COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

PETROLEUM SEARCH SUBSIDY ACTS

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PURI SEISMIC SURVEY, PAPUA, 1959

BY

AUSTRALASIAN PETROLEUM COMPANY PROPRIETARY LIMITED

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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

Minister: SENATOR THE HON. W. H. SPOONER, M.M.

Secretary: H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Director: J. M. RAYNER

This Report was prepared for publication in the Geophysical Branch

Chief Geophysicist: R. F. THYER

FOREWORD.

In 1959 the Commonwealth Government enacted the Petroleum Search Subsidy Act 1959, under which companies proposing to drill for new stratigraphic information or to carry out either geophysical or borehole surveys in search of petroleum could be subsidised for the cost of drilling or of survey operations approved by the Minister for National Development.

The Bureau of Mineral Resources, Geology and Geophysics is required, on behalf of the Department of National Development, to examine the applications, maintain surveillance of the operations, and in due course publish the results.

A seismic survey was carried out under the Petroleum Search Subsidy Act 1959 in the Puri area of Papua by Australasian Petroleum Company Proprietary Limited. This Publication deals with that survey and contains the information furnished by Australasian Petroleum Company and edited in the Geophysical Branch of the Bureau of Mineral Resources. The final geophysical report was written by Mr. D. P. Merrett, Geophysical Adviser to Australasian Petroleum Company and an appreciation of the geology of the area and the objectives of the survey was written by Mr. S. V. Sykes, Chief Geologist of Australasian Petroleum Company. The methods of carrying out the seismic survey and the results obtained are presented in detail.

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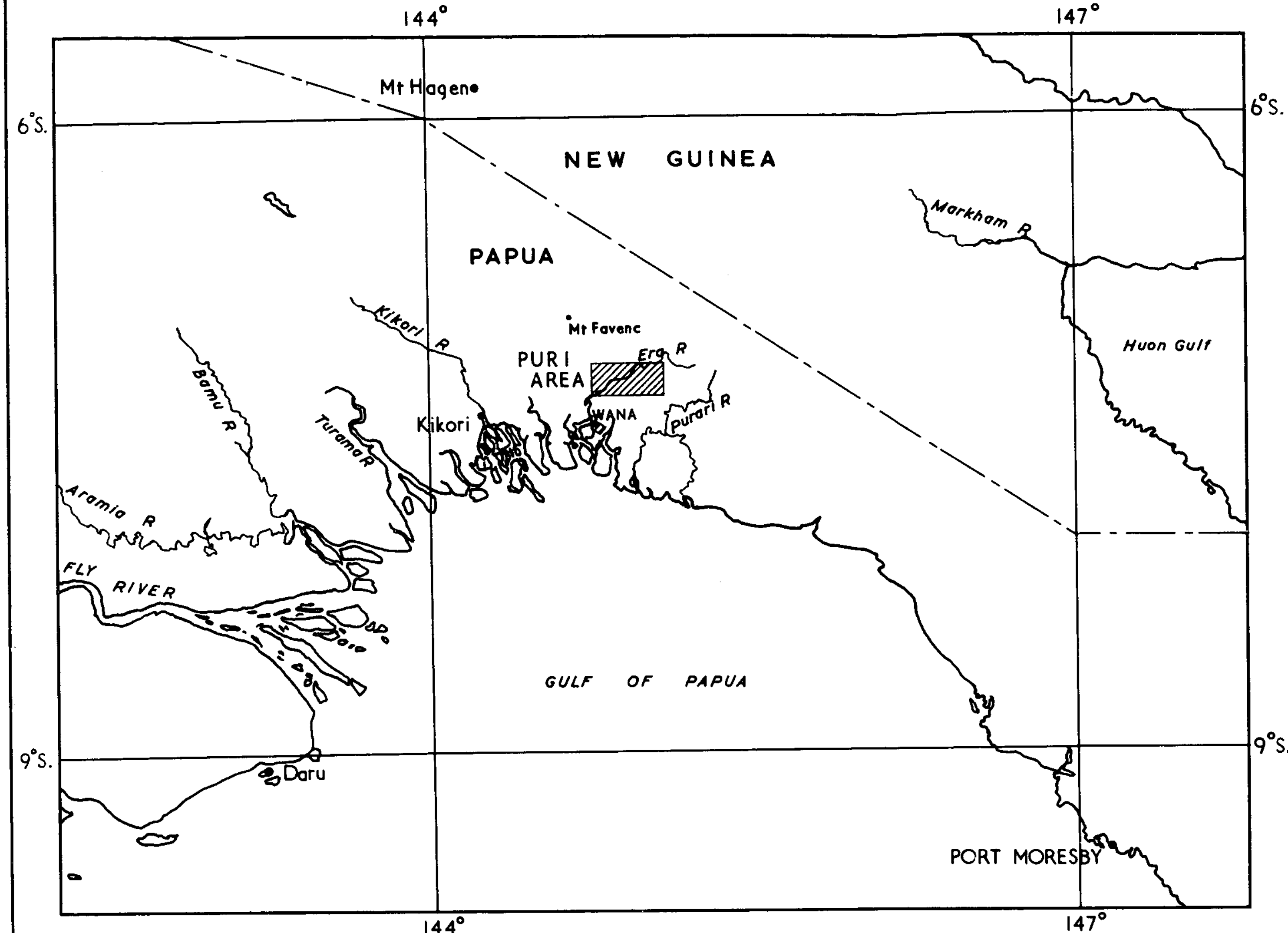

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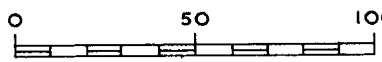

AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

KAF — 1

PURI — SEISMIC SURVEY

GENERAL LOCATION

REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA	DATE COMPILED: FEBRUARY 1960
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AUTHOR: D. P. MERRETT	DRG No RS 146/60

ABSTRACT

This report refers to seismic work carried out in the Puri area of Papua by Seismograph Service Ltd. for Australasian Petroleum Co. Pty. Ltd. during the period 6th May - 15th December, 1959.

The objective of the survey was to determine the structural pattern of the Tertiary limestones in order to define any closed structures that may have economic oil accumulations. Altogether some 75 miles of continuous reflection traverses were observed and also a single refraction in-line profile of two spreads.

An anticlinal feature was observed along one line but as there was no evidence of any significant pitch reversal along the strike line it seems there is no structure worth drilling in the area south of the Puri and Kereru Anticlines. The overall quality of the reflection data was poor but was considered adequate to disprove the presence of any major closed structures.

I. INTRODUCTION

Australasian Petroleum Co. Pty. Ltd., owned jointly by British Petroleum Co. Ltd., Vacuum Oil Co. Pty. Ltd., and Oil Search Ltd., holds petroleum tenements in the Papuan Basin, Papua. As part of its exploration programme, a seismic survey was carried out in the Puri area during the period 6th May - 15th December, 1959. The Company applied for and was granted a subsidy, under the Petroleum Search Subsidy Act, 1959, of half the cost of the operation.

The work was under the technical supervision and direction of the following company personnel :-

L.P. Bliaux	...	...	Geophysical Consultant to A.P.C.
M.D. Dobrin	...	...	(Triad Oil Company Ltd., Canada) Geophysical Adviser to A.P.C.
D.P. Merrett	...	...	(British Petroleum Co.) Assumed duties of Geophysical Adviser on Dobrin's departure from Papua.
D. Nicol	...	...	(British Petroleum Co.) Senior Surveyor.

Seismograph Service Ltd. of Kent, England was engaged to conduct the seismic survey and to provide technical equipment and the following technical personnel :-

A.J. McDowell	...	...	Party Leader
G.M. Edmond	...	...	Chief Computer for part of the Survey
J. Black	...	...	Chief Computer after Edmond's departure from Papua
R.J. Lugg	...	...	Observer
E. Rogers	...	...	Surveyor

World Wide Helicopters Ltd. was engaged to provide a helicopter transport service which was considered essential in view of the inaccessibility of the area and the character of its terrain.

All additional personnel needed for the operation were provided by Australasian Petroleum Co.

Location and Purpose of the Seismic Survey.

Sediments ranging in age from Recent to Cretaceous exist in the Puri area, with disconformities between the Cretaceous and Eocene, and between the Eocene and Miocene. The Puri Anticline and Kereru Range lie en echelon on the southern margin of a belt of late Pliocene orogeny.

The locality of the seismic survey (Fig. KAF-1) is mostly in the area south of the Puri Anticline centered at approximately latitude $7^{\circ}21'$ south and longitude $145^{\circ}55'$ east, but partly in a small area near Wana.

In late 1958, exhaustive testing of the Puri No. 1 Well produced an encouraging but non-commercial amount of hydrocarbons, gas, and condensate, in the "Taurian" limestones of the sub-thrust block of the Puri Anticline.

This show immediately upgraded the sub-thrust block of the Puri structure and it was considered that a commercial accumulation of oil may exist along strike in this block. However, further information obtained in April 1959 from Puri No. 1A Well (a sidetrack hole to the north-west of Puri No. 1) showed the sub-thrust limestones to be dipping south at 50 degrees under a flat thrust plane. Attention was then focussed on the area south of this south-dipping sub-thrust limb as it was considered that any closed structure of reasonable size in the Tertiary limestone would be an excellent oil prospect, providing it was within reach of the helirig.

The surface Pliocene deposits coupled with the effect of the Era Thrust Fault completely mask any surface geological expression of folding in the limestones south of the Puri and Kereru Anticlines. A seismic survey was considered the only practical means of delineating structure in these covered Tertiary limestones.

Altogether some 75 miles of continuous reflection traverses were observed and also a single refraction in-line profile of two spreads.

The overall quality of the reflection data was poor but was considered adequate to disprove the presence of any major closed structure.

II. GEOLOGY AND OBJECTIVES OF THE SURVEY

Editorial Note by the Bureau of Mineral Resources, Geology and Geophysics

The stage names used within this report have been enclosed in quotes to denote that they have not yet been defined in accordance with the Australian Code of Stratigraphic Nomenclature. However, these names are well founded and have been used extensively by the Australasian Petroleum Company Pty. Ltd., and Island Exploration Company Pty. Ltd., who have jointly operated in Western Papua since 1938.

The "Taurian" and "Muruan" stages are referred to the Lower and Upper Miocene respectively. The "Ivorian" stage deposition, referred to the Middle Miocene, is represented by 300 feet and 500 feet of marl in the Wana and Puri Wells respectively which, in the Wana-Puri province, is transitional between, and conformable with, underlying "Taurian" limestone and overlying "Muruan" argillaceous sediments.

A dense basinal limestone, assigned to the "Taurian" stage, has been identified in the Puri and Wana Wells and in outcrop in the core of the Puri Anticline and in the Kereru

Range. It is about 1,200 feet thick at Puri and about 1,800 feet thick in the Kereru area. In the Puri-Wana province, on the south-western flank of the Tertiary Papuan Basin between shelf on the south-west and through to the north and east, the dense "Taurian" limestone provides a strong density contrast with the overlying, predominantly argillaceous, sedimentary pile. The persistence of this limestone in the Wana-Puri province in dense basinal facies and at a constant stratigraphic level is a basic premise for the interpretation of the seismic results. However, to the north and east of the Wana-Puri line the dense "Taurian" limestone grades into non-calcareous trough sediments and to the south-west into shoal and reef limestone expressed seismically as a refracting medium of lower velocity than the dense basinal limestone.

The presence of a transitional zone of 300 to 500 feet of the conformable Middle Miocene marl between the dense "Taurian" limestone and "Muruan" sediments would preclude precise definition of the top of the dense "Taurian" limestone by seismic methods. Thus it is possible that throughout the report the unit referred to as dense "Taurian" limestone may include part or all of the overlying marl formation.

Geology

The area surveyed is in the Papuan Basin on the Shelf Zone adjoining the south-western margin of the Aure Trough.

It is an asymmetrical basin with gently folded strata on the south-western side, where the basin is hinged on the Australian Shield, and very steeply folded strata against the Central Ranges of New Guinea. In the Aure Trough there are at least 15,000 feet of Miocene marine sediments - greywacke, tuffaceous sandstone, mudstone and shale. To the south-east, Miocene limestone and mudstone rest unconformably on Eocene limestone, siliceous shale, and chert, on Mesozoic strata, or on metamorphic and igneous rocks of the basement complex. The Papuan Basin is marked by the large amount of volcanic material in the Upper Tertiary sediments.

The following comments on the stratigraphy and the structure of the area surveyed are taken from a geological appreciation which formed part of the company's application for subsidy and were prepared by S.V. Sykes, Chief Geologist.

Stratigraphy

The stratigraphy is shown in Table 1.

TABLE 1.

STRATIGRAPHY

Age		Description	Thickness
Recent		Alluvial plain and deltaic deposits	? up to 50 ft
Pleistocene		Volcanic agglomerate	500 ft +
---Angular Unconformity---			
Pliocene		Freshwater sandstone, siltstone, coal, and mudstone grading down to marine.	6000 ft ±
Upper Miocene	"Muruan" stage	Marine mudstone	4500 - 5800 ft
Middle Miocene	"Ivorian" stage	Marl with *Orbulina*	500 - 600 ft
Lower Miocene	"Taurian" stage	Dense argillaceous limestone - calcilutite	1150 - 1800 ft
Lower Miocene	"Kereruan" stage	Algal and foraminiferal calcarenite	200 - 400 ft
---Disconformity---			
Eocene		"Echinoderm" calcarenite and algal limestone	150 - 200 ft
---Disconformity---			
Lower Cretaceous		Mudstone and siltstone	1600 ft

(1) Cretaceous

The thickness of the Cretaceous in the Puri area is unknown but it is in excess of 1600 feet.

There is a major disconformity at the base of the Eocene, and all of the Upper Cretaceous and most of the Lower Cretaceous are missing. The Lower Cretaceous beds consist of dark grey hard silty mudstones, occasionally sandy, pyritic, and slightly micaceous. Considerable and rapid lateral variations of lithology occur, mudstones and shales grading to silts over relatively short distances.

(2) Eocene

The Eocene is thin and variable in thickness. In the Puri Well some 200 feet were encountered and in the Kereru Range, exposures up to 150 feet thick have been measured.

The Eocene limestones occur in two main types :-

(i) an algal limestone, light cream, massive, partially recrystallised, up to 40 feet thick, overlain by

(ii) an echinoderm calcarenite, typically recrystallised, with sand grains usually along stylolites, and sporadic glauconite and occasionally with bands of calcareous sandstone.

(3) Miocene

"Kereruan" Stage (Lower Miocene)

The thickness is variable : 200 feet have been recorded in the Puri Well and 400 feet were measured in the Kereru Range outcrops.

The limestones consist of well-bedded, sometimes massive, dense, light brown to cream, medium grained algal and foraminiferal calcarenites. They disconformably overlie the Eocene limestones. They grade upwards conformably and imperceptibly into the dense argillaceous limestones of the "Taurian" Stage.

"Taurian" Stage (Lower Miocene)

The "Taurian" limestones consist of fine grained, thin to massive bedded, usually well jointed argillaceous limestone. The thickness is 1150 feet in the Puri Well and up to 1800 feet on the Kereru Range and they grade upwards conformably and imperceptibly into the *Orbulina* marls of the "Ivorian" Stage.

"Ivorian" Stage (Middle Miocene)

Consists of a series of well-bedded, very fine grained, grey marls with abundant *Orbulina* and *Globigerina*. The marls are 500 and 600 feet thick.

They grade upwards conformably and imperceptibly into the mudstones of the "Muruan" Stage.

"Muruan" Stage (Upper Miocene)

Consists of a predominantly argillaceous sequence of dull grey, carbonaceous, foraminiferal mudstone with occasional thin siltstones and very fine grained sandstones, locally calcareous.

The beds thicken to the east and in the East Kereru Range are about 4500 feet thick while at the Puri Well area the thickness is of the order of 5800 feet.

(4) Pliocene

The thickness of the Pliocene is of the order of 6000 feet but local variation and incomplete sections prevent a closer general estimate.

It can be divided into three main divisions :-

(i) A lower sandstone division, consisting of approximately 3000 feet of compacted, well-bedded, fine grained blue-grey marine sandstones and sandy mudstones which are locally carbonaceous, and thick and thin bands of calcareous sandstones, and intercalated mudstone.

(ii) A middle coal division, consisting of a sequence of thick beds of blue grey mudstones and silts with numerous interbedded coal seams and thin fissile mudstones. The thickness probably does not exceed 1800 feet.

