclase-quartz-titanaugite-aegerine rock were noted. Heavy minerals include titanaugite, biotite, magnetite, ilmenite and aegerine. Among the chips were scarce fragments of a black, glassy rock containing white spherules which may represent the chilled margin of an intrusion.

1925m. Almost all chips are of a medium-grained, black and white speckled igneous rock. Heavy minerals are predominantly titanaugite and ilmenite, with rarer biotite and aegerine. Quartz is a constituent of most chips, and the rock could probably be termed a quartz syenite (see later for description of similar rock from the core).

1930-1958m. Cuttings were examined at 5m intervals to a depth of 1955m, and a final sample from 1958m. In all samples, the black and white, medium-grained igneous rock was the main constituent. A larger proportion of sedimentary fragments at 1940m probably represents down-hole contamination. In the igneous rock fragments, there is a slight tendency for quartz to decrease and titan-augite to increase with depth.

RESOLUTION I. PETROLOGICAL EXAMINATION OF SIDEWALL CORES, 1877.5m & 1908.5m.

1877.5m Heavily pyritised black siltstone. Spherules of pyrite suggest that some is biogenic. The siltstone is crossed by a

/...

1.5mm wide vein of a crystalline white material that was identified by optical and X-ray means as dolomitic carbonate. The material effervesces slightly in fairly concentrated acid.

1908.5m. Quartzose siltstone containing abundant radiating aggregates of the zeolite thomsonite. Aggregates reach several mm in diameter. The siltstone is not indurated, and thin sections could not be made without vacuum impregnation equipment not available at present. However, grain mounts will be made available shortly.

The presence of the vein of crystalline carbonate, and the abundant zeolite in the cuttings and sidewall cores suggest that contact effects from the intrusion extended at least 34m from the intrusion. From observations of similar contact effects near teschenite intrusions on land (Marlborough coast), the intrusion is possibly several hundred feet thick.

RESOLUTION I. PETROLOGICAL EXAMINATION OF THE CORE, 1958.2-1963.05m

Depth (m)	Rock Type
1958.2	Quartz syenogabbro
1958.5	Olivine teschenite
1958.9	Teschenite (very minor olivine)
1959.2	Olivine teschenite (cf Transition rock, Acheron)
1959.3	Leucoteschenite
1959.45	Teschenite (very minor olivine)
1959.75	Leucoteschenite
1960.3	Teschenite (rather alkaline, very minor olivine)
1960.6	Leucoteschenite (highly alkaline)
1962.3	Teschenite (very minor olivine)
1962.5	Olivine leucoteschenite (very minor titanaugite)
1962.8	Olivine teschenite (cf 1959.2m)
1963.05	Olivine Leucoteschenite.

/...

<u>Quartz syenogabbro</u> 1958.2m

A coarse-grained mesocratic rock with granular and sub-ophitic titanaugite locally rimmed with green aegerine augite. The plagioclase is strongly zoned from labradorite to sodic oligoclase, and is often rimmed by anorthoclase. Ilmenite is abundant, in large, probably late-phase, grains. Fine-grained patches of quartz, green biotite, apatite and chlorite are developed locally.

This rock bears very strong similarities to the quartz syenogabbro of the Acheron Outlier, Canterbury.

<u>Olivine teschenite</u> 1958.5m, 1959.2m, 1962.8m

Medium-grained, mesocratic rocks containing abundant large crystals of titanaugite ophitically enclosing olivine and plagioclase. The titanaugite is locally replaced by Ti-hornblende (kaersutite) at edges. Olivine (hortonolite) is a prominant constituent of these rocks, and is more or less altered to dark green and brown alteration products, and is sometimes completely replaced by talc and granular magnetite. Plagioclase is strongly zoned labradorite to oligoclase, and sometimes rimmed by anorthoclase. Analcite is plentiful, both as patches in the groundmass, and as a replacement for feldspar. Zeolite (thomsonite) is also present as veins and patches, and bright red-brown biotite (Ti-rich), apatite, chlorite and ilmenite are plentiful accessories.

The rocks are generally similar to the olivine teschenite of the Acheron Outlier.

<u>Olivine leucoteschenite</u> 1962.5m, 1963.05m

Medium-grained leucocratic rocks, generally similar to the olivine teschenites except for a greatly decreased titanaugite content. The titanaugite that is present tends to occur as relatively small grains, rather than the large ophitic plates found in the olivine teschenites. Olivine is also less altered in the olivine leucoteschenites.

/...

Teschenite 1958.9m, 1959.45m, 1960.3m, 1962.3m.

Medium-grained mesocratic rocks containing large ophitic grains of titanaugite, which sometimes shows exsolution platelets of ? ilmenite. The plagioclase, partially replaced by analcite, is zoned labradorite to oligoclase, and rimmed by anorthoclase. Analcite is plentiful in the groundmass, and zeolite (thomsonite) is also present in a couple of rocks. Apatite, ilmenite, biotite and olivine are accessories.

The rocks are very similar to teschenites from the Acheron Outlier.

Leucoteschenite 1959.3m, 1959.75m, 1960.6m.

Medium to coarse-grained leucocratic rocks in which titanaugite is a very minor constituent. Most of the rock consists of plagioclase, strongly zoned from sodic labradorite to sodic oligoclase and usually having a fairly wide rim of anorthoclase. Analcite, partially replacing feldspar, and zeolite are plentiful. Coarse-grained apatite and ilmenite are common accessories.

Summary

These rocks are teschenitic, and in a general way may be compared to rocks in the sills and laccoliths that intrude the Piripauan (Upper Cretaceous) Coal Measures in the Acheron Outlier near Lake Coleridge, Canterbury.

However, there is no major differentiation trend shown over the comparatively small depth represented by the core, and thus, no close comparison can be made with the differentiated Acheron laccoliths. Perhaps the most significant rock is the quartz syenogabbro at the top of the core, and the quartz-bearing chips from cuttings above this. The quartz syenogabbro is similar to rocks that occur towards the top of the laccoliths in the Acheron, and it may be that the Resolution I body has differentiated in a similar manner. If this is so, the hole possibly penetrated about half the total thickness of the intrusion. The possibility that the intrusion is a fairly thick one is supported by the wide zone of contact metamorphism mentioned earlier.

RESOLUTION 1. GRAIN MOUNTS FROM CUTTINGS 1299.0-1797.5m

1299.0m. Approximately 50 percent of the grains are of carbonate, mainly fragments of shells and micro fossils. Glauconite makes up about 20 percent and quartz is the most abundant detrital mineral. The quartz grains are moderately well rounded, clouded and pitted, and show undulose extinction in many grains. Their appearance is consistant with derivation from an igneous or metamorphic source. Other detrital minerals present are microcline (sericitised), muscovite, hematite, chlorite, zircon, and augite (one grain). There are very rare fragments of a zeolitized volcanic glass (heulandite-clinoptilolite).

1306.5m. Carbonate is just sub-equal to glauconite in this sample. Both make up nearly 75 percent of the sample. Quartz is slightly more abundant than at 1299.0m, and feldspar and clay minerals are more prominant. Some quartz is rounded, but much is angular, and there are a few grains of a quartz-rich, medium-grained igneous rock. There is a small amount of highly sericitized feldspar, a few grains of titanaugite, and rare fragments of pinkish heulandite or clinoptilolite, probably formed from volcanic glass.

1328.0m. A very fine-grained sediment composed of over 50 percent carbonate grains (mainly organic), with about 45 percent quartz a little glauconite, feldspar, and rare titanaugite, apatite, diopside, magnetite and pyrite. Quartz grains are rounded, whereas feldspars and ferromagnesian minerals are angular. There is a tuffaceous content of about 2 percent, and some zeolitized (heulandite) volcanic glass.

1480.0m. A highly tuffaceous, fine-grained sediment consisting of angular shards of devitrified volcanic glass (palagonite and celadonite), with numerous perfect cubes and octahedra of magnetite and pyrite. There are rare fragments of feldspar, and some brownish-green augite. This is a basaltic tuff. Scarce grains of carbonate and glauconite probably represent contamination.

1546.5m. A fine silt-size sediment. Approximately 80 percent is well-rounded quartz grains, and fragments of quartz-rich metamorphic rocks. Feldspar grains (albite and microcline) make up most of the remainder, with scarce grains of magnetite, pyrite and carbonate. There are a few fragments of zeolitized volcanic glass.

1562.0m. Fine-grained sediment composed of about 50 percent moderately-rounded to sub-angular quartz grains, organic carbonate, devitrified volcanic glass, magnetite and rare epidote and glauconite.

/...