(iii) An upper sandstone division, consisting of non-marine, cross-bedded, ferruginous, medium to coarse grained sandstones, and thin fine grained, well-bedded sandstones with interbedded grey sandy mudstones and carbonaceous mudstones. Occasional thin lignitic coal seams occur in the upper part of the sequence. The thickness is approximately 700 to 1000 feet.

(5) Pleistocene

Volcanic agglomerates, up to 500 feet or more in thickness, occur in the extreme west of the area. They are the erosional remnants of the once much larger volcanic apron of the Mount Favenc, which lies to the north-west.

Structure

The Puri Anticline and the Kereru Range, which lies en echelon and west of the Puri Anticline, are situated on the southern margin of the severely folded belt of the Late Pliocene orgeny. Both structures are asymmetrical to the south-south-west and are thrust faulted to the south-south-west. The intensity of the south-westward movement decreases eastwards from the Kereru Range.

The area south of the Puri Anticline and the Kereru Range is composed mainly of gently folded Pliocene beds which are cut by several faults in the west. It is considered that the underlying Tertiary limestones are gently folded and perhaps affected to a minor degree by faulting.

The Kereru Range exposes about 1600 feet of Lower Cretaceous mudstones and siltstones in the core of the structure. It is an elongate structure, asymmetric to the south, which pitches out near the Era River west of Puri. It is underlain by a major low angle thrust fault, the Kereru Fault. The Era Fault which outcrops some 7000 feet to the south of the Kereru Fault, is considered to be part of the same thrust-fault complex. To the east the Kereru Fault diminishes in throw and joins with the Era Fault, to underlie the Puri structure at depth.

The Puri Anticline exposes the upper 250 feet of "Taurian" limestone in the core. This is flanked by the following succeeding younger formations : the "Ivorian" marls, the "Muruan" mudstones, and the Pliocene sandstones and mudstones. The structure is overturned, and overthrust to the south-south-west; the thrust was penetrated at 7,425 feet in Puri No. 1 Well and the thrust plane is exposed at surface some 15,000 feet to the south-south-west of the Puri anticlinal axis as the Era Fault.

Objectives of the Seismic Survey

The objective of the survey was to determine the structural pattern of the Tertiary limestones in the area in order to define any closed structures that may have economic oil accumulations within reach of the drill.

It was considered that the seismic survey would also provide stratigraphic information on the thickness of sediments overlying the "Taurian" limestones. This thickness varies considerably throughout the region both by deposition and faulting, so by obtaining the depth to the limestone by refraction methods and by linking the reflection results to previous limestone depth control at the south-western end of the area, it was expected that knowledge of these sediments would be increased substantially.

The "Taurian" limestone sequence is known to change facies to a shale sequence to the east and south-east and it was expected that the refraction results would give information on this facies change.

III. FIELD PROCEDURES

Helicopter Operation

The seismic survey was carried out within a 15 mile radius of the Era helibase and the party used two Bell helicopters to supply and move personnel and equipment out to and along the seismic lines.

Helicopter clearings were made to specifications of 360 feet long by 160 feet wide with a landing platform at one end. Clearings were made at every third shot-point, approximately 3000 feet apart, for the convenience of the observers (see Recording).

The Bell helicopters had a load capacity of 400 lb when operating from base camp or river clearings, but this was reduced to 300 lb out of bush clearings.

Survey

Topographically the region of the survey consists of a series of steep hills and escarpments to the north which gradually flattened to swamp at the southern end of the prospect. The Era and Mena Rivers and Tau Creek gave access to some of the lines but the majority could only be reached by helicopter or on foot.

The origin of the survey was taken from the rotary table at Puri No. 1 Well at 340 feet above sea level. The survey was carried out with a Watts No. 1 Microptic Theodolite, chain, and rod. Along the reflection traverses shot-points were laid out at intervals of 1080 feet. Shot-points were plotted as co-ordinates on base maps which were compiled from aerial photographs. All co-ordinates were reduced to a Lambert metre projection.

Levels are listed in feet above sea level and the maximum vertical error of closure was within the limits of ± 1 ft x $\sqrt{M}$ (where M is the length of the traverse in miles). The horizontal closure attained was approximately 1 in 500.

Drilling

Four United Geophysical Company portable "Pacdrill" outfits were used together with Hawthorne tricone finger and hard formation bits. These outfits were maintained in the field by a rotation of five drilling crews. Most holes were drilled to 75 feet and preloaded with a charge of 10 lbs. In rougher terrain the optimum depth of 75 feet was not always attainable when drilling through the harder formations. In the general Puri area the drilling rate for each rig averaged slightly less than one hole per day.

One SSL Drillmaster Minor was available but was too heavy to manhandle in rougher terrain. It was used along line 6-9 at Wana where in the more open country two 150-feet holes could be drilled in a day.

Recording

The field equipment consisted of the following :-

One 24-trace Carter FR 1 magnetic tape recording system.
One 24-trace Variable-Area Recording (VAR) camera coupled to the above.
A pair of Hall-Sears pre-filters (HS.405) - each with 12 channels.
EVS. 2 reflection geophones (natural frequency 20 c/s) and British Petroleum swamp refraction geophones.

Even with portable equipment, the rugged terrain and dense rain forest created many problems in field progress. Because of the terrain, it was decided to make helicopter clearings at every third shot-point. It was possible to record three shot-points from one instrument set-up by using extension cables. With this system all recording equipment could be moved from one clearing to the next by helicopter thus avoiding long "carries" and reducing the risk of damage to the equipment.

During the earliest stage of the reflection programme it was evident that there was a high level of low-frequency noise obscuring earlier reflections down to 2.0 seconds. Two methods were adopted in the field to eliminate this noise.

(a) Noise tests were carried out to determine the geophone pattern giving optimum noise cancellation.
(b) A pair of Hall-Sears pre-filters were obtained to eliminate low-frequency energy in front of the input transformer of the recording system.

Experimental noise studies were carried out at the southern end of Lines 6-3 and 6-7. In both cases most of the noise came directly from the shot. The apparent velocities were exceptionally low with correspondingly short wavelengths ranging from 12 to 50 feet. Applying directivity curves for a 12-unit geophone group the optimum separation of geophones for cancelling this noise would be approximately 6.5 feet. For production recording 12 geophones per trace were laid out along the profile with an interval of 6.5 feet between individual geophones.

Three-hole pattern shots were tried but did not produce any significant improvement in record quality on a single hole drilled to a depth of 75 feet. Five, nine, and eleven-hole patterns of shallow hand-augured holes also produced inferior records compared with a single deep hole.

Field testing showed the optimum pre-filter setting to be at the 22 c/s cut-off with a slope of 30 db/octave. The improvement in the shallower reflections was generally quite pronounced but at times greater than 2.5 seconds reflections were normally better defined on records made without the pre-filters. For production recording at least two shots were observed in each hole - the first at maximum depth with the pre-filters and the second without the pre-filters.

Playback Unit

A Playback unit was set up in Era Base Camp consisting of a Variable-Area Playback (VAP) unit and a Density-Modulated Display (DMD) unit. After processing, the VAR transparencies were played back through the VAP to produce the DMD section. There was provision on the VAP for application of static and dynamic corrections.

All available playback filters as well as a number of stages of mixing were tried in running off the initial DMD sections from the VAR film transparencies. As a general rule the 12 - 40 c/s filter produced the optimum DMD section.

Both a 30% and a 50% uni-directional mix introduced criss-cross patterns which confused the interpretation, and mixing was therefore discontinued.

The Carter magnetic tapes, recorded simultaneously with the VAR transparencies, were despatched to British Petroleum Company Limited for playback in their Geophysical Office in London.

IV. RESULTS OF THE SURVEY

Presentation of Results

The results of the seismic survey are presented as contour maps on three horizons and as plotted seismic cross-sections incorporating an interpretation of the results.

The following additional information has been filed in the Bureau of Mineral Resources, Geology and Geophysics, and is available for future reference:-

1. Variable-Area cross-sections on all reflection lines.
2. Driller's, shooter's, and observer's records.

Data Quality

Overall reflection quality is poor and there is a general progressive deterioration in data towards the west. Only one horizon can be followed with any degree of reliability on the basis of reflection continuity or character correlation. This event appears at a two-way time of 3.0 - 3.2 seconds in the east of the prospect, rising to 1.8 - 2.0 seconds in the west.

At shallower levels there is neither reflection continuity nor is character correlation possible. "Phantoming" at these levels is restricted to dip trends; even where dip trends can be established with reasonable reliability, no precision can be given to the amount of dip as measured along partial reflections. Furthermore, little reliance should be placed on dip trends not consistent over several spreads; as, for example, the localised apparent reversal on Line 6-1 between Lines 6-2 and 6-3.

The corrected DMD sections were convenient for field appraisal of results, but for purposes of detailed interpretation the exaggerated horizontal scale is unsatisfactory. One serious disadvantage is the difficulty of separating diffracted events that did not persist over several spreads, from normal reflected energy.

V. COMPUTING METHODS

Reflection

Weathering and Elevation Corrections

A graphical summation weathering method was employed using first-break plots from which the horizontal sub-weathering velocity (Ve) is obtained. The weathered zone with velocity (Vw) was replaced by the sub-weathering material by multiplying the average delay time associated with the weathered layer (tw) at each station by the factor "f" - where

$$f = \sqrt{(Ve - Vw)/(Ve + Vw)} \text{ and}$$

$$Ve = 6000 \text{ ft/sec and } Vw = 2000 \text{ ft/sec.}$$

(The total station correction was f.tw + Eg/Ve (where Eg is the station elevation above datum) plus the shot-point correction (Es-ds)/Ve (where Es is the elevation of the shot-point above datum and ds is the depth of shot).

Velocity Distribution

The velocity distribution used for the Puri reflection survey is mainly based on the time depth relationships observed in the Wana Well survey carried out in 1951. This time depth curve (see Fig. KAF-7) has been modified to incorporate the sub-weathering velocity of 6000 ft/sec observed from the first arrival times on the Puri reflection records, and the Cretaceous speed observed in the Puri 1B velocity survey, carried out in August 1959. The increase of "Muruan" speed with depth as observed in the Wana Well has been extrapolated into the depth range beyond that corresponding to the base of the "Muruan" at Wana. Time depth relations for alternative dense "Taurian" limestone depths of 10,000 feet and 14,000 feet are also indicated along this curve.

Migration

The data on the DMD sections were transferred to migrated cross-sections on a 1:1 scale of 1000 feet = 2.5 cm by use of a migration protractor and wave front chart. The migration protractor is used for reading reflection times and step-outs due to dip from the corrected record sections. These step-outs measured over 1000 feet horizontal spread distance, were then migrated by using a circular wave front and ray-path chart which is constructed on the principle of interval velocity being linear with depth, i.e. $V \simeq Ve + Kz$.

For the Puri reflection survey, the velocity function from the Wana Well survey was assumed, as the plot of interval velocity against depth falls rather closely along a straight line, and the instantaneous velocity function finally adopted was $V \simeq 6000 + 0.8\,z$ feet/sec. The time-depth curve corresponding to the wave front chart is shown for comparison on Fig. KAF-7.

Refraction

Delay time profiles were constructed using appropriate velocities, based upon the method described by Wyrobek (1956). In the case of the Green Refractor, use was made of the relationship that the delay time profile between two shot-points should match the half-intercept-time profile when calculated using the true velocity of the refractor.

Since no satisfactory reversed coverage was obtained from the Blue Refractor the results are displayed only as a delay time profile based on an assumed true velocity of 17,000 ft/sec.

VI. INTERPRETATION

Puri Area

(i) Interpretation Based on DMD Sections

Fig. KAF-3 represents an attempt to follow the only semi-continuous reflection on the DMD sections recorded in the survey. In places this horizon can be mapped on continuity. Across gaps an attempt has been made to correlate on the basis of reflection character. The reflection is a characteristically low-frequency event but the number of cycles of energy recorded varies from place to place and therefore it is possible to miscorrelate cycles across gaps in continuity.

This horizon shows a high axis best developed on Line 6-3 but which attenuates westwards and also to the south-east. A synclinal axis is suggested at the southern ends of Lines 6-3 and 6-2 which persists to Line 6-7. Line 6-1 is approximately parallel to the strike line and shows a regional rise to the west and north-west of about 1.350 sec two-way time which represents a rise of approximately 6000 feet assuming an average velocity of 9000 ft/sec. There is no evidence of any significant pitch reversal along strike Line 6-1.

On Lines 6-12, 6-8, 6-3, and 6-2 there is evidence of a marked break in continuity, and a fault trend is shown with displacement down to the south-west and south. The throw is at a maximum on Line 6-12 of some 0.200 sec two-way time, but apparently decreases northwestwards. At a two-way time of 3.0 sec a displacement of 0.200 sec would represent a throw of approximately 1000 feet.

(ii) Interpretation of Cross-Sections

Three phantom horizons were constructed from the dip segments on the migrated cross-sections.

(a) A shallow phantom horizon near the base of the Pliocene was tied in depth at the southern end of Line 6-3 based on a geological cross-section drawn between the Wana and Puri Wells.

(b) An Intermediate phantom horizon was arbitrarily chosen at the southern end of Line 6-3 at the intersection of refraction Line 6-4.

(c) A Deep phantom horizon was chosen to follow the zone of good reflections in the neighbourhood of 3.0 seconds on Line 6-3.

The individual dip segments are irregular and this is attributed to the poor quality of many of the reflections, imperfections in some of the static corrections, the inaccuracy of measuring dip over shorter segments, and over-migration of deeper dip segments. The three phantom horizons are drawn so as to average out discordances in the individual segments, with more weight being given to the better quality data.

In the case of the Deep phantom horizon, an upward adjustment of depth of about 2000 feet has been applied to the phantom because the velocity function accepted for the wave front chart is based on the over-simplified assumption of interval velocity increasing with depth. As a result, the migrated segments fall deeper than they should as compared with time depth relationship extrapolated from the Wana Well survey.

Notes on Migrated Cross-Sections

Line 6-3 (Fig. KAF-8)

Line 6-3 was the first profile to be covered in the reflection programme. Fig. KAF-8 shows the three phantom horizons, as well as suggested fault patterns superimposed on the migrated reflection segments. Surface topography and observed geological dips and fault outcrops are indicated as well as shot-hole drilling logs.

The phantom horizons at the base of the Pliocene and at the Intermediate level show an anticlinal axis in the vicinity of shot-point 20. The high axis on the Deep phantom horizon is between shot-points 21 and 22. The relief on the Shallow and Intermediate phantom horizons is of the order of 1500 feet whereas the Deep phantom horizon has approximately 2000 feet of reversal.

The fault patterns shown on the section were drawn on the basis of well data, surface geology, discordances in dip between reflection segments, and diffraction patterns observed on the DMD sections.

The apparent sources of diffraction patterns were located by use of a transparent template superimposed on the DMD sections showing theoretical diffraction time-distance curves for various depths as computed from the velocity function for the Wana Well. Fault-trends were drawn through the loci of these sources and are shown as steep-angle relief faults without any appreciable displacement.

The main Era Thrust Fault is drawn so as to connect its surface outcrop with its position as determined in the Puri Wells. A deep normal fault is shown to have a displacement down to the south beneath Shot-point 25 of about 1200 feet. The throw across this displacement is based on an attempted character correlation of the deep reflection on the DMD section.

The interpretation in the immediate vicinity of the Puri Well is highly questionable because of the complexity of the structure and because of poor data quality.

Line 6-2 (Fig. KAF-9)

The general quality of data on DMD sections along Line 6-2 is inferior to that along Line 6-3.

At the Intermediate phantom horizon level there is a high axis at Shot-point 20 almost due west of the crestal region on Line 6-3. Two synclinal axes occur at Shot-points 12 and 28. The overall relief is about 1000 feet, approximately one half of that shown on Line 6-3, suggesting the structure is decreasing westwards. The high axes in the Pliocene and Deep phantom horizons occur at Shot-points 21 and 22 respectively.

The outcrop of the Era Thrust Fault is shown in the vicinity of Shot-point 23 based on geological surface information. A few diffraction patterns were tentatively identified with apparent centres located beneath Shot-point 23. As in Line 6-3 the loci of these centres suggests a high-angle fault which is interpreted as a relief fault without any appreciable displacement. A second low-angle relief fault is drawn through a line of discordance in dip between reflection segments.