1567.5m. A very fine-grained sediment with about 50 percent well-rounded to sub-angular quartz grains, 30 percent organic carbonate and the remainder composed of feldspar, magnetite, pyrite, zircon and a few fragments of palagonite tuff (?contamination).

1610.0m. Silt-size sediment very similar to 1546.5m except that well-rounded quartz grains make up at least 90 percent of the sample. Organic carbonate fragments and zeolitized volcanic glass (heulandite-clinoptilolite) make up the rest of the sample. Rare zircon present.

1668.0m. Very similar to 1610.0m, with the addition of about 1 percent pyrite and hydrated iron oxides.

1758.5m. Similar to 1610.0m and 1668.0m except for a slight increase in the amount of zeolitized volcanic glass.

1776.0m. Again very similar to the three preceeding samples, with the addition of a small amount of tuffaceous material (1percent) in the form of titanaugite, magnetite, apatite and feldspar. ?Contamination.

1797.5m. Silt-grade sediment generally similar to 1610-1776m, but with higher content of sericitized feldspar, hydrated iron oxides, zircon, epidote, magnetite, and fine-grained rock fragments. The sediment from this depth appears to be rather less mature than those above.

G. A. Challis

G.A. Challis
Mineralogist
for Director

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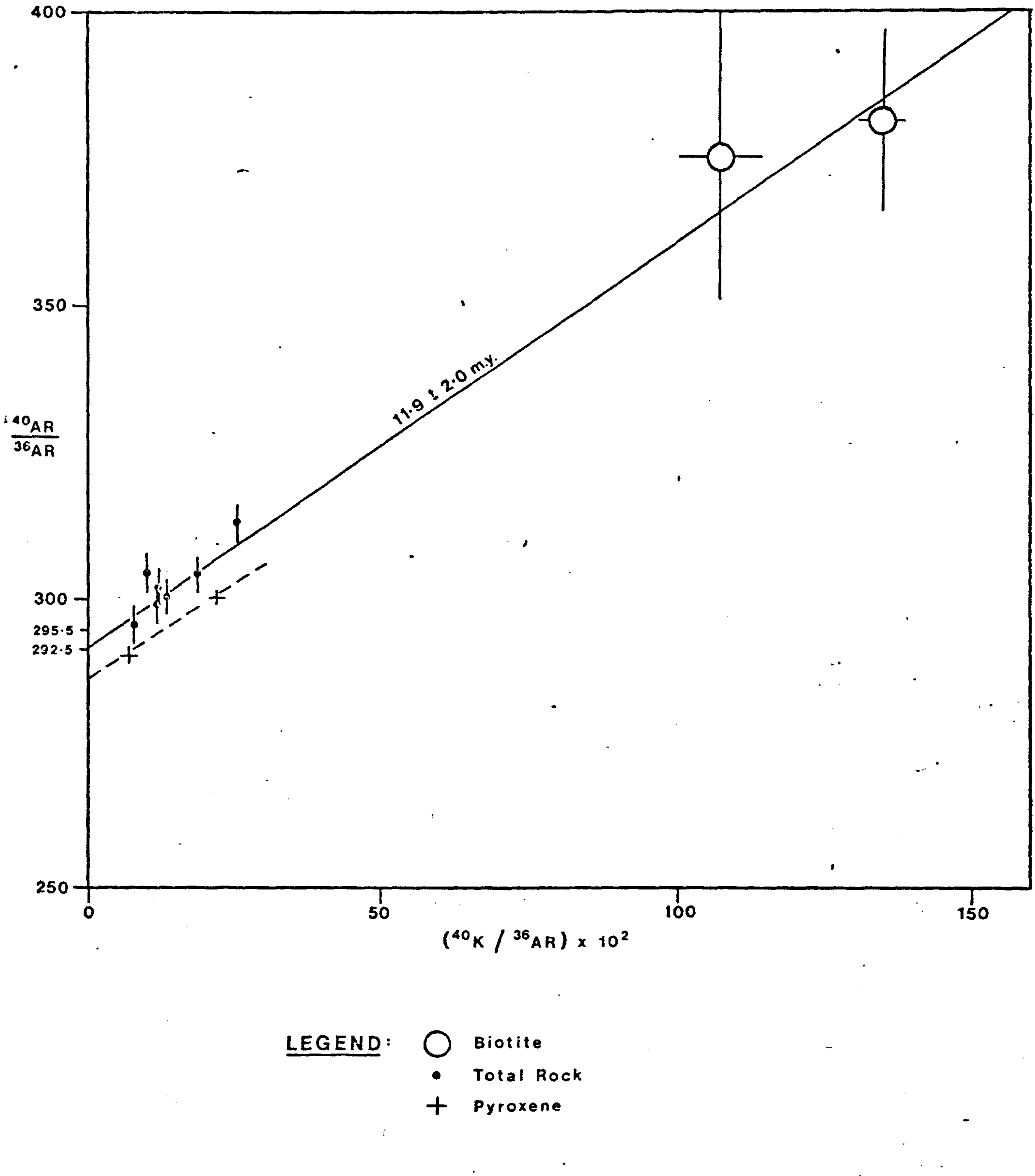
APPENDIX 6.

RADIOMETRIC DATINGS

by Dr. C.J.D. Adams,

Institute of Nuclear Sciences, D.S.I.R.

648 103



POTASSIUM/ARGON AGE DATING OF TESCHENITE TERMINAL CORE 1958-1963m. brt - RESOLUTION-1

POTASSIUM/ARGON AGE DATING OF TESCHENITE TERMINAL CORE 1958-1963 m. brt - RESOLUTION-1

INS. No.[1]	Depth (metres)	K %	$^{40}Ar/^{36}Ar$	$^{40}K/^{36}Ar \times 10^2$	$^{40}Ar(rad)^*$ nl/gm	$^{40}Ar(rad)^*$ % total	Age* m.y.
R3789TR/1)	1958.71	0.948	303.6	107.2	0.457	2	12±4
/2)	to	0.948	298.9	122.4	0.159	0.3	4±10
/3)		0.948	299.9	126.4	0.202	0.3	5±13
R3789tr/1)	1958.75	0.852	301.8	120.6	0.286	-	8±4
/2)		0.852	303.9	187.2	0.244	2	7±3
R3789cpx/1	m	0.197	300.3	222.5	0.026	3	3±1
R3790TR/1	1962.21 to 1962.25 m	0.774	294.8	83.2	-0.060	-2 !	-2±6
R3791cpx/1	1958.20 to 1958.25 m	0.846	290.9	70.1	-0.412	-3	-12±8
R3792tr/1)	1958.85	0.863	368.9	140.1	0.301	20	9±2
/2)	to	0.863	313.2	255.0	0.393	5	11±2
R3792bi/1)	1958.95	4.764	375.3	1080.0	2.336	27	12±4
/2)	m	4.257	380.6	1355.0	1.775	24	10±1

1: TR = Total rock powder - 420 + 210u, tr = total rock chips 5 mm cube, cpx = pyrozene - 420 + 210u, bi = biotite - 420 + 210u.

2: Decay constants etc. are given in NZ K-Ar Age List, NZJGG 18 (1975).

* The ^{40}Ar (radiogenic) concentrations, the 'atmospheric' argon contents and ages are calculated by making the conventional assumption that the non-radiogenic argon in these rocks is of present-day atmospheric argon composition. Since these rocks have exceptionally low radiogenic argon contents the ages and errors are extremely sensitive to any departures from this assumption. To avoid this problem the isochron presentation is preferred and the age derived by this method is not dependent upon this assumption although the error on the age remains rather large. I would prefer you to quote the isochron age rather than the conventional ages listed in the table which are obviously calculated under invalid assumptions.

<u>Note</u>: For qualifying remarks, see attached letter to Dr. P.J. Hill dated 4 December 1975.

SIR(INS) 3

TELEPHONE 666 919

All correspondence to be addressed
to Director

In replying, please quote
these numbers
INS-50/114/1-CJA

NEW ZEALAND 648 105

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
THE INSTITUTE OF NUCLEAR SCIENCES

PRIVATE BAG, LOWER HUTT

4 December 1975

Dr P. Hill,
B.P. (New Zealand) Ltd,
20 Customhouse Quay,
WELLINGTON.

Dear Peter,

Attached you will find the K-Ar dating results for the teschenite samples at the base of the Resolution No. 1 borehole. As I mentioned to you in September, these samples had extremely high concentrations of 'atmospheric' argon which almost obliterated the tiny amounts of radiogenic argon which is produced by the radioactive decay of ^{40}K. To measure this type of argon mixture, it is essential to calibrate the mass spectrometers very carefully so that we know how accurately our instruments can measure a particular isotope ratio. For this reason I have spent the last 2-3 months doing calibration measurements at the same time as dating several groups of young volcanic rocks, including your Resolution No. 1 rocks. I am now quite sure we can achieve consistent isotope ratio measurements over periods of months, and accordingly I am confident of our latest batch of results.

Despite the accuracy of the analytical measurements, dating young volcanic rocks always suffers from the severe interference problem of atmospheric argon in these rocks. Put simply, when we extract argon from such rocks about 95% is not radiogenic but was incorporated in the rock when it solidified. Most people assume that such argon is from the atmosphere and must therefore have an atmospheric argon composition similar to the present day. Since we know the $^{40}Ar/^{36}Ar$ ratio in the atmosphere we can measure the ^{36}Ar in the rock and hence calculate the corresponding amount of ^{40}Ar in the rock and subtract this from the total ^{40}Ar that we measure on the mass spectrometer. The remaining quantity, ^{40}Ar (radiogenic), is used to calculate the age but has a very high error because one is measuring a small difference between two large quantities.

In recent years, we have found also that the non-radiogenic or so-called 'atmospheric' argon need not necessarily be of exact atmospheric composition, and of course this incorrect assumption then leads to spurious ages. We therefore adopt the 'isochron' presentation of results used by Rb-Sr dating, in which $^{40}Ar/^{36}Ar$ is plotted against $^{40}K/^{36}Ar$. From this we can measure the age, which is proportional to the isochron slope, and the argon isotopic composition of the non-radiogenic argon in the rocks which is the isochron intercept, I have done this for the Resolution No. 1 samples and they indicate an age for the teschenite of about 12 $\pm$ 2 m.y. and the 'initial' argon is very close (292.5) to atmospheric argon (295.5). These are the most reliable ages for the teschenite which I would prefer you to quote. Two clinopyroxenes separated from the teschenite may fall on a different isochron line, yielding the same age, but a slight lower 'initial' $^{40}Ar/^{36}Ar$ ratio. As you can see from the error estimates of the data, the ages of these rocks have a very large error themselves and this is an unavoidable consequence of the intrinsically high non-radiogenic argon concentrations. I suspect this in itself is related to the high analcite/zeolite content which I think 'soaks' up a tremendous amount of gas during solidification of the rocks. You might know that artificial varieties of these minerals are used in the chemical industry as molecular sieves for selective gas absorption.

I hope you find the results useful and I must apologise for the long delay in getting your results to you. However, you will appreciate that this was the first time we have dated rocks like this, and we had to make absolutely sure of our calibration before handing the results out! The next time should get the results out very quickly.

Yours sincerely,

Chris Adams

(C.J. Adams)
for Director

Encl:

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APPENDIX 7.

MAGNETIC SUSCEPTIBILITY

by T.C. Mumme

Geophysics Division, D.S.I.R.

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MAGNETIC SUSCEPTIBILITY

The D.S.I.R. (Geophysics Division) were asked if they could provide an estimate of the size, shape and thickness of the teschenite body. They were provided with two pieces of core and the magnetic anomaly map produced by Fisher (1975). Using magnetic modelling programmes developed at the D.S.I.R., a number of different fits to the magnetic anomaly profile were obtained. The report from the D.S.I.R. is given below, together with a set of curves showing the fit of the model to the actual profile.

"The magnetic parameters of the two teschenite samples from Resolution-1 were measured and are listed below.

Sample	Geophys. Cat.No.	Depth (m)	Remanent Magnetisation (A/m)	Volume Susceptibility (SI)
1	7766	1958	9.840 (i.e. 9.840_{10}^{-3}emu)	5.52_{10}^{-2}(i.e. 4.39_{10}^{-3}emu)
2	7767	1962	5.918 (i.e. 5.918_{10}^{-3}emu)	4.27_{10}^{-2}(i.e. 4.39_{10}^{-3}emu)

Using a mean remanent magnetisation of 7.900 A/m and a mean susceptibility of 4.89_{10}^{-2} (SI), giving a total magnetisation of 10.2 A/m, a number of magnetic profiles were calculated for various vertical cylindrical bodies of depth 1902 metres below sea level.

The profiles were calculated across the steepest gradient of the anomaly (i.e. NW to SE) and a graph of the profiles is enclosed for your information.* From the profiles, it appears that at that depth the anomaly produced is more volume dependent than shape, the probable volume of the body being about 3×10^8 m^3.

In conclusion, I would say that though the above is apparent I would tend to favour a sill-like body of dimensions 1200 m - 1500 m radius and of thickness 55 - 75 metres. "

(Sgd) T.C. Mumme

* Enclosure 15

RESOLUTION-1

MUD & CHEMICALS DATA

Date July 1975	Remarks	Depth Metres	Mud Wt. lb/gal	Vis	PV / YP	GEL. 0/10	pH	API Fluid Loss	Pf	Pm	Salt or Chloride (ppm)	Calcium (ppm)	Sol. %	Oil %	Sand %	Temp F°	MBT#/bbl bentonite	Magco Bar	Magco Gel	Spersene	XP-20	Caustic SXS	Caustic Drums	Soda Ash	Lime	D.D.	Pipe Lax	Al. Sterate
			MUD PROPERTIES															CHEMICALS CONSUMPTION										
6	Mix spud mud																		500			85		12				
9	Spud in spot mud on connections. Magcobar use for temporary guide base.	109																312	100			32		28				
10	Drill 36" fill hole run 30" casing and cement	127																	130			8		8	18			
11	Drill 26" hole spot viscous mud on connections	313																	110			19		19				
12	Drill 26" hole fill twice with viscous mud. Prepare pit of kill mud.	390																540	500			22		22	16			
13	Ran 20" casing and cement. Ran stack and riser	390																	178			8						
14	Test B.O.P. drill cement and 17½" hole. Formation pressure check to 11.3 lb/gal	397																		50								
15	Drilling, wiper trip, survey, drilling	926	9.5	34	6/2	1/3	10.0	15.0	1.2	2.3	26000		11.0			77			180	128	45	25				1		
16	Drilling, survey, wiper trip, circulate preparing to log	1235	10.0	38	8/5	1/3	9.7	9.5	1.1	2.4	19500		11.5			97		400	200	50		14		3	2			
17	Logging R.I.H. circulate P.O.H.	1235	9.9	36	17/3	1/3	8.5	10.0	1.3	2.0	13000		12.0						10	200	100		10					1
18	Ran 13 3/8" casing	1235	9.5	35	9/7	1/16	8.4	22.0	0.2	0.8	12400		10.0		TR				140	60	30		8					
19	Cement casing, pull riser and stack	1235	9.6	34	10/7	1/12	8.5	18.0	0.2	1.0	12800	720	10.0		TR		16		43									
20	Working on stack	1235	9.3	33	8/5	1/2	8.5	23.0	2.6	4.4	14800	80	8.5		NIL		15	100					5					
21	Working on stack	1235	9.4	38	10/5	0/8	9.5	18.0	0.3	1.3	16300	80	8.0		NIL		15											
22	R.I.H. drill cement and 12¼" hole. Rig pumps incorrectly lined up. Seawater pumped into well. Pipe stuck on wiper trip at 1322 metres	1451	9.4	37	9/2	0/3	10.5	11.0	0.8	3.2	17200	300	7.5		NIL	79	16		200									
23	Spot pipe lax circulate 30 minutes pipe free 125,000 lbs pull 100,000 lbs over to shoe. Gumbo on drill string. Reduce water loss and increase P.H.	1451	9.4	37	10/2	0/2	11.0	9.0	1.5	3.8	18800	240	7.5		TR	79	16	200	210	135	70		6					
24	R.I.H. ream to bottom. Circulate and condition mud. Pull to shoe. R.I.H. 5 metres - fill	1729	9.4	37	11/2	0/2	11.0	6.0	1.1	3.1	16600	200	8.0	0.5	TR	77	18		200	20	10		9	4	6		1	
25	Drill. Wiper trip no fill. Drill circulate bottoms up. P.O.H. R.I.H. no fill	1851	9.6	40	13/3	1/4	10.5	7.0	0.5	1.8	16500	140	9.0	0.25	TR	82	22	115	9	20	15		9		8	1		1
26	Drill. Circulate prior to P.O.H. to core	1958	9.7	39	13/6	1/7	10.8	5.4	0.8	2.9	16000	160	7.0	0.5	TR	80	23		67	20	10	20	3		2			
27	R.I.H. cored 100% recovery. R.I.H. reamed rat hole condition mud to log	1963	9.7	38	9/3	1/4	11.0	6.7	1.3	3.0	16800	160	8.5	0.5	TR	86	23		56	20	10	20			4	1		
2[illegible]	Logging	1963	9.5	36	9/1	1/3	11.0	4.9	1.3	3.0	17000	140	7.0	0.5	½	-	23		38	59	30	15		2	5			
29	Preparing to abandon well	1963																		7	3							
															TOTAL			1667	2871	769	323	268	50	106	61	3	1	2