The phantom horizon at the base of the Pliocene is shown faulted out against the Era Thrust Fault since the "Muruan" is tentatively believed to outcrop north of the Era Fault Zone.

A deep normal fault is indicated beneath Shot-point 27 with a displacement down to the south of about 500 feet as estimated by character correlation across a displacement in the deep reflection on the original DMD section.

Because of the known geological complexity and poor data, the geophysical interpretation in the overthrust area is not considered reliable, and all displacements shown affecting the shallower levels are questionable.

Line 6-6 (Fig. KAF-10)

Line 6-6 follows the general trend of progressive deterioration of data quality westwards and generally this line is considered inadequate to lend itself to reliable interpretation.

Only one fault is indicated on the section. This thrust is established by surface outcrop in the vicinity of Shot-point 37.

The phantom horizon at the base of the Pliocene is shown faulted out against this thrust as the "Muruan" is identified as out-cropping north of the thrust. This phantom is reasonably supported by consistent data.

The Intermediate phantom horizon shows a high axis between Shot-points 33 and 34 but the relief along the southern flank is most questionable.

Interpretation of the Deep phantom horizon is unreliable as the low-frequency reflection has virtually disappeared on this line.

Line 6-7 (Fig. KAF-11A & B)

The best quality DMD section for the north-eastern part of the line, recorded in typical foothills country, was obtained using the prefilter setting at the 22 c/s cut-off with a slope of 30 db/octave. The better quality data were obtained at the north-eastern end of the line; south of Shot-point 40 there was a general deterioration in quality.

The best DMD section for the southern part of the line, recorded in low-lying swamp, was obtained without using the pre-filter. Although the quality was generally poor the deep low-frequency reflector was semi-continuous and in places reasonable character correlation could be made by jumping from one part of the section to another.

The phantom horizon at the base of the Pliocene on Fig. KAF-11A shows an apparent crestal zone at Shot-point 29B. Beneath Shot-point 38 the Pliocene is shown faulted out against the "Muruan" by the Era Thrust. The position of the Thrust was again located by using surface geological evidence. The Pliocene phantom horizon associated with the Tau Syncline, north of the Era Thrust, is based on geological maps in the Puri-Kereru area.

On Fig. KAF-11B the Pliocene phantom horizon falls to the south to a synclinal axis in the vicinity of Shot-point 21.

The Intermediate phantom horizon on Fig. KAF-11A shows a broad anticlinal axis between Shot-points 31-34 with a fall-off to the north-east at Shot-point 46 of some 600 feet. A similar reversal is continued on Fig. KAF-11B down to a broad synclinal axis between shot-points 13 and 8.

The Deep phantom horizon on Fig. KAF-11A shows an anticlinal axis at Shot-point 32 with a fall off to the north-east at Shot-point 46 of approximately 900 feet. On Fig. KAF-11B there is a net drop of some 700 feet to the south from Shot-point 29A to a broad synclinal axis between Shot-points 13 and 11.

Line 6-10 (Fig. KAF-12)

The phantom horizon at the base of the Pliocene is generally flat between Shot-points 1 and 9. North of Shot-point 9 the data became less reliable and are completely absent north of Shot-point 17. The outcrop of the Era Fault is shown just north of Shot-point 19 but in the absence of any geophysical data no estimate of displacement affecting the Pliocene has been attempted.

There appears to be a minor reversal in the vicinity of Shot-point 13 with a fall of approximately 200 feet to the intersection with Line 6-1 at Shot-point 20. North of this intersection there are no data at the shallower level and no phantom horizon has been drawn.

Data quality at the intermediate phantom horizon level was generally very poor. The phantom horizon drawn indicates a questionable high axis between Shot-points 20 and 21 with a net fall to the south-west at Shot-point 2 of approximately 900 feet.

Data are scarce at the level of the Deep phantom horizon but weight was given to a band of better quality reflections occurring between Shot-points 7 and 12 indicating a south-westerly flank. Elsewhere along the line the deep phantom horizon is questionable, as is the high axis indicated at Shot-point 23.

Line 6-14 (Fig. KAF-13)

Line 6-14 was the final cross-strike line recorded in the survey and the data quality was definitely poorer than along Line 6-10, following the trend of progressive deterioration westwards.

The shallower data are very poor and any interpretation at the Pliocene and Intermediate phantom horizon levels cannot be considered reliable. The Era Fault outcrops between Shot-points 55 and 56 but in the absence of any geophysical data no displacement is indicated along the Pliocene phantom horizon.

There is fragmentary evidence of a broad anticlinal axis in the Deep phantom horizon in the vicinity of Shot-point 56.

Line 6-1

Line 6-1 is the major strike line of the survey and was recorded in five separate segments during the course of the survey. The positioning of the segments was a compromise to follow geological strike as close as possible yet still following easiest access across the rugged topography. This Line was most important in that it was hoped to detect along it evidence of contra-regional dip which might give a lead to a feature worth drilling.

The following generalisations may be made about Line 6-1.

(a) There is a general deterioration of data quality from east to west.
(b) Apart from a minor reversal at the shallower levels between Lines 6-3 and 6-2, it indicates regional rise from east to west.
(c) The apparent convergence westwards between the Intermediate and Deep phantom horizons could mark a major unconformity between the two.

Shot-Points 63 to 51 (Fig. KAF-14A)

At all levels the section shows a net fall to the south-east. The base of the Pliocene falls some 300 feet; the Intermediate phantom horizon falls some 400 feet. Data at the Deep phantom horizon level are somewhat contradictory between Shot-points 57 and 61 and the net fall of about 700 feet shown along the line is questionable.

Shot-points 50 to 18 (Fig. KAF-14B)

At a point some 6000 feet west of the intersection with Line 6-3 the phantom horizon at the base of the Pliocene begins to rise to the west with a net rise of 1300 feet to Shot-point 18.

In the vicinity of Shot-point 45 the Intermediate phantom horizon begins to rise to the west for some 400 feet to a culmination between Shot-points 39 and 40. At this minor reversal the phantom drops about 100 feet to Shot-point 36 whereupon it resumes its regional rise to the west of just under 1000 feet to Shot-point 18.

The Deep phantom horizon rises steadily to the west some 3000 feet between Shot-points 50 and 18.

Shot-points 18 to 5A (Fig. KAF-14C)

The Pliocene is shown to rise some 300 feet to the west between Shot-points 18 and 5B. The Intermediate phantom horizon shows a rise of 750 feet whereas the Deep horizon rises approximately 1000 feet.

Shot-points 5B to 110 (Fig. KAF-14D)

Both the Intermediate and Deep phantom horizons show a net regional rise to the west of approximately 300 feet. Data at the Pliocene level are scarce and the phantom drawn is questionable, especially the increase of dip between Shot-points 101 and 104 which may be interpreted as a fault within the Pliocene.

Shot-points 111 to 142 (Fig. KAF-14E)

Information is again scarce at the Pliocene level and west of the intersection with Line 6-14 the phantom is extremely questionable. Between Shot-points 111 and 130 there is a net regional rise to the west of some 250 feet.

Between Shot-points 111 and 142, the Intermediate phantom horizon shows a net rise to the west of approximately 1500 feet while the Deep phantom horizon shows a similar regional rise of 2000 feet.

Line 6-4 (Fig. KAF-15)

Data quality along Line 6-4 was generally fair but contradictory dip evidence made interpretation somewhat questionable. All three phantoms are drawn showing apparent contra-regional rise to the east. The phantom horizon at the base of the Pliocene shows a questionable rise to the east of about 500 feet; the Intermediate phantom horizon rises some 300 feet while the Deep phantom horizon rises approximately 400 feet.

Line 6-8 (Fig. KAF-16)

The data along Line 6-8 showed that the high axis observed on Lines 6-2 and 6-3 swings south-eastwards. At the Intermediate phantom horizon level the high axis occurs in the vicinity of Shot-point 17.

The Deep phantom horizon shows a reversal at Shot-point 18 with a fault at Shot-point 19 with displacement up to the north-east of some 800 feet. This throw was based on an attempted character correlation in the deep reflector on the original DMD section.

The phantom horizon at the base of the Pliocene shows a reversal between Shot-points 16 and 17.

The Era Thrust is shown to outcrop near Shot-point 18 but in the absence of any geophysical evidence, no displacement has been shown affecting the Pliocene phantom horizon.

The regional dip along Line 6-1 south-east extension, disproved any possibility of a reversal of pitch between Lines 6-3 and 6-8. Line 6-4, although it showed apparent contra-regional dip, is considered to be too far south of the main anticlinal axis to be of any significance. This apparent contra-regional dip is interpreted as a traversing of the north-eastern flank of the syncline established at the southern end of Line 6-3.

Line 6-11 (Fig. KAF-17)

The DMD quality along strike Line 6-11 was quite satisfactory especially between Shot-points 1 and 5.

The phantom horizon at the base of the Pliocene shows a net fall to the south-east of about 200 feet between Shot-points 1 and 14.

At the Intermediate phantom horizon level there is fall to the south-east of some 300 feet between Shot-points 1 and 5. Between Shot-points 5 and 10 the phantom horizon flattens and then falls a further 100 feet between Shot-point 10 and the end of the line.

The Deep phantom horizon shows a slight rise of less than 200 feet between Shot-points 1 and 8; this rise is not regarded as contra-regional but is associated with the eastern flank of the syncline at the southern end of Line 6-3. South-east of Shot-point 8 the phantom horizon flattens.

Line 6-12 (Fig. KAF-18)

Line 6-12 was the most easterly cross strike line recorded during the programme. The better quality data on Line 6-11 did not persist along Line 6-12.

The phantom horizon at the base of the Pliocene shows a high axis between Shot-points 10 and 11.

At the Intermediate phantom horizon level there is only fragmentary evidence of a gentle reversal in the vicinity of Shot-point 13.

The Deep phantom horizon is shown to be faulted between Shot-points 9 and 10. The DMD section on this line shows a marked break in continuity of the deep low-frequency reflection between Shot-points 8 and 13. A character correlation obtained by jumping from one part of the section to another suggests the displacement is down to the south-west with a throw of just under 0.200 seconds two-way time. At this depth this would represent a throw of about 1000 feet. The trends of the conflicting dip segments on Fig. KAF-18 suggests that the fault is probably normal.

Contour Maps Based on Migrated Cross-Section

Fig. KAF-4 is a depth contour map on the Deep phantom horizon based on the migrated cross-sections using "corrected" depth values. Structurally it is broadly similar to Fig. KAF-3. The regional rise to the west and north-west is about 7000 feet.

One significant difference in interpretation between Figs. KAF-3 and KAF-4 occurs to the north of the fault on Line 6-3. Fig.KAF-3 shows a rise of 0.150 secs to the north whereas Fig.KAF-4 shows a fall of some 1000 feet. Since there is virtually no reflection continuity north of the displacement, more weight is attached to the phantom horizon contoured on Fig.KAF-4.

Fig. KAF-5 is a contour map on the Intermediate phantom horizon based on the migrated cross-sections. At this level there was virtually no reflection continuity and the phantom horizon was generally based on fragmentary dip trends. Faults possibly affecting the Intermediate phantom horizon can be postulated from apparent diffraction patterns and anomalous dip trends but from the seismic data available it is not possible to infer the direction and throw of such faults.

An anticlinal axis is shown with maximum relief on Line 6-3 but this axis is shown to attenuate westwards as in the case of the Deep phantom horizon. Evidence on Line 6-1, parallel to strike, indicates a regional rise of some 5000 feet to the west and north-west without any significant evidence of pitch reversal.

If the rise along Line 6-1 is valid at the Intermediate phantom horizon level, then there would appear to be evidence of an unconformity between the Intermediate and Deep phantom horizons with westward convergence of the two horizons.

As in the case of the deeper horizons the contours on the Pliocene (see Fig. KAF-6) show a high axis on Line 6-3 which attenuates to the west and north-west along strike. The regional rise along strike is also indicated at the Pliocene phantom horizon level and is about 2500 feet. Unfortunately, data at this shallow level are generally of poor quality which further deteriorates westwards and therefore the amount of relief indicated is questionable.

The positioning of the Era Thrust is based on its surface outcrop, and where geological evidence of the overthrust Pliocene is not available no estimate of displacement has been attempted.

(iii) Experimental Refraction Line 6-4

The object of the refraction programme was to determine whether the dense "Taurian" limestone could be observed at all in the area as a first arrival and, if so, to establish its depth. Previous refraction experience in the general area suggests there may be facies changes within the dense "Taurian" limestone.

Refraction Line 6-4 runs east-west and is located some 29,000 feet south of the Puri No. 1 Well location; it consists of two spreads each of 24 British Petroleum swamp geophones at 500 feet intervals, constituting a total geophone coverage of 22,500 feet. Four shot-points were chosen at points of easy access. A, B, and C were to the west of the spreads at distances of 38,300, 18,700 and 5000 feet respectively from Geophone Station 101. Shot-point D was situated to the east of the spreads at an approximate distance of 1500 feet from Geophone Station 146. (See Fig. KAF-2). Charge sizes up to 3000 lb were used from the distant Shot-points A and B.

For the refraction programme the recording equipment was modified to give a filter pass band from 2 to 40 c/s and suitable AGC time constants. The shooters were supplied with radios and KAV pip-pip units to transmit a time-break with subsequent pips at one-second intervals.

Topography shots were recorded at every fourth station so that complete station-by-station coverage was obtained for weathering corrections. (See Fig. KAF-20.) The mean sub-weathering velocity was 5900 feet/sec and the assumed weathering velocity was 2000 feet/sec. The effect of the weathered layer was again removed by determining the delay time associated with it and thence its depth. Shot-point and station elevation corrections were then applied from the base of the weathered layer down to the sea level datum using the appropriate "oblique" velocities.

The quality of the variable-area refraction records was generally satisfactory but some doubtful radio time-breaks were recorded owing to interference caused by the Carter unit power-pack. Good time-breaks and pips were recorded on the nearest spread to Shot-points A and C, but for the other shots the time-breaks were difficult to read.

Shallow refractors beneath the sub-weathering zone, ranging in velocity from 7000-8500 feet/sec, were recorded as first events on near shots from Shot-points C and D, and were also recorded as strong later events at greater distances from Shot-points A and B (See Fig. KAF-19). However, for this study attention was directed towards the following two refractors -

(a) Green Refractor: true velocity - 10,000 feet/sec.
(b) Blue Refractor (dense "Taurian" limestone): assumed velocity - 17,000 feet/sec.[1]

(a) <u>Green Refractor</u>

Delay-time profiles were drawn using an assumed velocity of 10,000 feet/sec. A continuous profile shot towards the east was constructed using delay time segments from Shot-points B_2, C_1, and B_1. This was matched with the delay time segment shot to the west from Shot-point D_2; this was accomplished without tilting at a double offset distance of 3500 feet. The match gives two-way sub-surface control over some 16 geophone stations.

Using projected reciprocal times between Shot-points C and D, half-intercept times were plotted under Stations 106, 110, 116 and 120. The mean profile fits the half-intercept points satisfactorily with a maximum error of $\pm$ 0.010 sec.

The overburden velocity down to this refractor, based on the Wana velocity survey, was taken as 7000 feet/sec; this gives a conversion factor (V_r tan I) of 9800 feet/sec. The general depth of the matched profile is about 3000 feet with a dip down to the west in excess of 200 feet/mile.

(b) <u>Blue Refractor</u>

The survey apparently failed to record limestone as a first arrival but a later high-velocity event was recorded shooting to the west from Shot-point D. A less well-defined high-velocity event was recorded from Shot-point C, but was considered too doubtful to be used in interpretation.

Footnote: (1) During this survey, the Green Refractor always had an apparent velocity of 10,500 feet/sec shooting east and 9000 feet/sec shooting west. The blue Refractor was only recorded shooting west and had an apparent velocity of 18,500 feet/sec.

Since no satisfactory reversed coverage was obtained from this refractor, the results are displayed as a delay time profile based on an assumed true velocity of 17,000 feet/sec (Fig. KAF-21 A).

Based on an extrapolation from the Wana velocity curve the overburden velocity was taken within the limits of 8200 feet/sec to 9000 feet/sec giving depth conversion factors of 9300 feet/sec and 10,500 feet/sec respectively. The intercept time at Shot-point D indicates that the depth of the refractor lies within the limits of 11,000 to 13,000 feet along the eastern end of the line. The two depth profiles (Fig. KAF-21 C) are displaced an assumed single offset distance of 5000 feet towards Shot-point D.

The apparent velocity is 18,500 feet/sec, so the limestone apparently dips down to the east at the rate of 150 feet/mile.

There is evidence of a high-velocity event moving across the Teledeltos monitor record shot from Shot-point A, into spread I, at a distance of some 50,000-60,000 feet. Owing to the lower dynamic range of the VAP equipment this energy is not detected as a recognisable event on the Variable Area records. Unfortunately, the event is too indistinct for precise times to be picked on the Carter playbacks but the apparent velocity is about 18,000 feet/sec. Using the approximate intercept time at Shot-point A, the minimum depth of the refractor would be about 16,000 feet. This could well represent basement depth in the area.

The tapes recorded from Shot-points A and B were played back at maximum gain through variable filter settings to test whether a weak first arrival from the limestone could be brought out, but no evidence of such an arrival was apparent.

In the absence of two-way control for the limestone, the 10,000 feet/sec refractor was profiled as a higher marker for determining structural trends over the line. The results indicate that the shallower marker dips to the west, whereas the limestone apparently shows regional east dip.

(iv) Identification of the Dense "Taurian" Limestone Level

In the case of a possible drilling location, the correct identification of the region on the DMD sections corresponding to the dense "Taurian" limestone would be of critical importance owing to the depth limitation of the helirig.

The main problem is whether the strong semi-continuous low-frequency reflection originates from the dense "Taurian" limestone or from some deeper horizon in the Mesozoic, probably the Cretaceous. This reflection is the first strong event on the records. The velocity contrast at the top of the dense "Taurian" limestone is the highest strong velocity contrast in the section; hence one might expect the first good reflection to come from the top of this formation.

On the other hand it is possible that reflections observed on seismic records are actually interference patterns between component reflections from individual velocity contrasts covering a depth range of about a wave-length. This could be several hundred feet and it follows that a highly stratified medium with many small velocity contrasts might give a stronger reflection than a single interface across which a large velocity contrast occurs.

There are two places where evidence relating to the problem of identifying the dense "Taurian" limestone level is available, namely refraction Line 6-4 and the link to previous refraction and marine reflection at the southern end of Line 6-7. (See Fig. KAF-2). In both cases the evidence is not thought to be of adequate quality to resolve the problem entirely.

Refraction Line 6-4

If the later arrival from Shot-point D is regarded as a second event refraction from the dense "Taurian" limestone, the intercept time at the shot-point indicates that the limestone depth lies within the limits of 11,000 - 13,000 feet along the eastern end of Line 6-4, and gives a vertical reflection time for zero distance of 2.8 sec. This would then suggest that the refractor is probably shallower than the prominent deep reflector recorded at 3.0 sec at the southern end of reflection Line 6-3. This, of course, depends on the anisotropy assumptions, and with any second event there is uncertainty as to what part of the wave train is being timed on the record. An approximate depth of 11,000 feet was transferred to the southern end of Line 6-3 in the vicinity of Shot-point 10 (see Fig. KAF-8), and the phantom labelled "Intermediate horizon". It is likely that this phantom is shallower than the dense "Taurian" limestone if in fact the dense "Taurian" limestone exists as such.

If the event from Shot-point D is regarded as wide-angle reflection it can be identified with the prominent deep reflection on Line 6-3. The T^2/X^2 plot (see Fig. KAF-22) gives reasonable straight alignment with a reflection time for zero distance of 2,950 sec. The slope gives an average velocity to the reflection of some 9200 feet/sec; this average velocity is surprisingly high unless the section above the reflector includes limestones, i.e. the prominent reflection might be deeper than the dense "Taurian" limestone.

Reflection Line 6-7

At the southern end of Line 6-7 the prominent low-frequency reflector is at a two-way time of 2.3 to 2.4 sec and ties very well in time with a reflection of similar character in the marine reflection survey along the Era River, immediately opposite the southern end of Line 6-7. An attempt has been made to trace the dense "Taurian" limestone level up the Era River from Wana using the United Geophysical strata-prints. The control is fairly good as far as the Era-Aiowa junction, but between Aiowa junction and the southern end of Line 6-7 there are some poor quality data and contradictory dips. Consequently the marine data give no indisputable dense limestone level at the southern end of Line 6-7 but reasonable interpretations favour the dense limestone level to be shallower than the prominent deep reflector. The deepest interpretation places the dense limestone level at a two-way time of 2.0 sec.

Refraction Line 1-12

Refraction should give the most positive depth control to the limestone, and Shot-point B (Line 1-12) is in the vicinity of the southern end of Line 6-7 (See Fig. KAF-2). The time distance curve available for refraction Line 1-12 originates from Seismic Party No. 1 in Fig KAA-7P (not included in this report). Unfortunately the cover on the lime stone refractor between Shot-point B and the spread into which it was shot is far from complete. Certain assumptions must be made in extrapolating back to the shot-point to arrive at an intercept time. Furthermore, no correction for LVL variations has been applied to Line 1-12, and consequently the exact intercept time at Shot-point B is questionable and probably lies within the limits 1.8 to 2.0 sec. These intercept times correspond to reflection times of 2.0 and 2.2 sec respectively.

Since the deep prominent reflection occurs between 2.3 and 2.4 sec at the southern end of Line 6-7 the longer intercept time at Shot-point B converted to a reflection time might suggest that the reflection originated from the dense "Taurian" limestone. However, the shorter intercept time converted to a reflection time would place the dense "Taurian" limestone shallower than the deep reflection.

Assuming a limestone thickness of 2500 feet, including the Eocene, and an interval velocity of 16,500 feet/sec, then the reflection time to the base of the limestone would be 0.3 sec longer than that to the top. Thus the prominent reflection might be from near the top of the Cretaceous.

The evidence of lack of conformity between the deep reflector and results above it, might be considered to support this view as there is an unconformity between the Mesozoic and the Tertiaries. Again the validity of the reflection data at the Intermediate phantom horizon level might be considered questionable and therefore the seismic evidence of apparent unconformity would be spurious.

Wana-Baimura Area

Line 6-9 (Wana-Baimuru) - Report KAH

The (unpublished) results of a waterborne reflection survey carried out by United Geophysical Company in 1957 show an attractive "high" some 23,000 feet south-east of Wana. This contra-regional rise from the Wana well is contradicted by an earlier refraction line over the same ground (Line 1-4) (Fig. KAH-1). There are two possible explanations:-

(a) The marine reflection interpretation could be in error since no direct tie exists from Wana to the structure and some of the data connecting the Era and Pie river system were extremely poor.

(b) The refractor along Line 1-4 could possibly not conform to the bedding but rather follow a boundary between a marked facies change within the limestone.

Reflection Line 6-9, some 4 miles in length, was programmed to extend south-eastwards from Wana to prove or disprove the existence of north-west reversal on the generally south-east pitching Wana fold. (See Fig. KAH-1).

Operating conditions were relatively simple along Line 6-9 since the ground was flat and dry weather had caused a substantial drop in water level.

Experience gained from production recording along the low-lying southern end of Line 6-7 showed that the pre-filtering was too severe and for Line 6-9 the Hall-Sears setting used was 30 c/s cut-off at a slope of 18 db/octave.

The quality of the data varied from very poor at the Wana end of the line near the Era River to good south-east of Shot-point 17. Some semi-continuity occurred at most levels but there is apparent contradiction in dip displayed by some of these line-ups, making interpretation difficult.

Four phantom horizons were constructed from the migrated dip segments on Fig. KAH-2. One was at the base of the Pliocene, one at the top of the dense "Taurian" limestone and one at the top of the Cretaceous. These three phantom horizons were tied in depth to the Wana No. 1 Well. The fourth phantom horizon probably a horizon in the basement, was chosen to follow the zone of deep low-frequency reflections. This reflection is not thought to correlate with the one of similar character recorded in the Puri survey.

All phantom horizons display a net drop to the south-east. The dense limestone phantom horizon shows some undulation in the vicinity of Shot-point 12 but there is an overall drop of 300 feet to the south-east. The phantom horizon at the top of the Cretaceous is more difficult to draw; at this level, except for the part of the line south-east of Shot-point 15, the evidence is conflicting and alternative interpretations could indicate some rise to the south-east from Wana, beneath the dense limestone level. From the fairly continuous alignments on the DMD section the most optimistic interpretation would indicate a rise from Wana to Shot-point 13 and another alternative would show a rise to Shot-point 6 followed by a fall to the south-east. Between Shot-points 10 and 13 the results are particularly confused and could be explained by faulting.

The Wana-Baimuru hypothetical structure has been down-graded by the observation of Line 6-9 but in view of the contradictory indication of the fairly continuous alignments and the dips of the better individual reflections, it is not considered that the result is wholly conclusive.

The fall of some 300 feet to the south-east at the dense limestone level, based on the better individual reflection data, confirms the result along the previous refraction Line 1-4. Over the same distance the dense limestone refractor shows a drop in excess of 400 feet to the south-east.

VII. CONCLUSIONS

The anticlinal feature observed on reflection Line 6-3 attenuates to the north-west along south-east regional plunge. There was no evidence of any significant pitch reversal along strike Line 6-1 and therefore no structure worth drilling in the area to the south of the Puri and Kereru Anticlines.

Refraction Line 6-4 failed to record limestone as a first arrival but in view of the negative reflection results the question of identification of the dense "Taurian" limestone level is no longer of immediate importance. The later event recorded on Line 6-4 could well be correlated with the 3.0 sec vertical reflection event on Line 6-3 but this does not establish its source to be the dense "Taurian" limestone.

If the source is the dense "Taurian" limestone a reasonable estimate would place its level somewhere between the Intermediate and Deep phantom horizons.

REFERENCES

WYROBEK, S.M. 1956 Application of delay and intercept times in the interpretation of multilayer refraction time distance curves. Geophys. Prosp. 4 (2), 112-130

APPENDIX

Statistics

1. Line Cutting, Helicopter Clearings, and Surveying -

Length of line cut	521,900 ft
No. of helicopter clearings completed	177
Length of line surveyed for reflection	441,600 ft
" " " " " refraction	22,500 ft
" " " " " ready for drilling but abandoned	100,000 ft

2. Drilling:- 5 Crews -

Crew days in field	582
" " " base	584
Number of holes drilled	454
Total footage	30,369
Average depth	68 ft
Number of hrs. drilling	4,074
" " " travelling and rigging	875
Average rate of penetration	$7\frac{1}{2}$ ft/hr
Quantities of mud, chemicals and casing used	NIL
Hawthorne bit assemblies used	8
$3\frac{1}{2}$" Hard formation blades used	30
$3\frac{1}{2}$" Regular formation blades used	12

3. Observing -

Duration of survey	32 weeks
Days in the field	137
" " base (productive time - e.g. maintenance etc.)	47
Days in base	37
Average productive hours per week	49
Spreads occupied, reflection	357
Number of miles traversed, reflection	75
" " " " refraction (Geophone coverage)	4
Dynamite used, refraction	14,000 lb
" " reflection	10,170 lb
No. of detonators used	1,368
" " reflection shots	1,020
Average charge size reflection	10 lb
No. of holes shot "	370

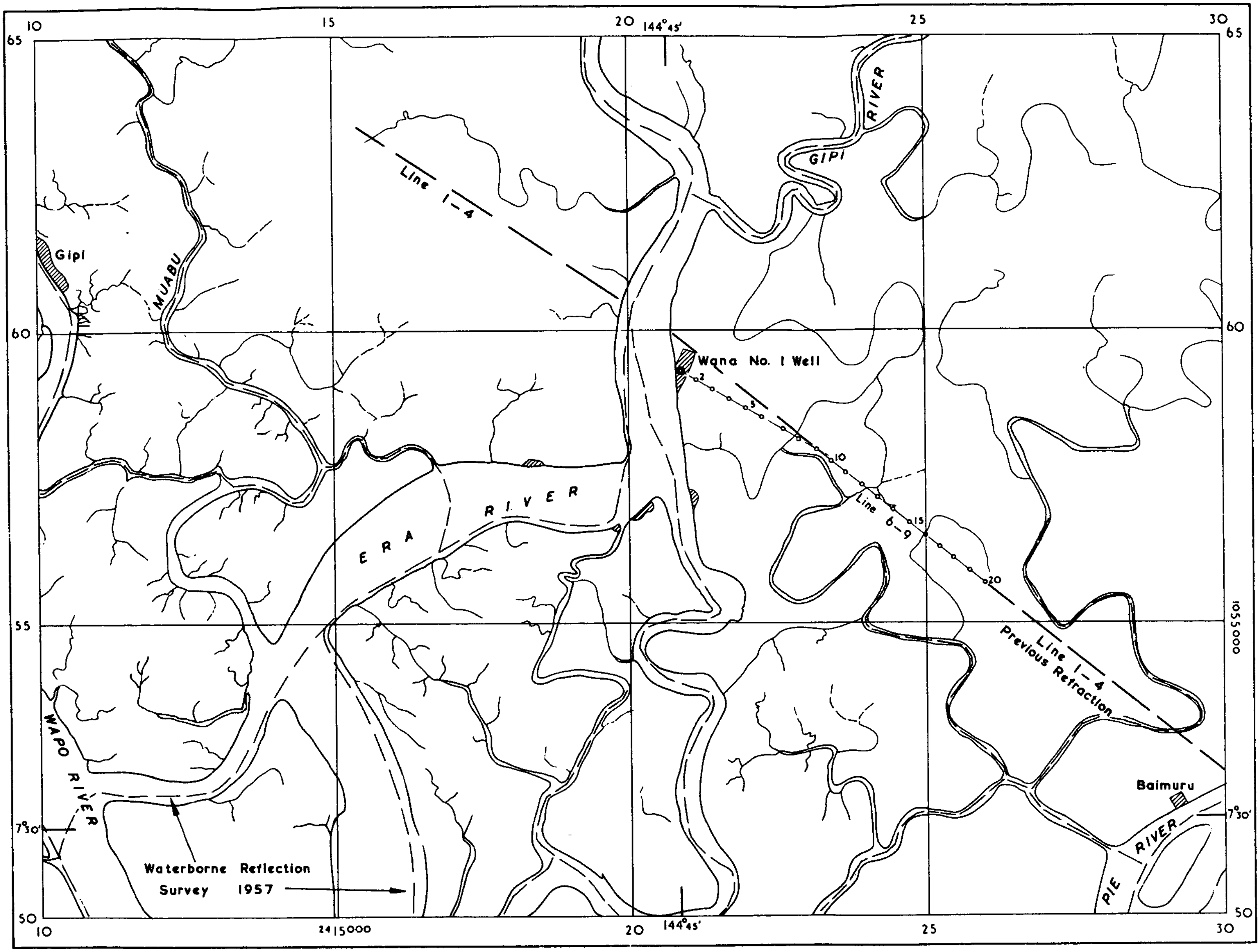
APPENDIX (Cont'd)

4. Personnel and Labour -

	SSL	Operator	
Personnel	8	12	
Skilled labour	-	12)	
Canoe operators	-	7)	
Surveying labour	-	84)	
Drilling labour	-	90)	Total - 256
Observing labour	-	40)	
Helicopter, Camp, General labour	-	3)	
Domestics	-	20)	