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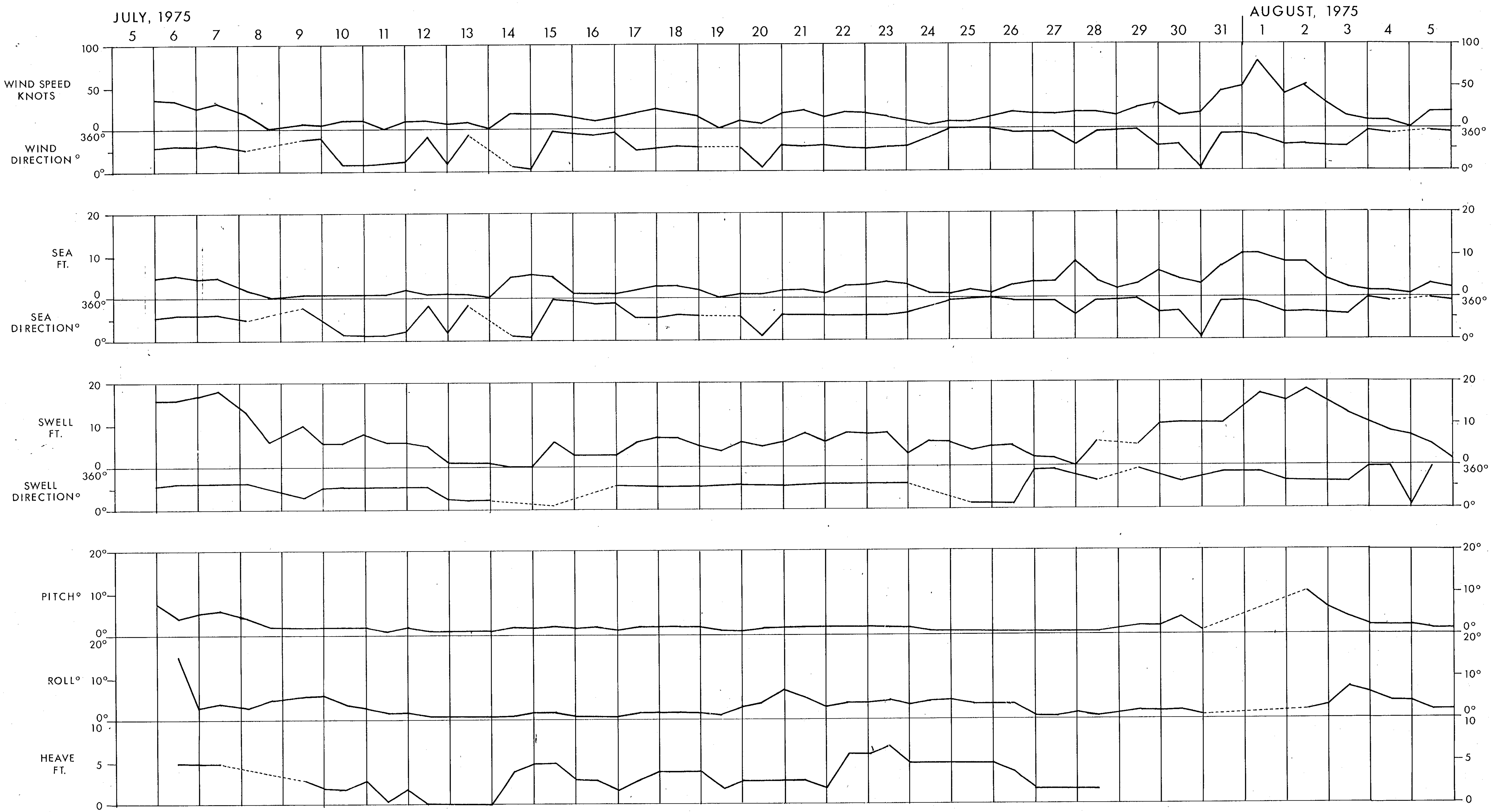
ENCLOSURE 2.



RESOLUTION No.1
SEA AND WEATHER CONDITIONS

ENCLOSURE 5

RESOLUTION 1.

WORKBOAT UTILISATION

Statistical breakdown for period:	Lady Vilma	1305 hr.	2.7.75.	to	1000 hr.	3.8.75.
	Sydney Tide	0000 hr.	2.7.75.	to	2400 hr.	3.8.75.

UTILISATION	LADY VILMA			SYDNEY TIDE		
	Days	Hours	Mins.	Days	Hours	Mins.
Steaming Time	9	09	23	8	07	12
Time on Location	17	21	15	11	08	25
Time at Nelson	3	01	30	8	08	42
Time at Lyttleton	1	12	47	4	03	12
Time at New Plymouth (SBPT a/c)					20	29
	31	20	55	33	00	00

DIESEL OIL (I. Gals.)

	Lady Vilma		Sydney Tide
On board 2.7.75.	41,400	On board 2.7.75.	23,820
Loaded Nelson	50,000	Loaded 2.7 - 3.8	29,724
Consumed on board	33,400	Consumed on board	16,854
Delivered to 'Glomar Tasman'	21,000	Delivered to 'Glomar Tasman'	12,000
Remaining 3.8.75.	37,000	Remaining 3.8.75.	24,690

BUNKER 'C' (I. Gals.)

On board 2.7.75.	40,146
Loaded during July	NIL
Transferred to 'Glomar Tasman'	40,146
Remaining 3.8.75.	NIL

DRILL WATER (I. Gals.)

	Lady Vilma	Sydney Tide
On board 2.7.75.	65,632	37,930
Loaded 2.7 - 3.8	276,864	178,340
Transferred to 'Glomar Tasman'	337,344	150,335
Pumped Overboard	5,152	22,350
Remaining on board	NIL	44,585

POTABLE WATER (I. Gals.)

	Lady Vilma	Sydney Tide
On board 2.7.75.	17,472	25,584
Loaded Nelson	25,088	35,416
Delivered to 'Glomar Tasman'	13,440	13,440
Consumed on board	8,960	31,360
Remaining on board	20,160	16,200

BULK & DECK CARGO (M. Tonnes)

	Lady Vilma	Sydney Tide
Dispatched from Nelson:		
Mud and Chemicals	353	255
Tubulars	14	380
General Cargo	11	50
Received into Nelson:		
Mud and Chemicals	NIL	NIL
Tubulars	30	282
General Cargo	15	5

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Enclosure 6.