5. Time Lost in Field -

Waiting on water	NIL
Bad weather	5 days
Helicopter availability	3 days



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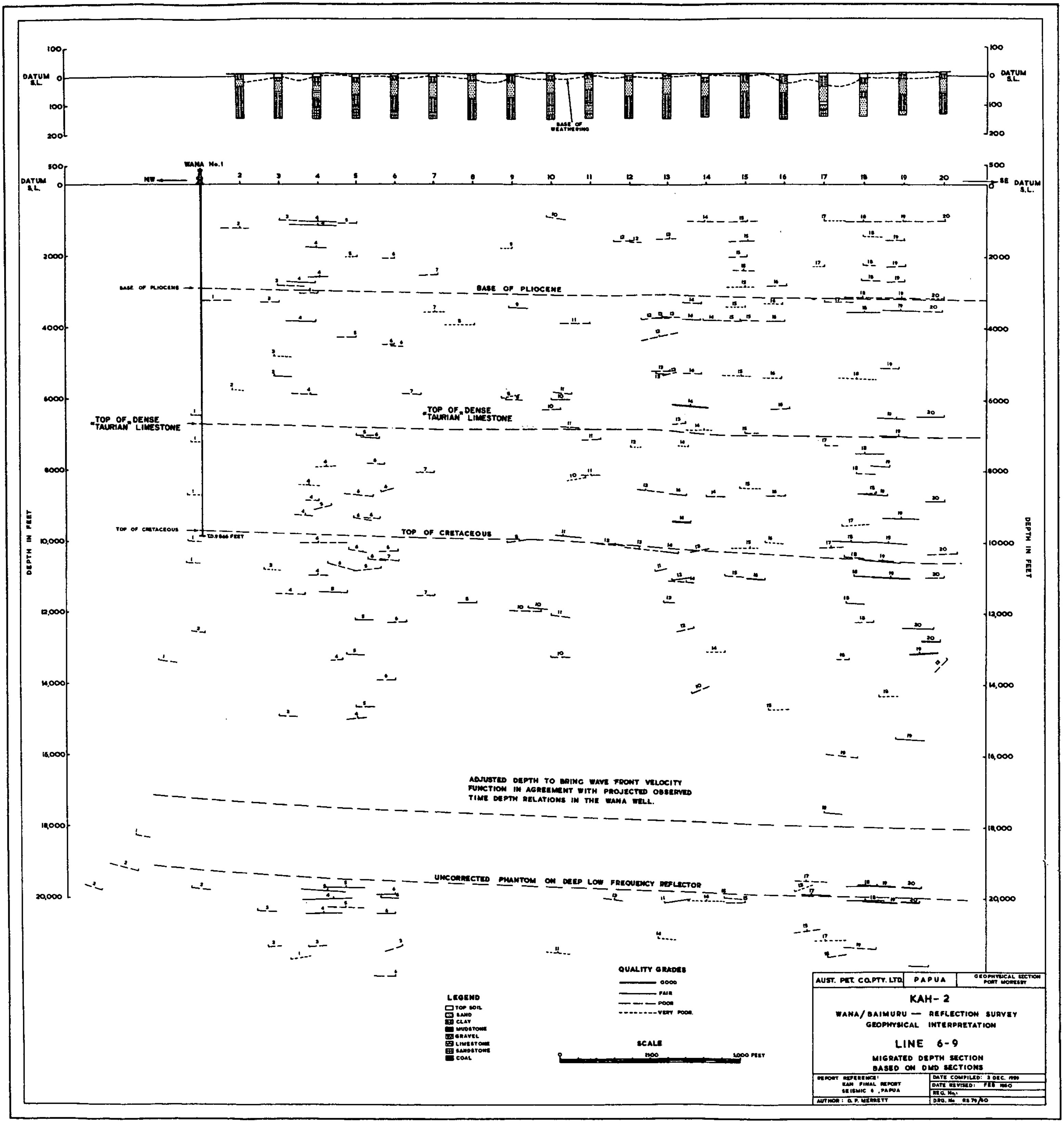
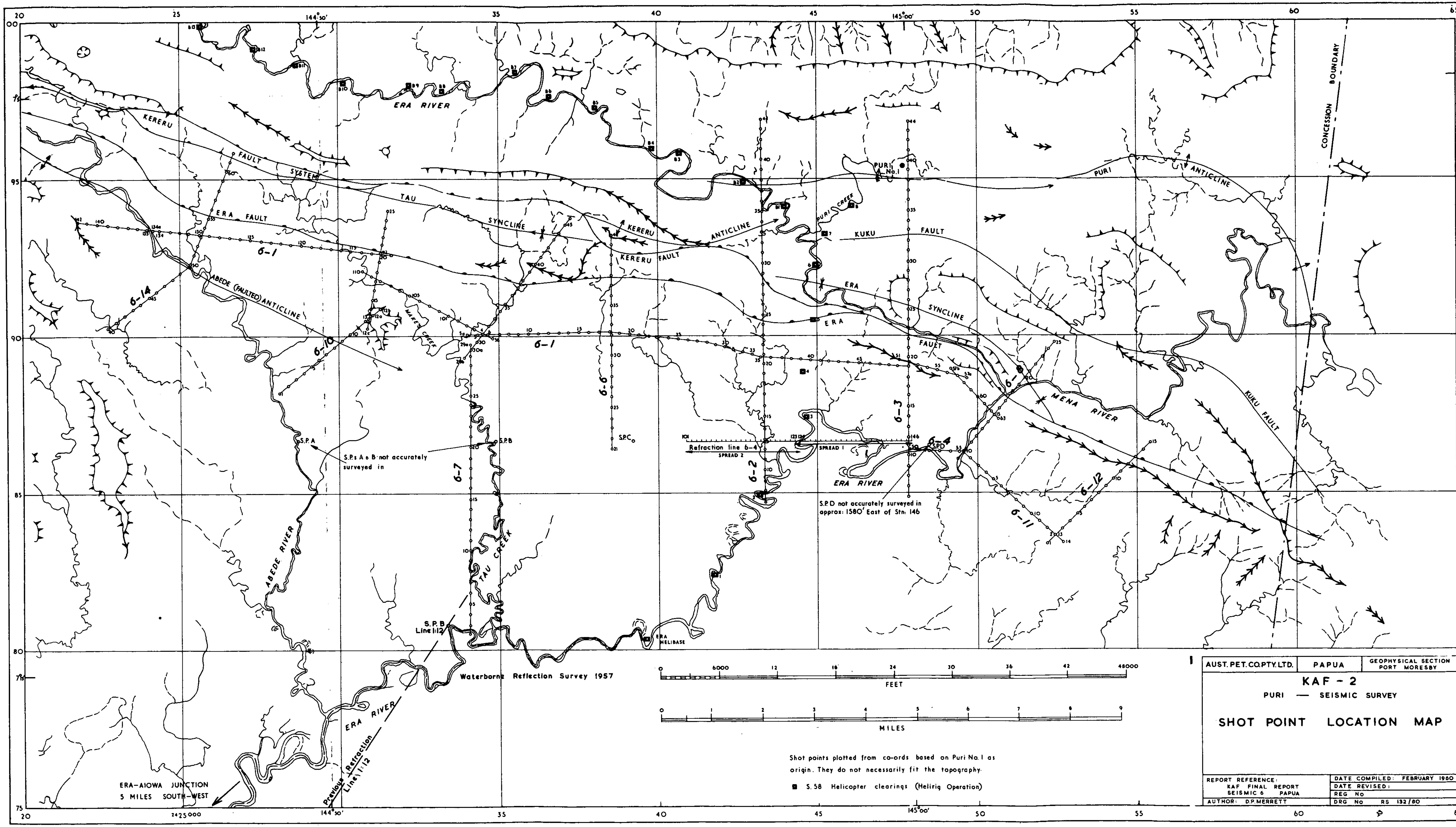
WANA — BAIMURU

SHOT POINT LOCATION MAP

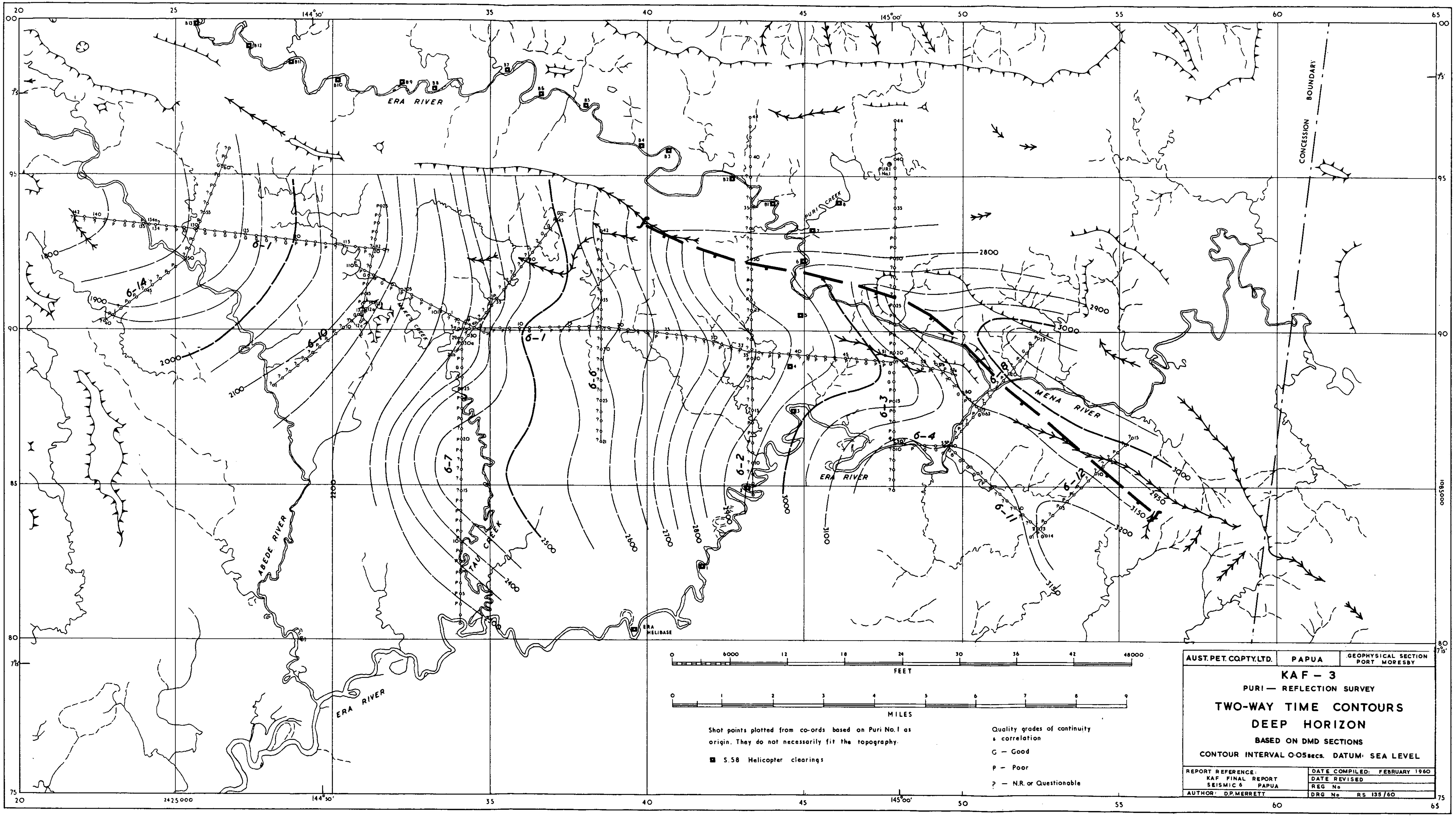
REPORT REFERENCE KAH FINAL REPORT SEISMIC 6 PAPUA	DATE COMPILED: FEBRUARY 1960
	DATE REVISED:
	REG No
AUTHOR: D.P. MERRETT	DRG No RS 130/60

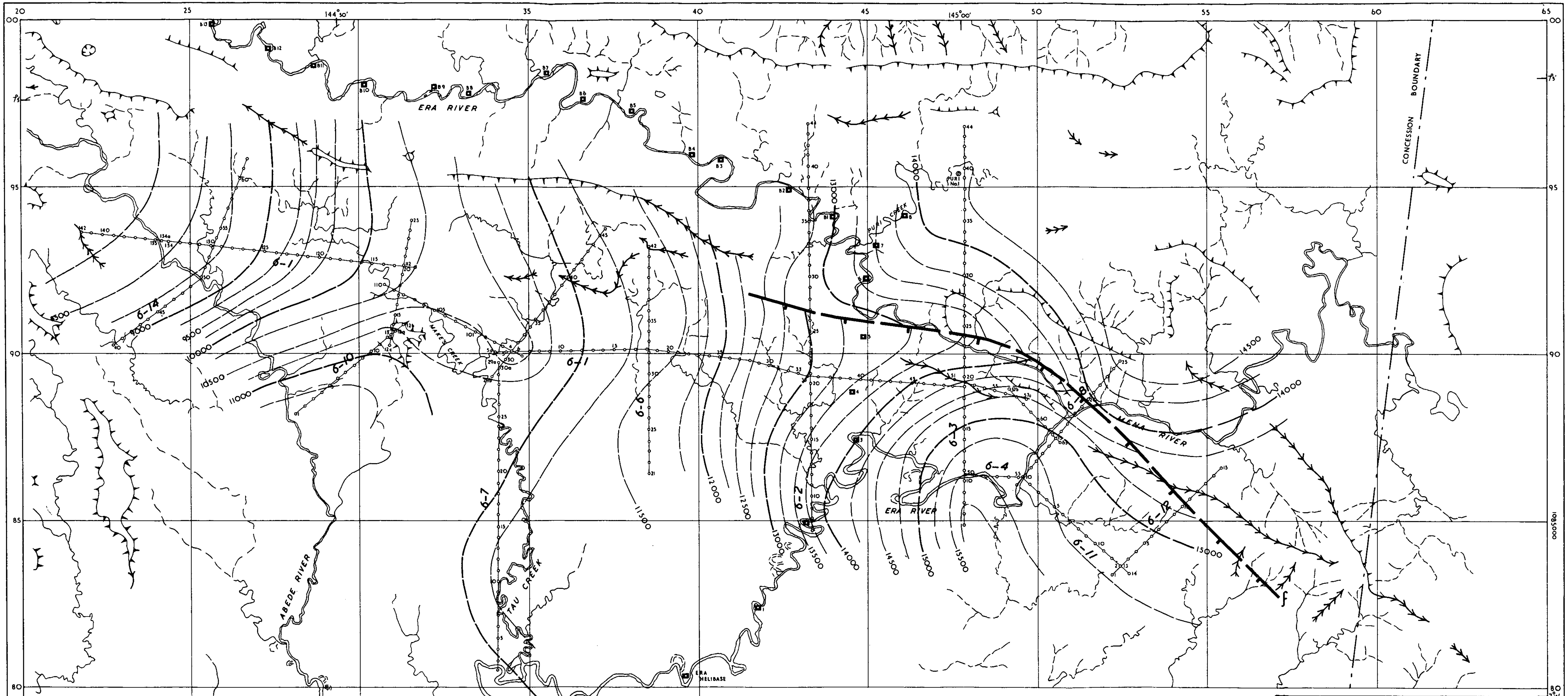


DATUM S.L.
BASE OF WEATHERING
WANA No. 1
NW
SE
BASE OF PLIOCENE
"TOP OF" DENSE "TAURIAN" LIMESTONE
TOP OF CRETACEOUS
T.D. 9846 FEET
DEPTH IN FEET
ADJUSTED DEPTH TO BRING WAVE FRONT VELOCITY FUNCTION IN AGREEMENT WITH PROJECTED OBSERVED TIME DEPTH RELATIONS IN THE WANA WELL.
UNCORRECTED PHANTOM ON DEEP LOW FREQUENCY REFLECTOR
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR.
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
SCALE
0
1000 FEET
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAH- 2
WANA/BAIMURU — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-9
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAH FINAL REPORT SEISMIC 6, PAPUA
AUTHOR: G. P. MERRETT
DATE COMPILED: 2 DEC. 1959
DATE REVISED: FEB 1960
REG. No.:
DRG. No. RS 79/60



LAMBERT CONICAL ORTHOMORPHIC
PROJECTION – SOUTHERN NEW GUINEA ZONE


AUST. PET. CO.PTY.LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF – 3
PURI — REFLECTION SURVEY
TWO-WAY TIME CONTOURS
DEEP HORIZON
BASED ON DMD SECTIONS
CONTOUR INTERVAL 0·05secs. DATUM: SEA LEVEL
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA
AUTHOR: D.P.MERRETT
DATE COMPILED: FEBRUARY 1960
DATE REVISED
REG No
DRG No RS 135/60
FEET
MILES
Shot points plotted from co-ords based on Puri No. 1 as origin. They do not necessarily fit the topography.
S.58 Helicopter clearings
Quality grades of continuity & correlation
G – Good
P – Poor
? – N.R. or Questionable
ERA RIVER
MENA RIVER
ABEDE RIVER
TAU CREEK
PURI CREEK
CONCESSION BOUNDARY
ERA HELIBASE
PURI No.1
144°30'
145°00'
7°15'



AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

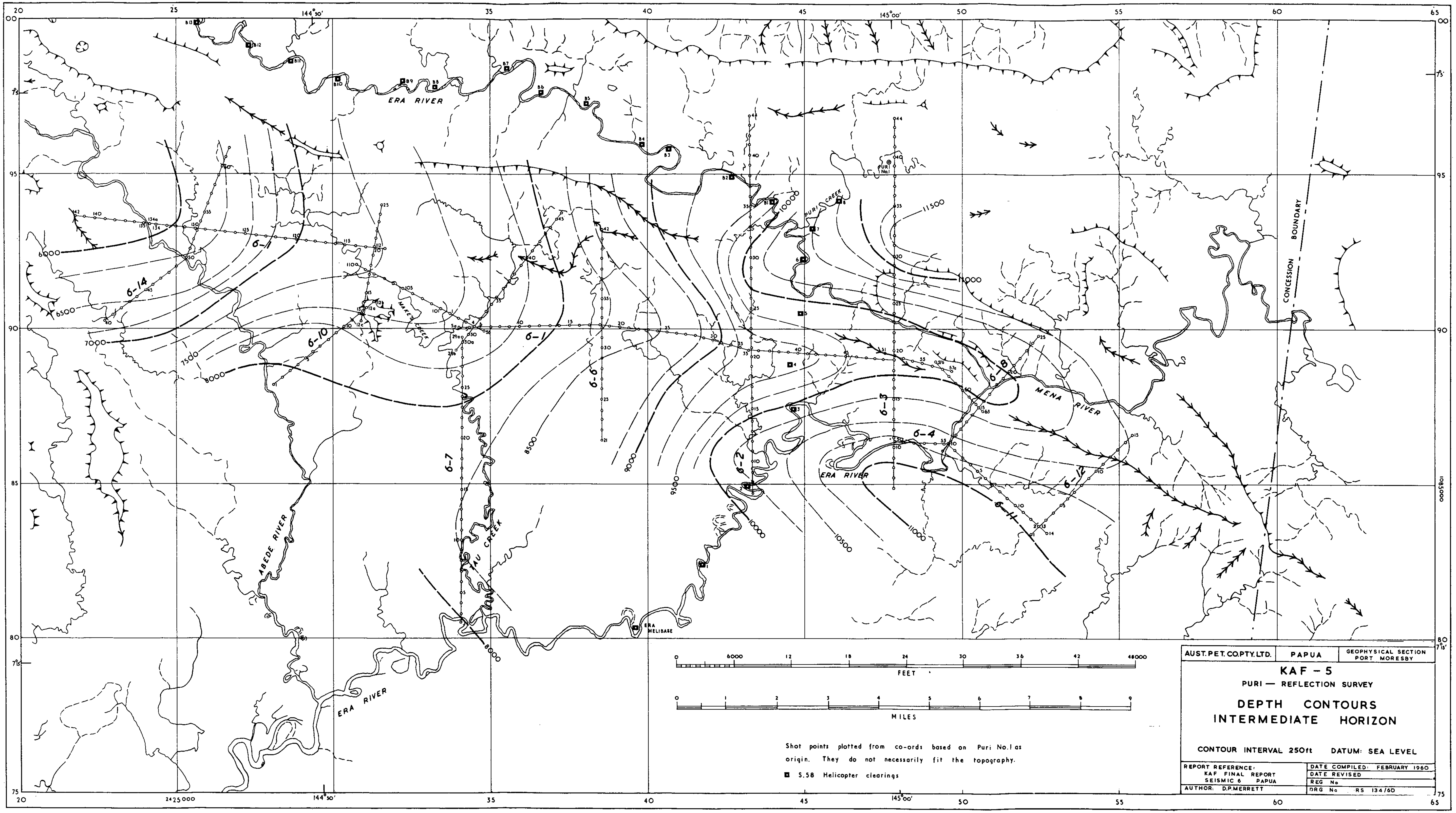
KAF – 4

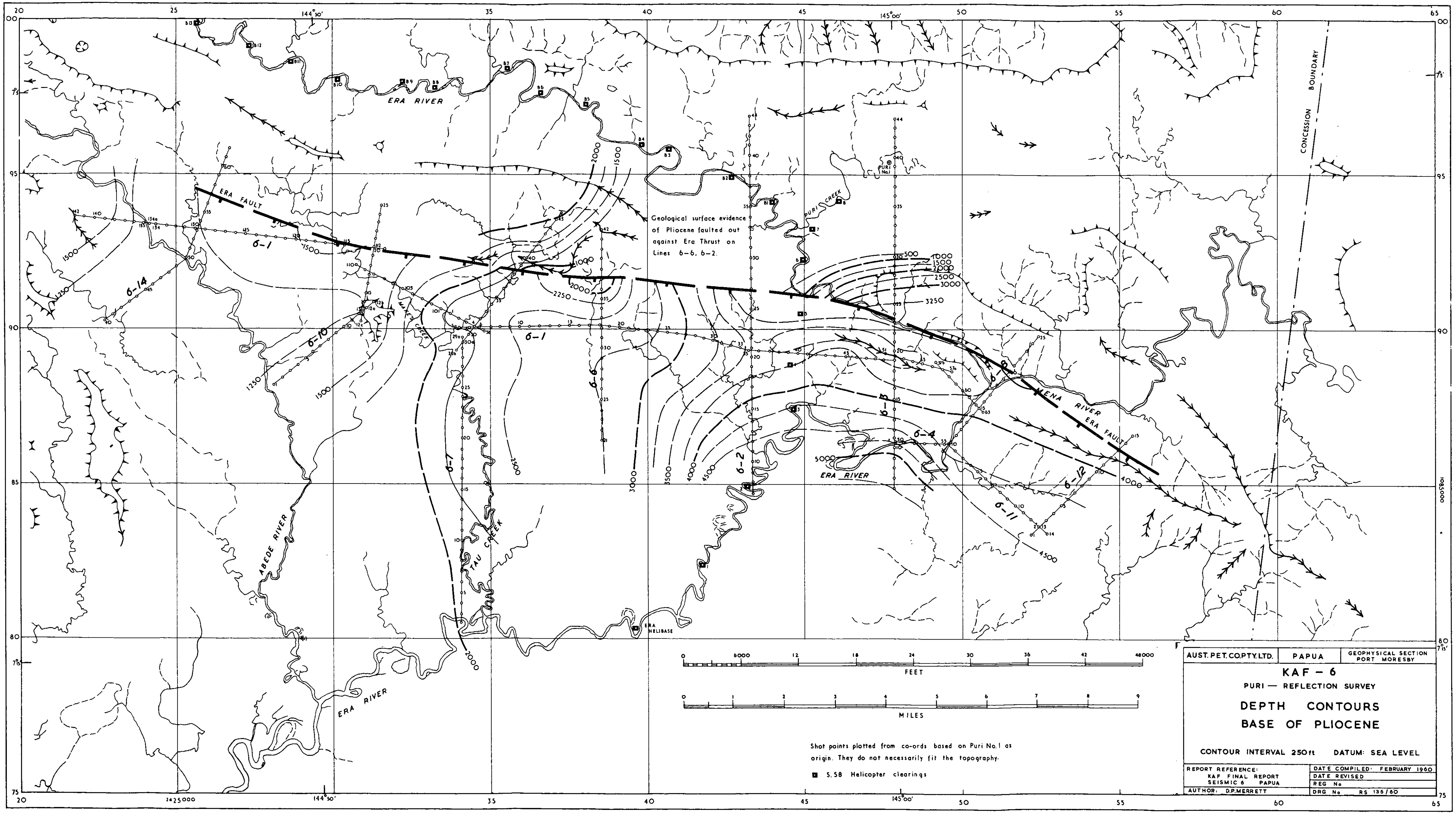
PURI — REFLECTION SURVEY

DEPTH CONTOURS DEEP HORIZON

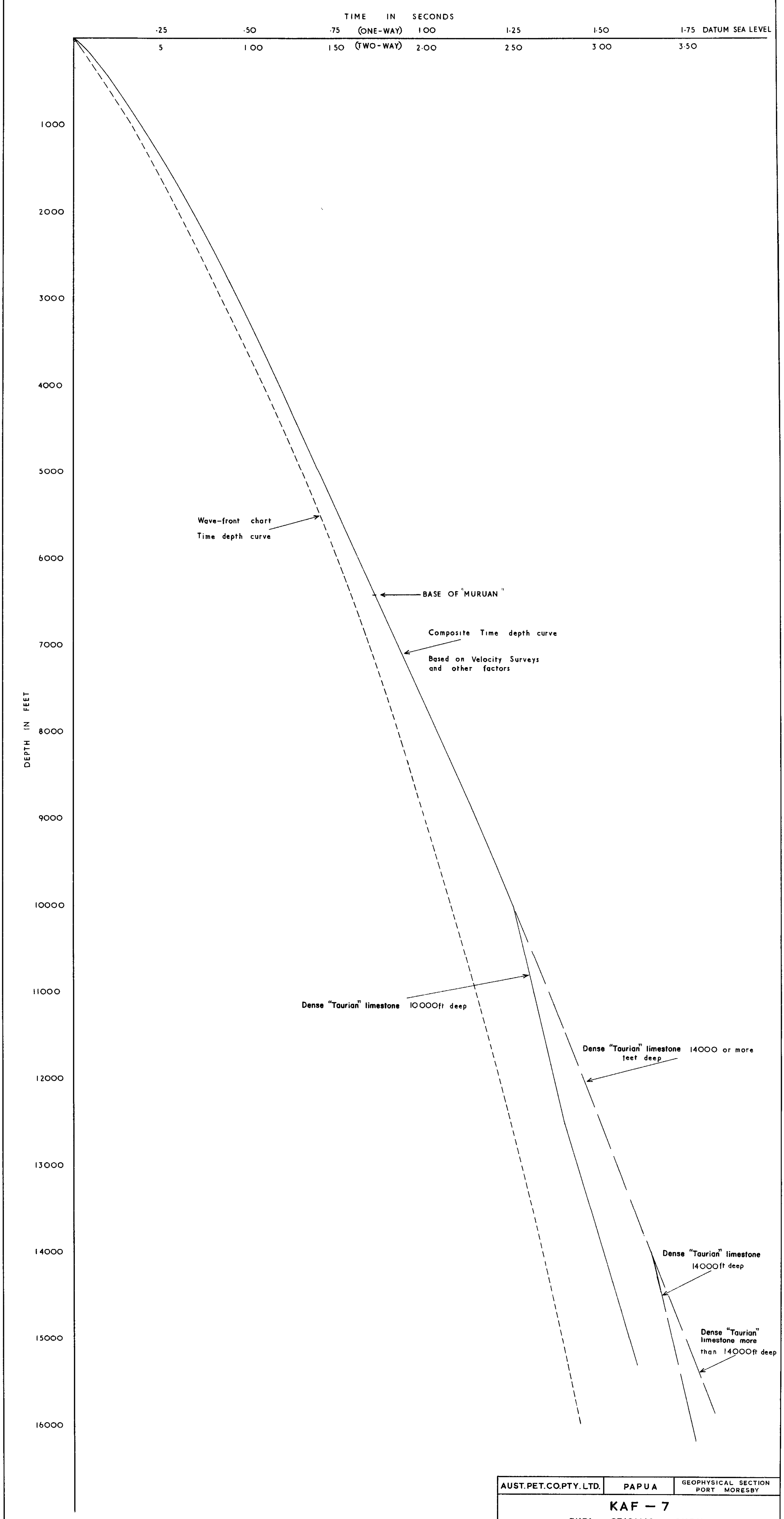
CONTOUR INTERVAL 250ft DATUM: SEA LEVEL

REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA	DATE COMPILED: FEBRUARY 1960
	DATE REVISED
	REG No
AUTHOR: D.P. MERRETT	DRG No RS 133/60


ERA RIVER
PURI CREEK
MENA RIVER
ABEDE RIVER
TAU CREEK
MAKES CREEK
CONCESSION BOUNDARY
ERA HELIBASE
PURI No.1
6-14
6-10
6-1
6-6
6-7
6-2
6-3
6-4
6-8
6-11
6-12
6000
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
144°30'
145°00'
FEET
MILES
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF - 5
PURI — REFLECTION SURVEY
DEPTH CONTOURS
INTERMEDIATE HORIZON
CONTOUR INTERVAL 250ft DATUM: SEA LEVEL
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA
AUTHOR: D.P.MERRETT
DATE COMPILED: FEBRUARY 1960
DATE REVISED
REG No
DRG No RS 134/60
Shot points plotted from co-ords based on Puri No.1 as origin. They do not necessarily fit the topography.
S.58 Helicopter clearings



ERA RIVER
ERA FAULT
CONCESSION BOUNDARY
PURI CREEK
PURI No.1
Geological surface evidence of Pliocene faulted out against Era Thrust on Lines 6-6, 6-2.
6-1
6-14
6-10
6-6
6-7
6-2
6-3
6-4
6-11
6-12
MENA RIVER
TAU CREEK
ABEDE RIVER
ERA HELIBASE
FEET
MILES
Shot points plotted from co-ords based on Puri No.1 as origin. They do not necessarily fit the topography.
S.58 Helicopter clearings
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF – 6
PURI — REFLECTION SURVEY
DEPTH CONTOURS
BASE OF PLIOCENE
CONTOUR INTERVAL 250ft DATUM: SEA LEVEL
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA
AUTHOR: D.P.MERRETT
DATE COMPILED: FEBRUARY 1960
DATE REVISED
REG No
DRG No RS 136/60



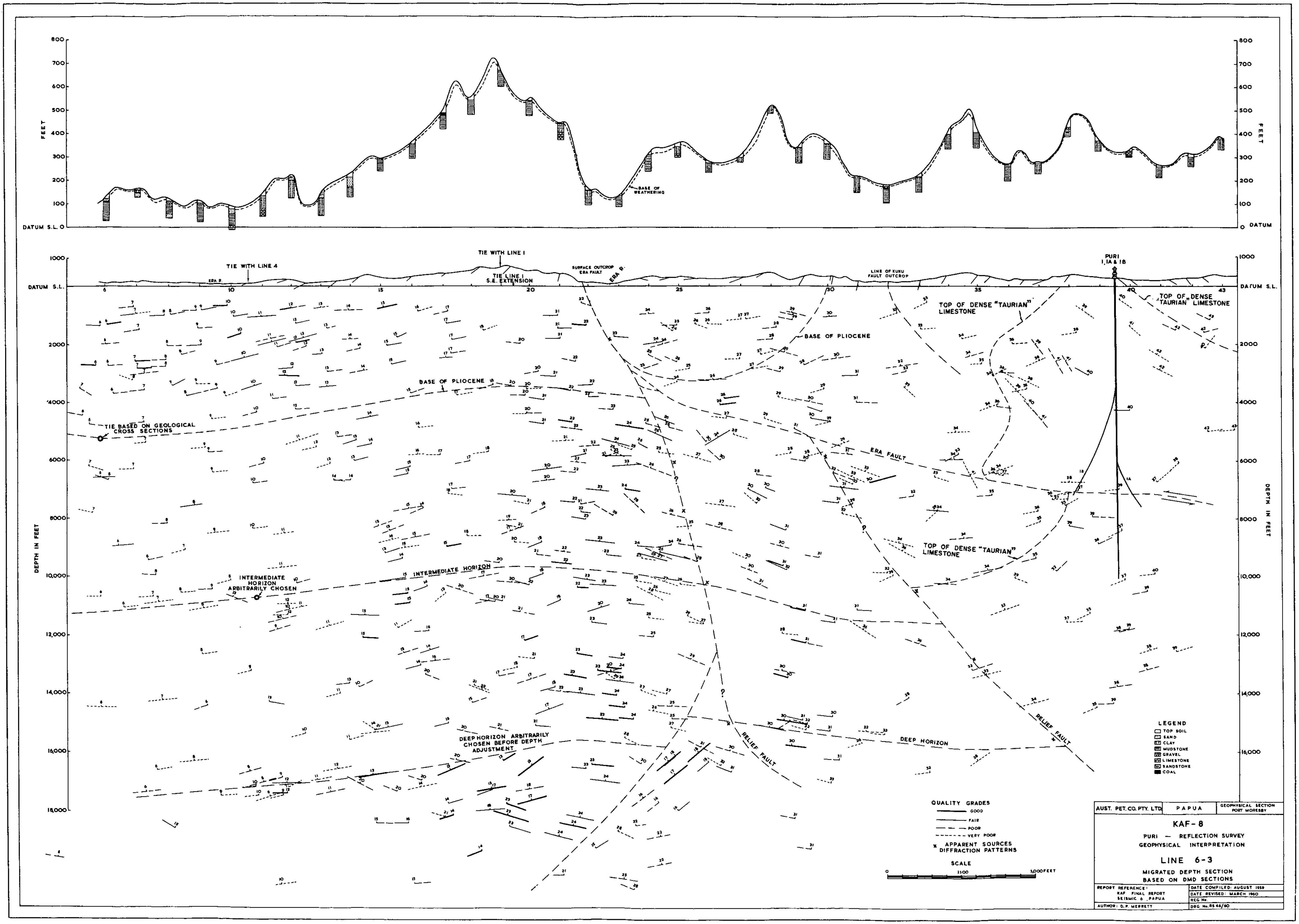
AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