CORE ANALYSIS

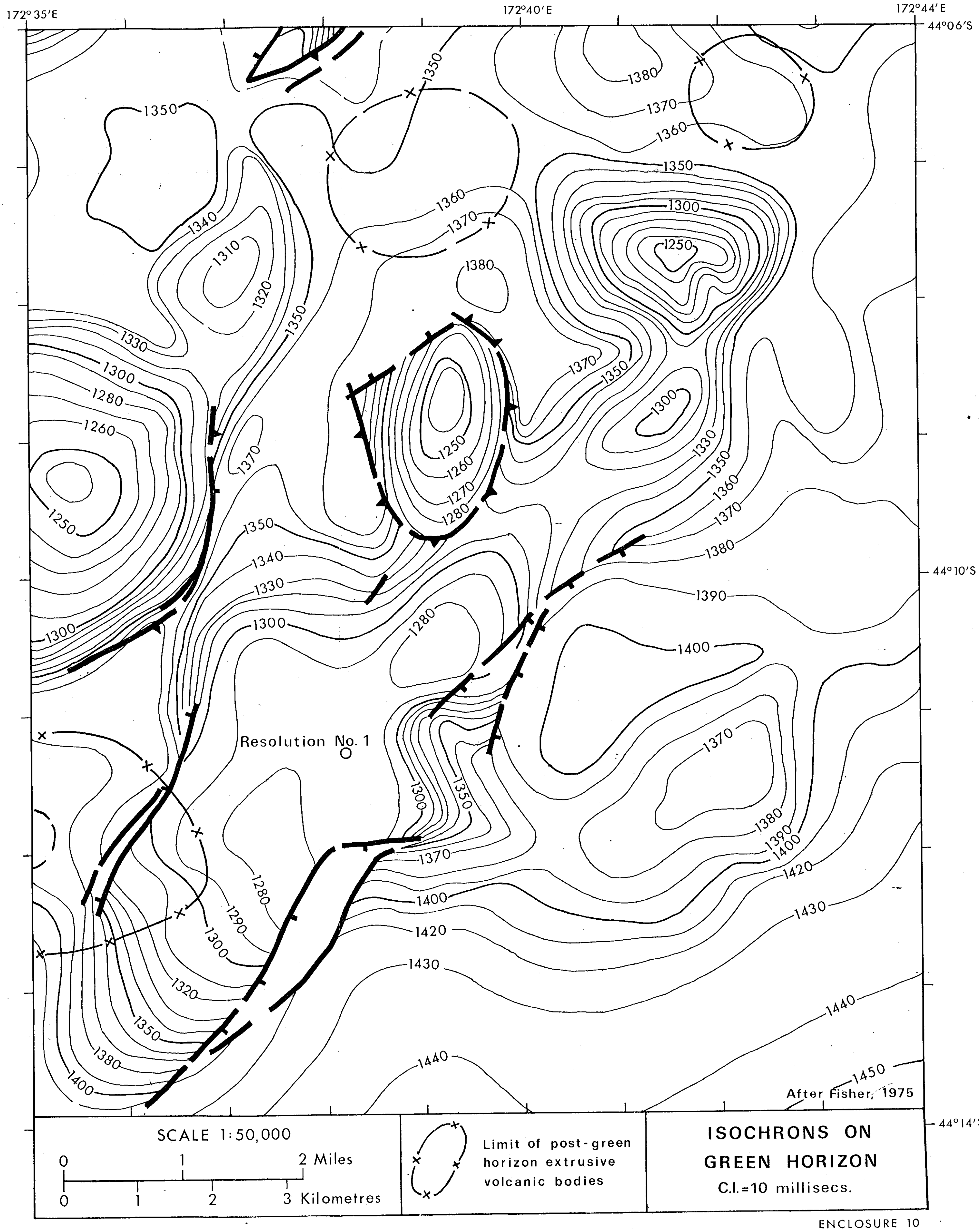
SCALE 1:20

Well No. RESOLUTION No.1

Core No.1 From 1958·00m To 1963·00m. Recovery 100%

FORMATION /AGE	LITHOLOGIC DESCRIPTION	DEPTH B.R.T. METRES DRILLED	DEPTH B.R.T. METRES LOG	GRAPHIC LITHOLOGY	SEDIMENTARY STRUCTURES	HYDROCARBON INDICATIONS	DIP OF BEDDING	FRAC-TURES	VISIBLE POROSITY	POROSITY % (AIR) (HORIZONTAL) 40 30 20 10	HORIZONTAL PERMEABILITY MDS (AIR) 5000 1000 500 100 50 10 5 1	1 0 1 2 3 4 Md Ø GRAIN SIZE 6 Ø 0 1 2	BULK DENSITY GM/CC (HORIZONTAL) 2.2 2.3 2.4 2.5 2.6 2.7 2.8	REMARKS
	TESCHENITE: leucocratic to mesocratic, medium to coarse grained basic igneous rock consisting mainly of titanaugite, olivine, plagioclase feldspar and locally, analcite. Subordinate biotite, hornblende, chlorite, ilmenite, apatite, zeolite, and locally quartz. Petrologically, the rocks in the core range from an olivine teschenite to a quartz syenogabbro.	1958·0 1959·0 1960·0 1961·0 1962·0 1963·0												

Described by Date

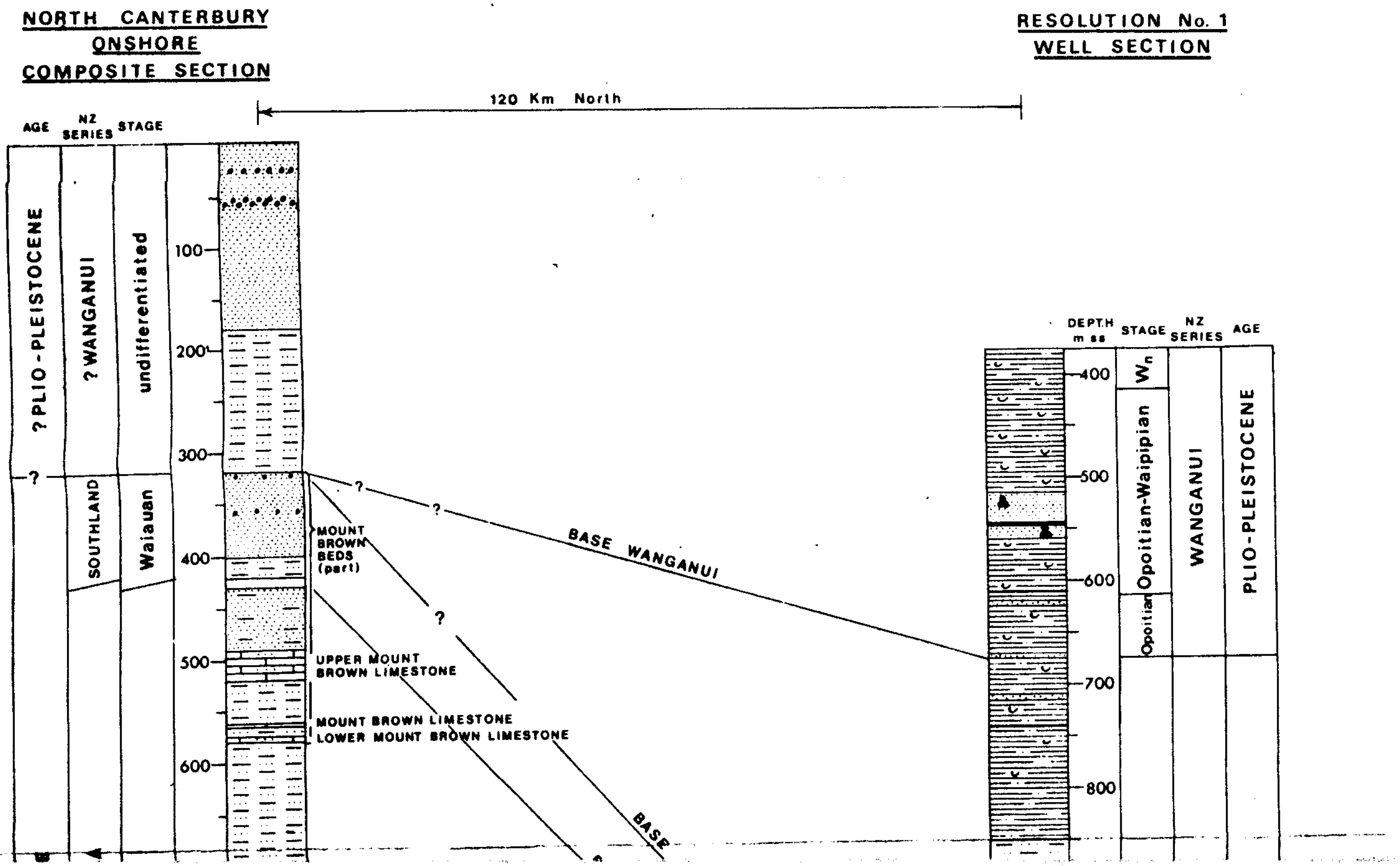

172° 35′E
172°40′E
172°44′E
44°06′S
44°10′S
44°14′S
Resolution No. 1
After Fisher, 1975
SCALE 1:50,000
0 1 2 Miles
0 1 2 3 Kilometres
Limit of post-green horizon extrusive volcanic bodies
ISOCHRONS ON GREEN HORIZON
C.I.=10 millisecs.

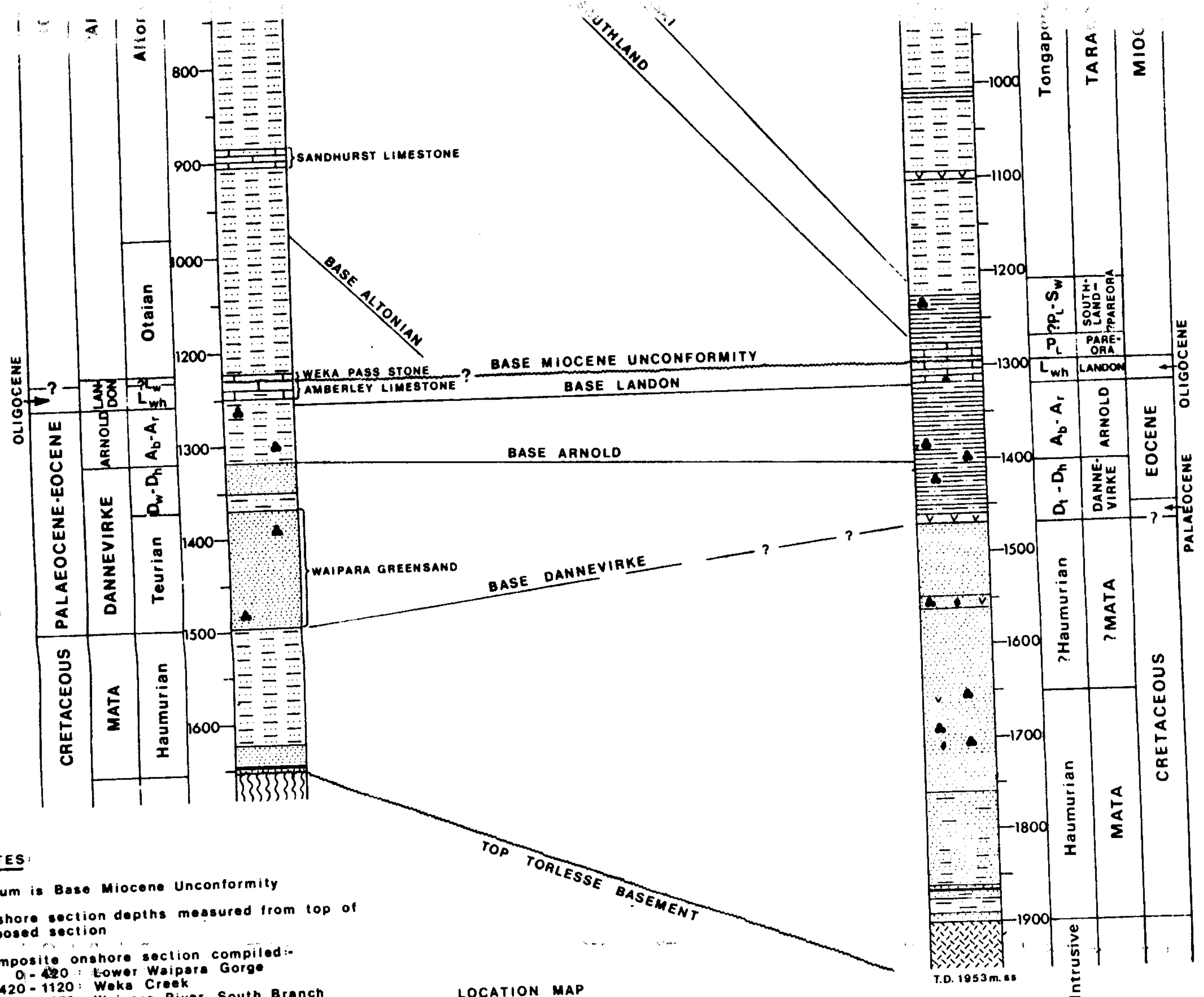
648 114

648 1_1

CORRELATION OF RESOLUTION No. 1 WITH ONSHORE NORTH CANTERBURY SECTION

VERTICAL SCALE 1:10,000

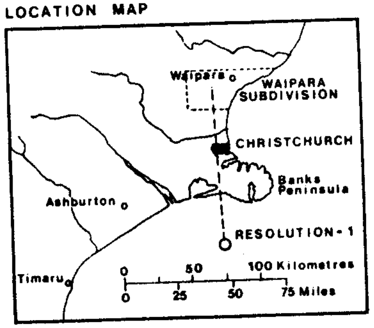




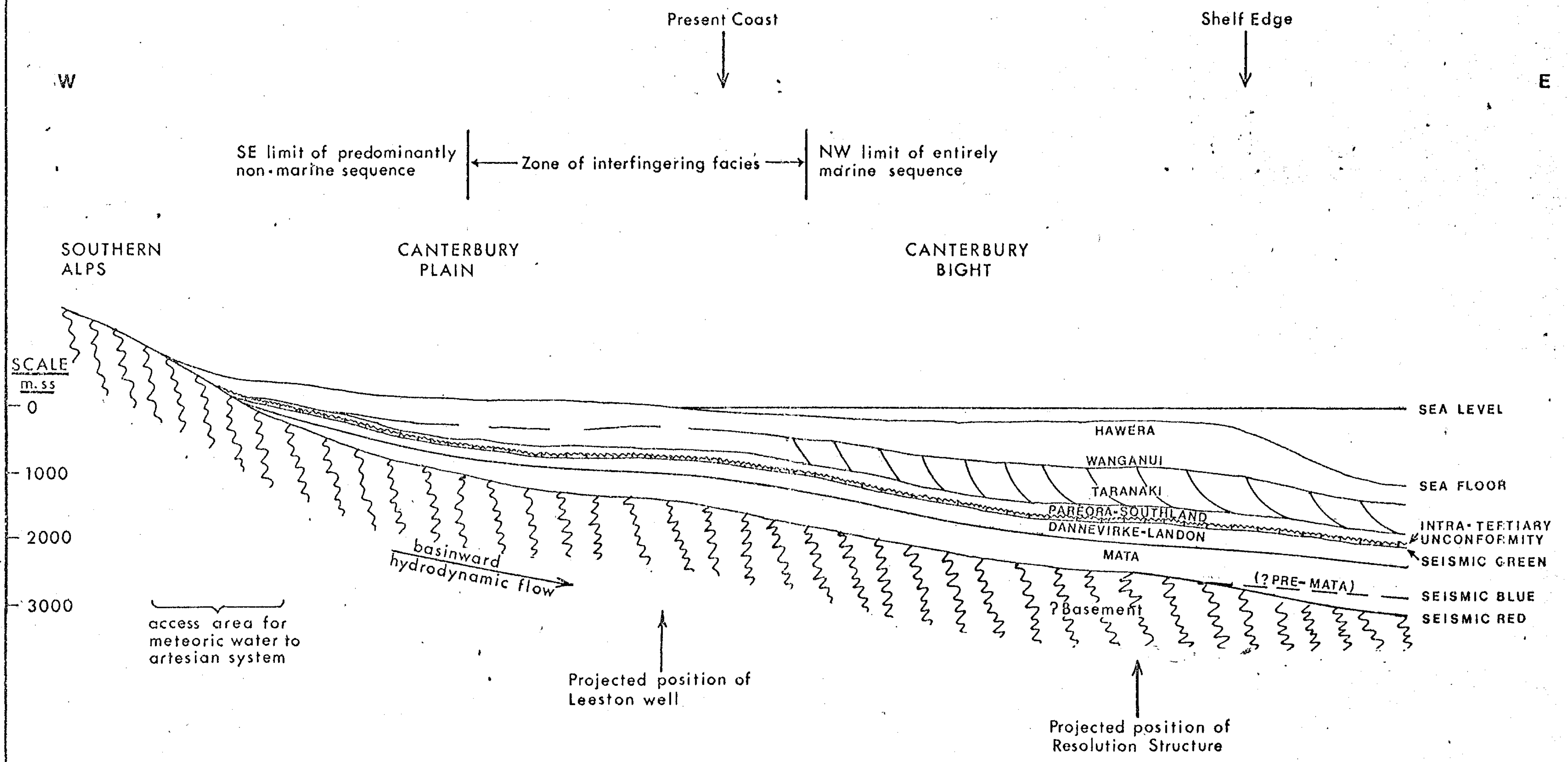
NOTES:

1. Datum is Base Miocene Unconformity
2. Onshore section depths measured from top of exposed section
3. Composite onshore section compiled:-
   0 - 420 : Lower Waipara Gorge
   420 - 1120 : Weka Creek
   1120 - 1570 : Waipara River, South Branch
   Source : Wilson, 1963
4. New Zealand Stage Symbols used are:-
   S_w : Waiauan
   P_l : Altonian
   L_w : Waitakian
   L_{wh} : Whaingaroan
   A_r : Runangan
   A_b : Bortonian
   D_h : Heretaungan
   D_w : Waipawan
   D_t : Teurian

LOCATION MAP



ENCLOSURE



DIAGRAMMATIC SECTION THROUGH NORTHERN PART OF CANTERBURY BASIN (SOUTH OF BANKS PENINSULA)

SEPT. 1975
DRG. NO. 46

ENCLOSURE 14

WELL NAME. RESOLUTION 1 .... COMPANY BP, SHELL, TODD .... NZMS1 SHEET [illegible] NZ FOSSIL REC...../f...