KAF — 7

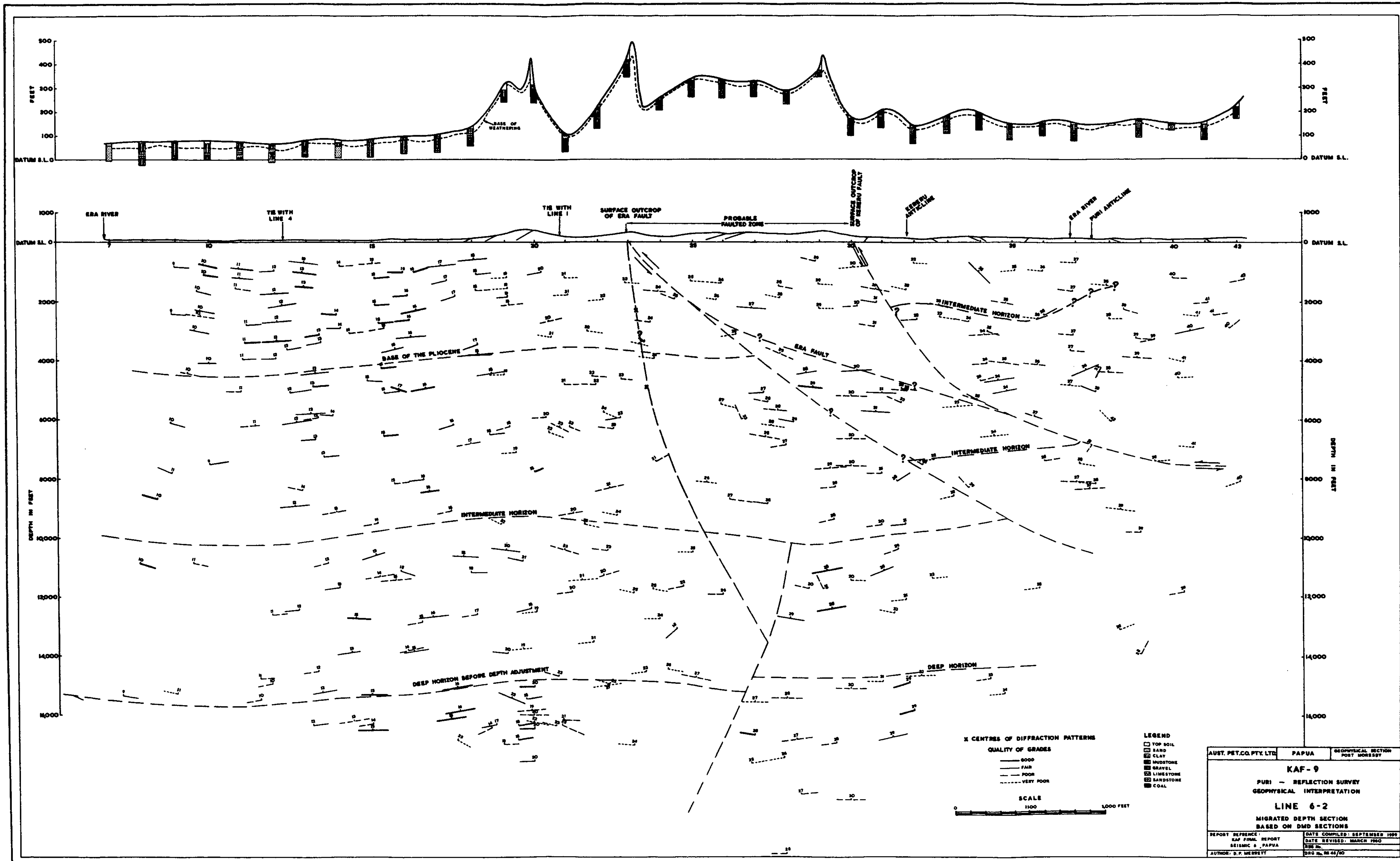
PURI — SEISMIC SURVEY

TIME — DEPTH CURVES

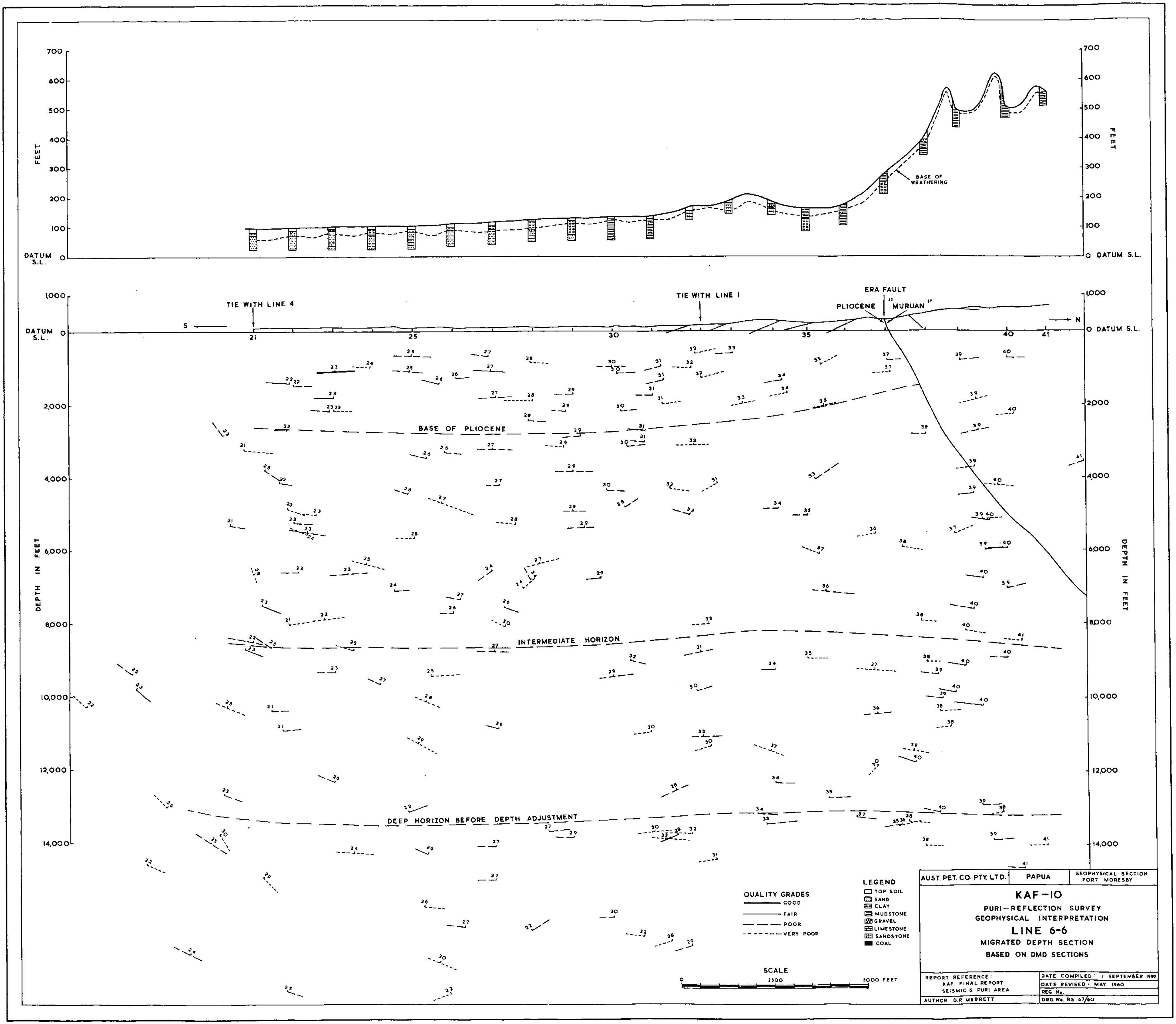
REPORT REFERENCE KAF FINAL REPORT SEISMIC 6 PAPUA	DATE COMPILED FEBRUARY 1960
	DATE REVISED
	REG No
AUTHOR. D.P. MERRETT	DRG No RS 144/60



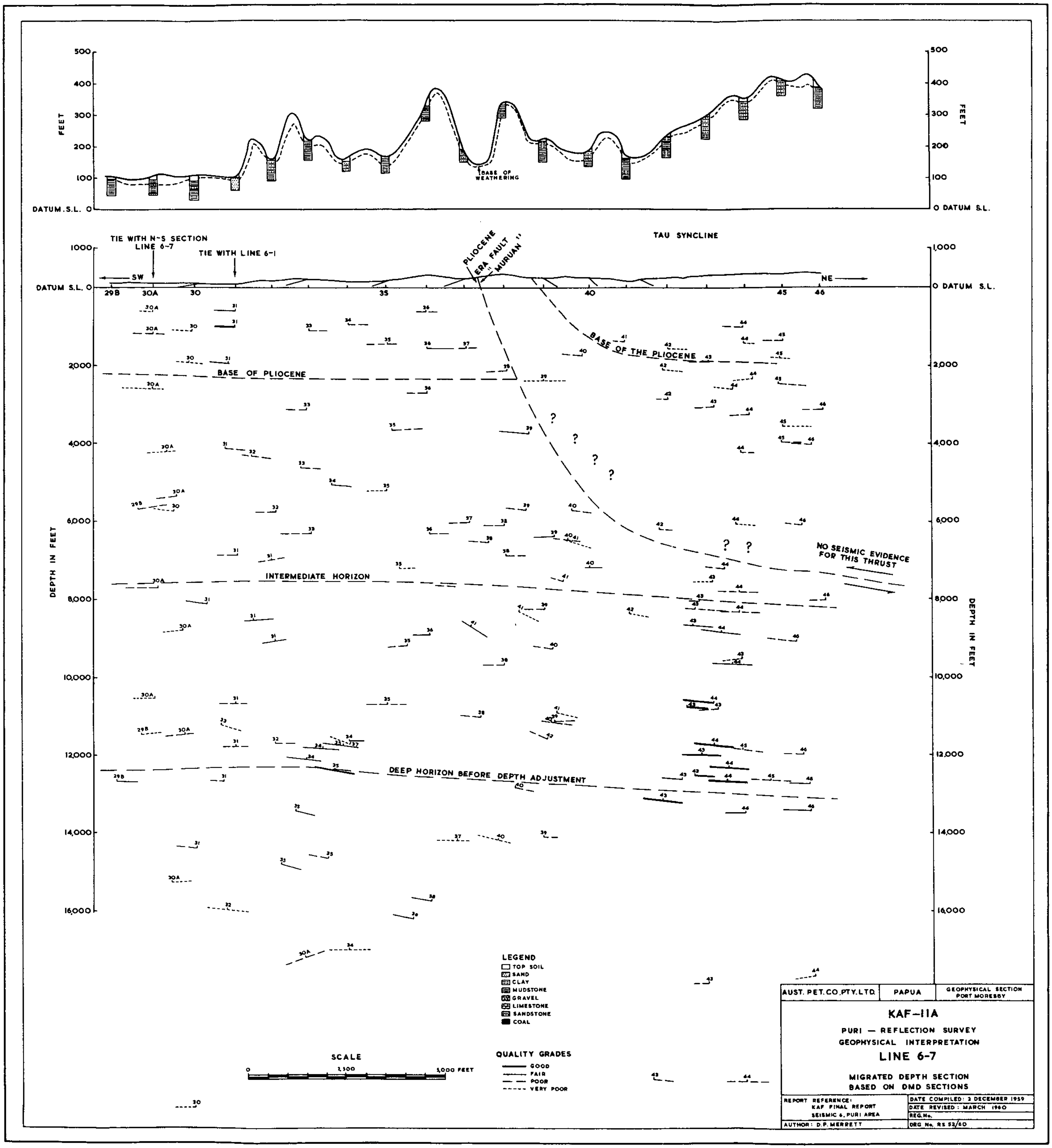
FEET
DATUM S.L.
BASE OF WEATHERING
TIE WITH LINE 4
TIE WITH LINE 1
TIE LINE 1 S.E. EXTENSION
SURFACE OUTCROP ERA FAULT
ERA R.
LINE OF KUKU FAULT OUTCROP
PURI 1, 1A & 1B
DEPTH IN FEET
TOP OF DENSE "TAURIAN" LIMESTONE
BASE OF PLIOCENE
TIE BASED ON GEOLOGICAL CROSS SECTIONS
ERA FAULT
INTERMEDIATE HORIZON ARBITRARILY CHOSEN
INTERMEDIATE HORIZON
DEEP HORIZON ARBITRARILY CHOSEN BEFORE DEPTH ADJUSTMENT
DEEP HORIZON
RELIEF FAULT
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
x APPARENT SOURCES DIFFRACTION PATTERNS
SCALE
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF - 8
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-3
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6, PAPUA
DATE COMPILED: AUGUST 1959
DATE REVISED: MARCH 1960
REG No.
AUTHOR: D.P. MERRETT
DRG No. RS 46/60

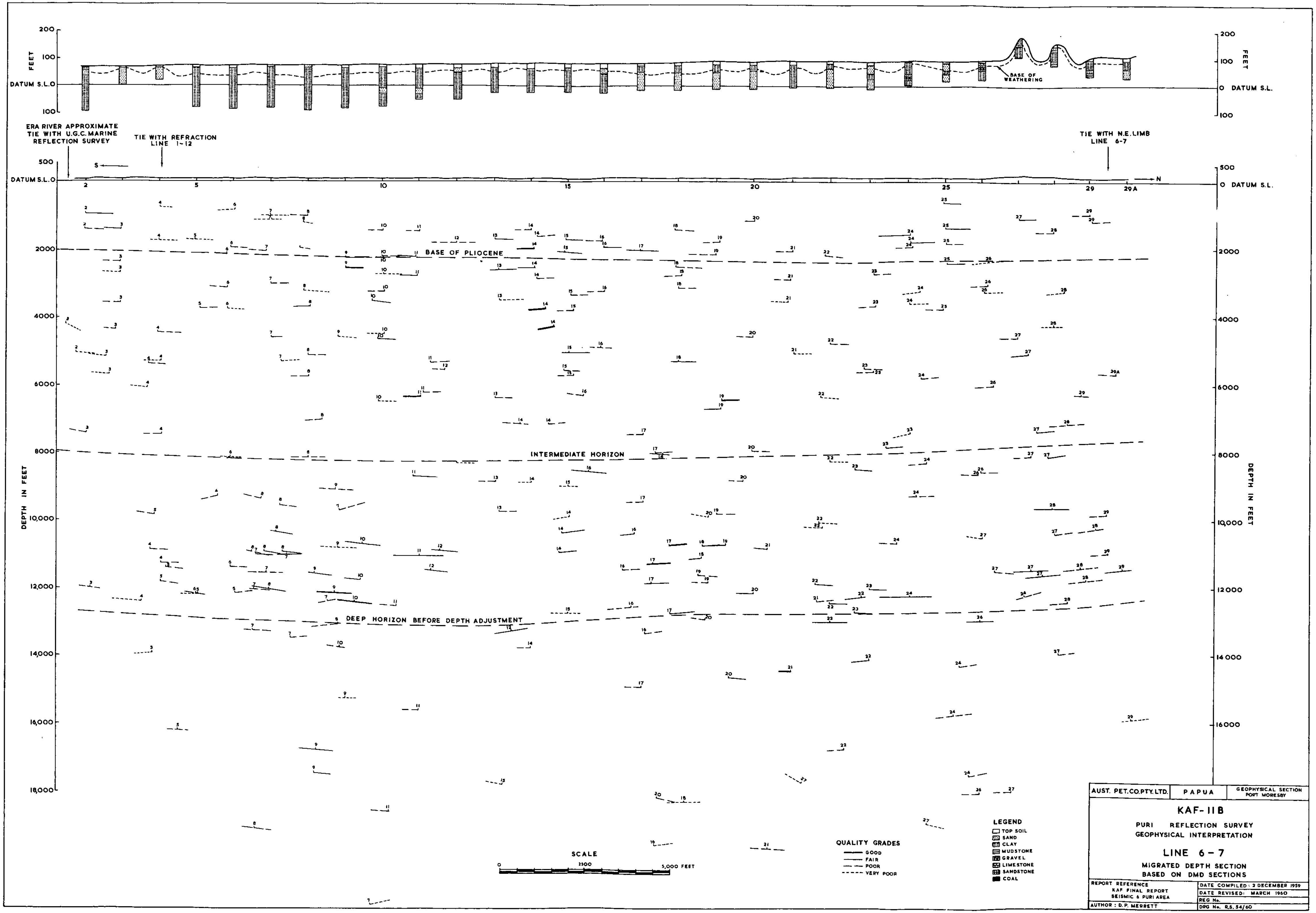


FEET
DATUM S.L.
BASE OF WEATHERING
ERA RIVER
TIE WITH LINE 4
TIE WITH LINE 1
SURFACE OUTCROP OF ERA FAULT
PROBABLE FAULTED ZONE
SURFACE OUTCROP OF KEREMU FAULT
KEREMU ANTICLINE
ERA RIVER
PURI ANTICLINE
BASE OF THE PLIOCENE
INTERMEDIATE HORIZON
ERA FAULT
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
DEEP HORIZON
DEPTH IN FEET
X CENTRES OF DIFFRACTION PATTERNS
QUALITY OF GRADES
GOOD
FAIR
POOR
VERY POOR
SCALE
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
AUST. PET.CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF - 9
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-2
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFRENCE: KAF FINAL REPORT SEISMIC 6, PAPUA
DATE COMPILED: SEPTEMBER 1959
DATE REVISED: MARCH 1960
AUTHOR: D.P. MERRETT