LOCATION.. PERIOD DRILLED.. July 1975 ...... LAB NOS F.......

CONFIDENTIAL? YES ~~NO~~ DRILLER............ COLLCTR.......... ELEC LOG HELD......... LITH LOG HELD.............. N.......

PART. 1 . SCALE: 20mm= 20m ..   STORAGE NO.................. P..............

stage	critical fossils	depth m	column	core	cttgs exam	casing, lithology, comments	environment	format.
		380	- - - - -			no samples above 380m ← lithology in column principally from well log		
Wn	Notorotalia zelandica abundant N. finleyi Mollusca	400	Shell		390 405	abundant shell fragments	very shallow marine	
Wn		420	beds		420 425			
		440	and			Mangapanian absent or unrecognized		
Wo-Wp	Notorotalia kingmai N. finleyi N. taranakia Cibicides molestus Notorotalia pliozea	460	Siltstone		445 450		very shallow marine	
		480	Shell					
Wo-Wp	Notorotalia kingmai N. kurupiensis	500	beds and		495 500		shallow marine	
		520	Siltstone					
		540						

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ENCL. 15

WELL NAME. RESOLUTION 1 .... COMPANY........................ NZMS1 SHEET....... NZ FOSSIL REC...../f.....
LOCATION.. PERIOD DRILLED.................. LAB NOS F.........
CONFIDENTIAL? YES ~~NO~~ DRILLER.............. COLLCTR........... ELEC LOG HELD......... LITH LOG HELD............. N.........
PART. 2. SCALE: 20mm= 20 m. STORAGE NO.................. P..................

stage	critical fossils	depth ~~ft~~/m	column	core	cttgs exam	casing, lithology, comments	environment	formation
		540	Shell beds & Siltstone					
Wo-Wp	Notorotalia pliozea N. kingmai Bulimina aculeata		glauconite		545 550	abundant shell fragments	shallow marine	
		560	Sandstone					
		580	and minor lignite					
Wo-Wp	Notorotalia cf. pristina	600			595 600	" " "	very shallow marine	
		620	Sandstone					
NF?		640	and		630 640 650 660	wood, angular sandstone fragments foraminifera all seem to be from cavings " " "	very shallow marine.	
		660	Siltstone					
		680						
NF?		700			690 700	coarse sand and shell grit " " "	very shallow marine	

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WELL NAME. RESOLUTION 1 .... COMPANY........ NZMS1 SHEET....... NZ FOSSIL REC...../f.....
LOCATION........ PERIOD DRILLED........ LAB NOS F........
CONFIDENTIAL? YES ~~NO~~ DRILLER........ COLLCTR........ ELEC LOG HELD........ LITH LOG HELD........ N........
PART. 3. SCALE: 20mm= 20m .... STORAGE NO........ P........

stage	critical fossils	depth ~~ft~~/m	column	core	cttgs exam	casing, lithology, comments	environment	formation
Tt	Textularia miozea Notorotalia pristina	700	Sandstone		700–710	abundant shell fragments + coarse sand	very shallow marine	
Tt	Textularia miozea abut Notorotalia pristina	720	and		720–730	" " " " "	" "	
Tt	Quinqueloculina Textularia miozea	740	Siltstone		740–750	shell fragments abundant	shallow marine	
		760	Sandstone					
		780	and Siltstone					
Tt	Textularia miozea Notorotalia pristina	800			790–800	rare planktonic foraminifera	inner shelf shallow marine	648 118
		820	Sandstone and					
Tt	Textularia miozea	840	Siltstone		840–850	scarce planktonic foraminifera	inner to mid shelf	
		860	— — —					

WELL NAME..RESOLUTION 1.......................... COMPANY.......................... NZMS1 SHEET....... NZ FOSSIL REC...../f......

LOCATION.. PERIOD DRILLED.................... LAB NOS F.........

CONFIDENTIAL? YES | NO DRILLER............. COLLCTR........... ELEC LOG HELD......... LITH LOG HELD............. N.........

PART.4.. SCALE: 20mm= 20m.. STORAGE NO................. P...................

stage	critical fossils	depth ft/m	column	core	cttgs exam	casing, lithology, comments	environment	formation
		860	- - - -					
			Argillaceous					
		880	Siltstone					
Tt	Textularia miozea Notorotalia hurupiensis				890		inner to mid shelf	
		900			900			
			Argillaceous					
		920	Siltstone					
Tt	Bolivinita pohana	940			940			
					950		" "	
		960						648 119
			Argillaceous					
		980	siltstone					
Tt	Bolivinita pohana Notorotalia taranakia N. hurupiensis				990	rare planktonic foraminifera	about mid shelf	
		1000			1000			
Tt	Globorotalia mayeri continuosa Bolivinita pohana				1010	increasing planktonic foraminifera	" " "	
		1020			1020			

E. RESOLUTION 1 .... COMPANY .... NZMS1 SHEET .... NZ FOSSIL REC ...../f......

LOCATION .... PERIOD DRILLED .... LAB NOS F..........

CONFIDENTIAL? YES ~~NO~~ DRILLER .... COLLCTR .... ELEC LOG HELD .... LITH LOG HELD .... N..........

PART. 5. SCALE: 20mm= 20m .... STORAGE NO .... P..........

stage	critical fossils	depth ~~ft~~/m	column	core	cttgs exam	casing, lithology, comments	environment	formation
		1020	Argillaceous					
		1040	siltstone		1040			
					1050			
		1060						
			Argillaceous					
		1080	siltstone					
Tt	Bolivinita quadrilatera Globorotalia mayeri continuosa	1100			1100	small planktonic foraminifera abundant	mid to outer shelf	
					1110			
		1120						
Tt	Globorotalia mayeri continuosa G. aff miozea	1140	Argillaceous siltstone		1140	planktonic foraminifera fairly common	mid to outer shelf	
					1150			
		1160						
		1180						

648 120

WELL RESOLUTION 1 .... COMPANY .... NZMS1 SHEET .... NZ FOSSIL REC ..../f ....

LOCATION .... PERIOD DRILLED .... LAB NOS F ....

CONFIDENTIAL? YES ~~NO~~ DRILLER .... COLLCTR .... ELEC LOG HELD .... LITH LOG HELD .... N ....

PART. 6. SCALE: 20mm= 20m. STORAGE NO .... P ....

stage	critical fossils	depth ~~ft~~/m	column	SW core	cttgs exam	casing, lithology, comments	environment	formation
		1180						
Tt	Globorotalia mayeri continuosa				1190	grey volcanics in cuttings		
		1200			1200			
			Argillaceous Siltstone		1210			
	Bolivinita pohana, Cyclammina medwayensis, Globorotalia miozea, Globorotalia mayeri mayeri in 1225m and 1229m	1220		1225	1220	← casing set at 1223.57m, then drilled out to 1235m	outer shelf – slope?	
Sw				1229	1230	planktonic foraminifera increasing		
		1240	-1237					
Sl basal	Orbulina suturalis (early form) 1247m		strongly glauconitic mudstone	1247	1250, 1255	strongly glauconitic; break in sequence with most of Sw + Sl missing – or very condensed sequence.		
		1260						
Sc	Globigerinoides glomerosus circularis		Silty mudstone		1265, 1270		outer shelf or deeper?	Grey Marls
Pl	Globorotalia miozea	1280		1285				
			Argillite		1295			
		1300	-1306		1300	Major disconformity: upper Lwh — Po missing		
Lwh	Globigerina angiporoides, Rotaliatina sulcigera		white glauconitic limestone	1308.5, 1312.5		= MacDonald Limestone, N. Otago.	outer shelf or deeper	MacDonald Lst
Ldr		1320		1318, 1320, 1323		= Amberley Limestone, N. Canterbury.		Amberley Lst
Ar	-1332m Globigerapsis index, Bolivina pontis		glauconitic sandstone	1330, 1332	1330			
Ak-Ar	-1335m			1335	1335			
Ak	-1335m Gaudryina reussi, Sphaeroidina variabilis	1340		1338				

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WELL NAME. RESOLUTION 1 .... COMPANY .... NZMS1 SHEET .... NZ FOSSIL REC ...../f....

LOCATION .... PERIOD DRILLED .... LAB NOS F........

CONFIDENTIAL? YES ~~NO~~ DRILLER .... COLLCTR .... ELEC LOG HELD .... LITH LOG HELD .... N........

PART. 7.. SCALE: 20mm= 20 m.. STORAGE NO .... P........

stage	critical fossils	depth ~~ft~~/m	column	SW core	cttgs exam	casing, lithology, comments	environment	formation
		1340	glauconitic sandstone					
AK	Bolivina cf moodyensis Saudrygina reussi		— — — —	1348	1350 1355		outer shelf?	
		1360	Light		1360 1365	Planktonic foraminifera plentiful		
	Saudrygina reussi		grey		1370 1375			
		1380	Soft	1380	1380 1385			
Ab upper	Saudrygina proreussi Bulimina bortonica Zeauvigerina Euuvigerina bortotara		calcareous	1387	1390 1395		outer shelf?	
			glauconitic	1396·5				
Ab lower	Euuvigerina wanzea Saudrygina proreussi	1400	mudstone		1400 1405 1410 1415			
	Elphidium hampdenense Globorotalia crater	1420			1420 1425	Porangan missing or not identified		
				1428	1430 1435			
Dh	.. ..	1440		1443	1440 1445		outer shelf?	
Dh-Dt	.. ..				1450 1455	exact age uncertain – Dm & Dw not recognised – possibly missing. Foraminiferal numbers decreasing shallowing?	shallowing?	
	arenaceous fauna – undiagnostic	1460		1462·5	1460 1465			
Dt	Bolivinopsis spectabilis + compta – agglutinated fauna Pollen flora indicate probable Dt age		— — — — non calcareous glauconitic sandstone	1474·5 1478	1475 1480		shallow – near shore	Waipara Greensand
		1480						
?F		1500	— — — — white quartzose sandstone				non marine?	

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WELL NAME. RESOLUTION 1 .... COMPANY........................ NZMS1 SHEET....... NZ FOSSIL REC...../f......

LOCATION.. PERIOD DRILLED.................... LAB NOS F..........

CONFIDENTIAL? YES ~~NO~~ DRILLER............ COLLCTR.......... ELEC LOG HELD......... LITH LOG HELD.............. N..........

PART. 8.. SCALE: 20mm= 20m ...... STORAGE NO................... P...................

stage	critical fossils	depth ft/m	column	core	cttgs exam	casing, lithology, comments	environment	formation
		1500	Sandstone				non marine?	
					1515			
NF	only from cavings	1520	white		1520			
					1525			
			quartzose		1530			
					1535			
NF		1540			1540			
					1545			
			fine		1550			
		1560	to					648 123
			medium					
		1580	grained					
		1600	non					
		1620	calcareous					
		1640						
NF					1645			
					1650			
		1660						

WELL NAME..RESOLUTION 1.................. COMPANY........................ NZMS1 SHEET....... NZ FOSSIL REC...../f.....

LOCATION.. PERIOD DRILLED................... LAB NOS F.........

CONFIDENTIAL? YES/NO DRILLER............. COLLCTR.......... ELEC LOG HELD......... LITH LOG HELD............. N.........

PART..9.. SCALE: 20mm= 20m.. STORAGE NO................. P....................

stage	critical fossils	depth ft/m	column	SW core	cttgs exam	casing, lithology, comments	environment	formation
		1660	Sandstone, white quartzose non calcareous					
Mh	Mh pollen flora	1680		1685				
Mh	Cyclammina elegans Bathysiphon Gaudryina healyi	1700	Alternating		1695 1700		shallow, near shore	Laidmore
		1720	silty					"Saurian Sands"
			glauconitic					Mid Waipara
Mh	Mh pollen flora Cyclammina elegans Bathysiphon	1740	mudstone	1740	1740 1750			
		1760						
			and					
		1780	sandstone					
Mh	Cyclammina elegans Bathysiphon	1800			1790 1800			
		1820						

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WELL NAME..RESOLUTION.1..................... COMPANY......................... NZMS1 SHEET....... NZ FOSSIL REC...../f.....

LOCATION.. PERIOD DRILLED.................... LAB NOS F.........

CONFIDENTIAL? YES ~~NO~~ DRILLER............. COLLCTR........... ELEC LOG HELD......... LITH LOG HELD............. N.........

PART.10. SCALE: 20mm= 20m.. STORAGE NO.................. P..................

stage	critical fossils	depth ~~ft~~/m	column	core	cttgs exam	casing, lithology, comments	environment	formation
		1820	alternating silty glauconitic mudstone and sandstone					
Mh	Cyclammina elegans Bathysiphon	1840			1840–1860		shallow	Laidmore "Saurian Sands"
		1860						
		1880	"					
Mh	Cyclammina elegans Bathysiphon	1900	white quartzose sandstone		1880–1900		Shallow	
		1911				1911		
		1920	igneous (teschenite)			Igneous		
		1940						
		1960				TD 1963		
		1980						

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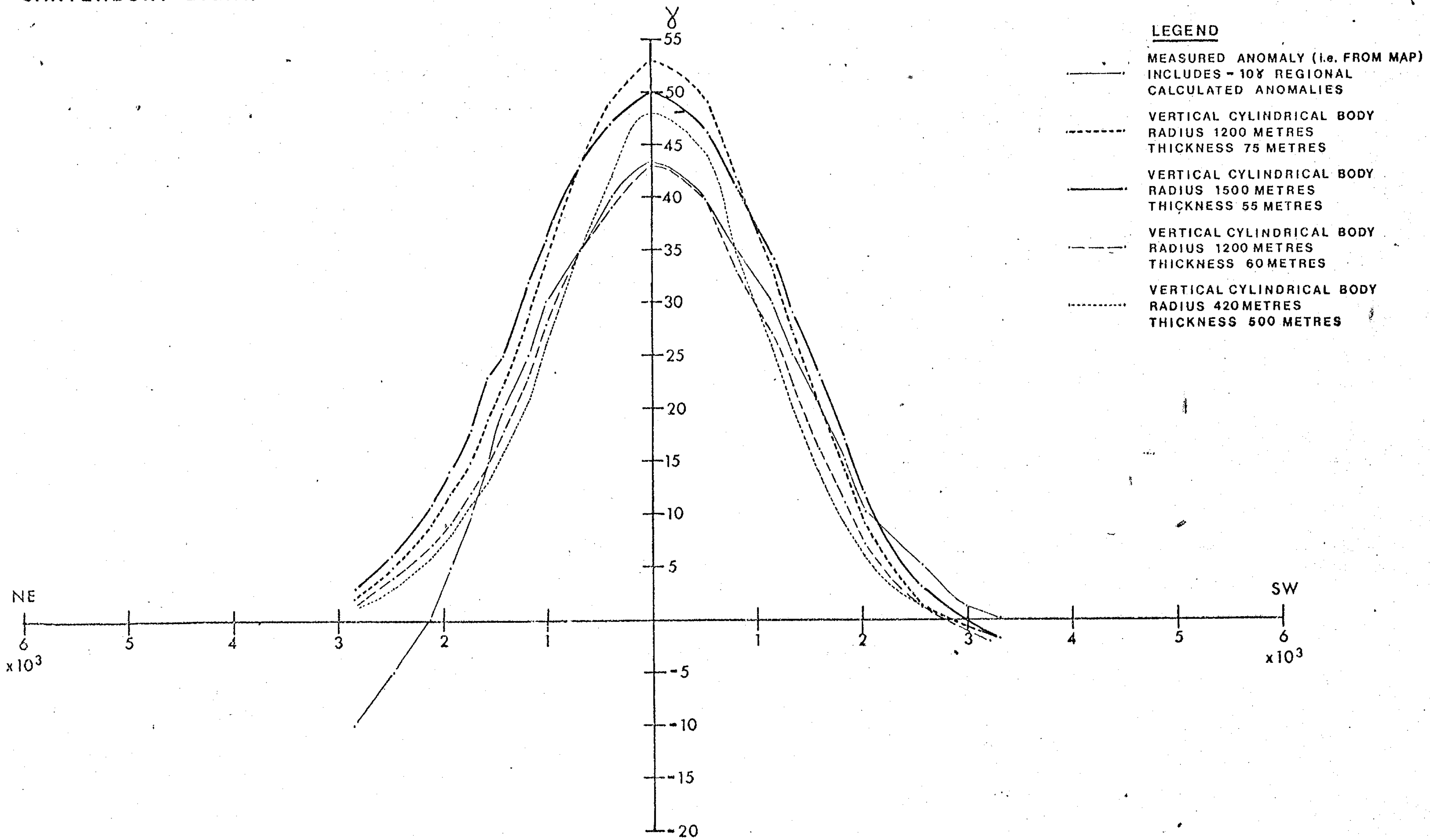
MEASURED AND CALCULATED MAGNETIC ANOMALY PROFILES ACROSS STEEPEST GRADIENT OF ANOMALY CAUSED BY TESCHENITE BODY 1902 METRES BELOW SEA LEVEL, CANTERBURY BIGHT.



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