FEET
DATUM S.L.
BASE OF WEATHERING
TIE WITH LINE 4
TIE WITH LINE 1
ERA FAULT
PLIOCENE
"MURUAN"
S
N
DEPTH IN FEET
BASE OF PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
SCALE
0
2500
5000 FEET
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF-10
PURI-REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-6
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PURI AREA
AUTHOR. D.P. MERRETT
DATE COMPILED: 1 SEPTEMBER 1959
DATE REVISED: MAY 1960
REG No.
DRG No. RS 67/60


AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF-11A
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-7
MIGRATED DEPTH SECTION BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6, PURI AREA
DATE COMPILED: 2 DECEMBER 1959
DATE REVISED: MARCH 1960
REG. No.
DRG No. RS 52/60
AUTHOR: D.P. MERRETT
TIE WITH N-S SECTION LINE 6-7
TIE WITH LINE 6-1
PLIOCENE
ERA FAULT
MURUAN
TAU SYNCLINE
SW
NE
DATUM S.L.
BASE OF WEATHERING
BASE OF PLIOCENE
BASE OF THE PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
NO SEISMIC EVIDENCE FOR THIS THRUST
FEET
DEPTH IN FEET
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
SCALE
0
2,500
5,000 FEET



AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

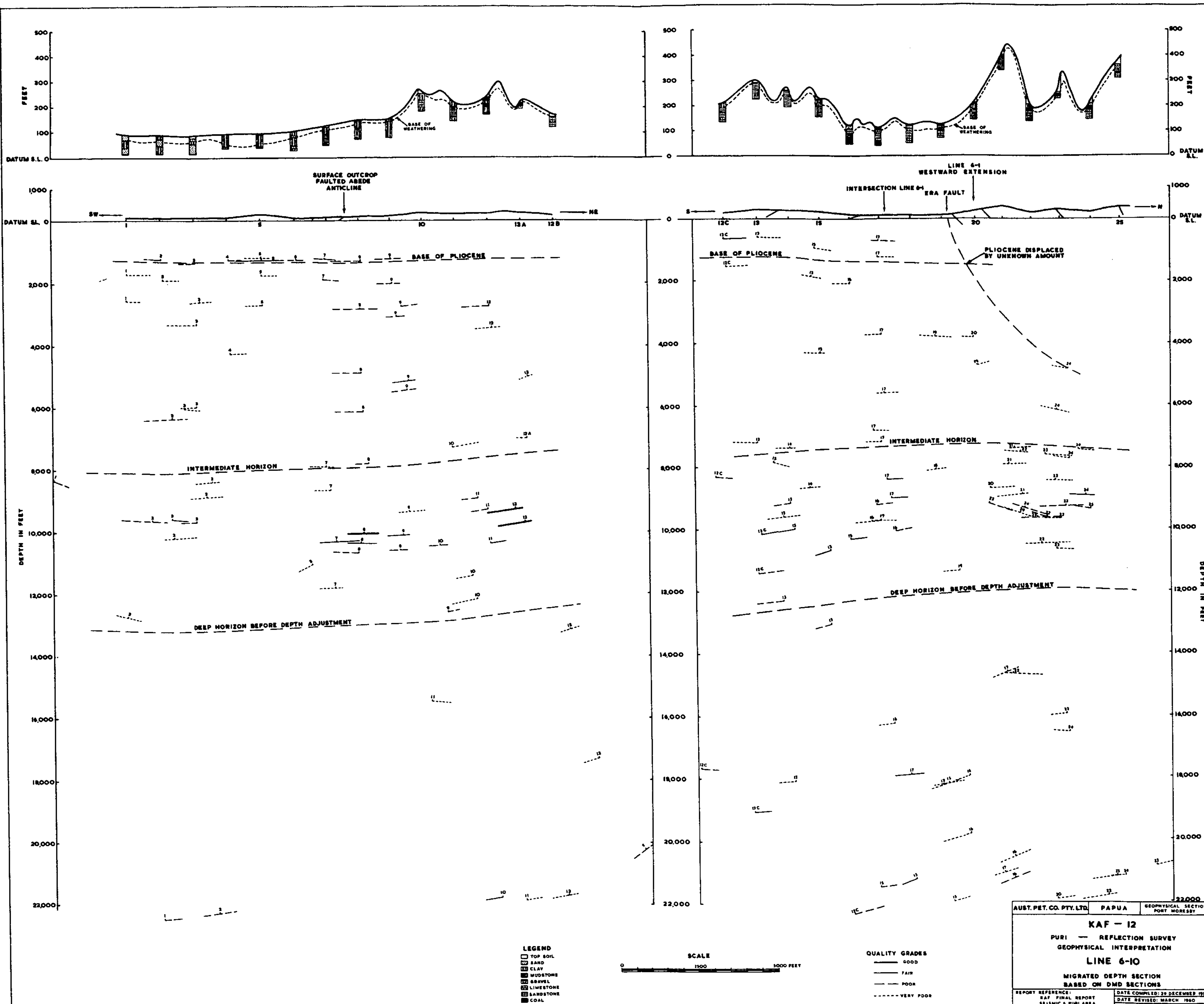
KAF-11B

PURI REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION

LINE 6 – 7

MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS

REPORT REFERENCE KAF FINAL REPORT SEISMIC & PURI AREA	DATE COMPILED: 2 DECEMBER 1959
	DATE REVISED: MARCH 1960
	REG No.
AUTHOR : D.P. MERRETT	DRG No. R.S. 54/60



AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

KAF — 12

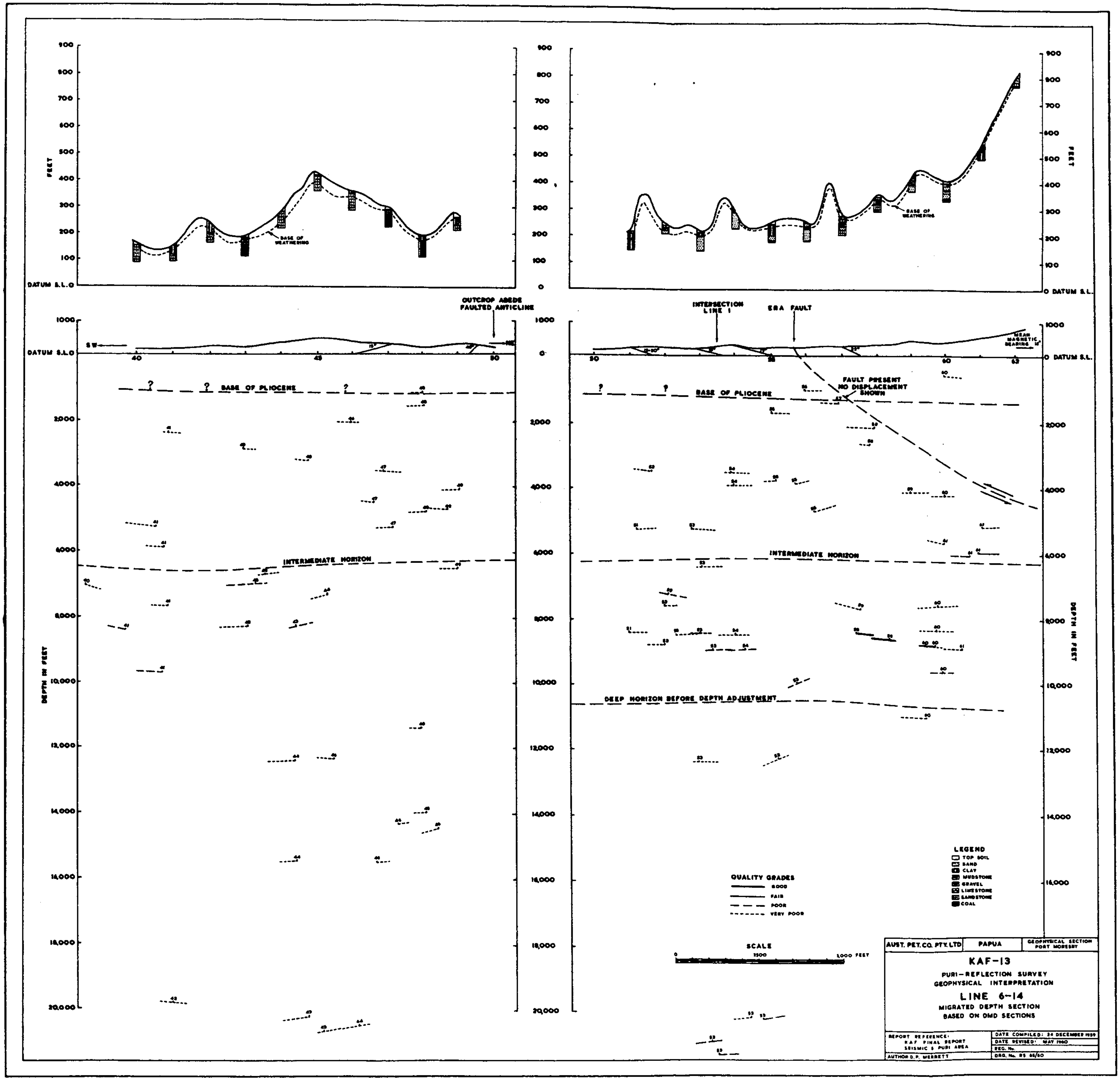
PURI — REFLECTION SURVEY

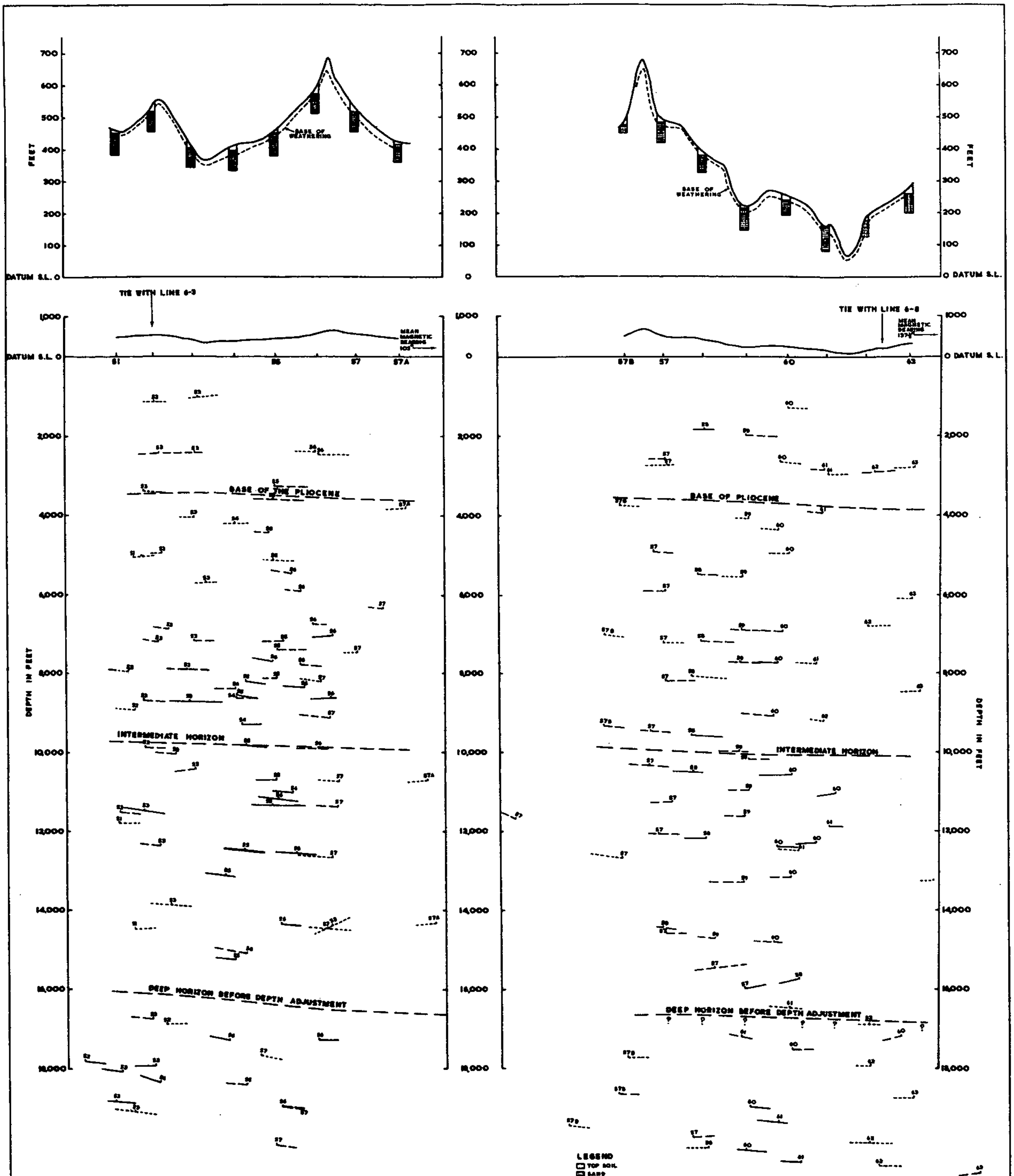
GEOPHYSICAL INTERPRETATION

LINE 6-10

MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS

REPORT REFERENCE: KAF FINAL REPORT SEISMIC & PURI AREA	DATE COMPILED: 29 DECEMBER 1959
	DATE REVISED: MARCH 1960
	REG No.:
AUTHOR: D.P. MERRETT	DRG: RS 88/60


FEET
DATUM S.L.O
OUTCROP ABEDE FAULTED ANTICLINE
INTERSECTION LINE 1
ERA FAULT
SW
MEAN MAGNETIC BEARING
BASE OF WEATHERING
BASE OF PLIOCENE
FAULT PRESENT NO DISPLACEMENT SHOWN
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
DEPTH IN FEET
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
SCALE
AUST. PET. CO. PTY. LTD
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF-13
PURI-REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-14
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC & PURI AREA
AUTHOR D.P. MERRETT
DATE COMPILED: 24 DECEMBER 1959
DATE REVISED: MAY 1960
REG. No.



LEGEND
- TOP SOIL
- SAND
- CLAY
- MUDSTONE
- GRAVEL
- LIMESTONE
- SANDSTONE
- COAL

SCALE
0 — 2,500 — 5,000 FEET

QUALITY GRADES
- GOOD
- FAIR
- POOR
- VERY POOR

AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

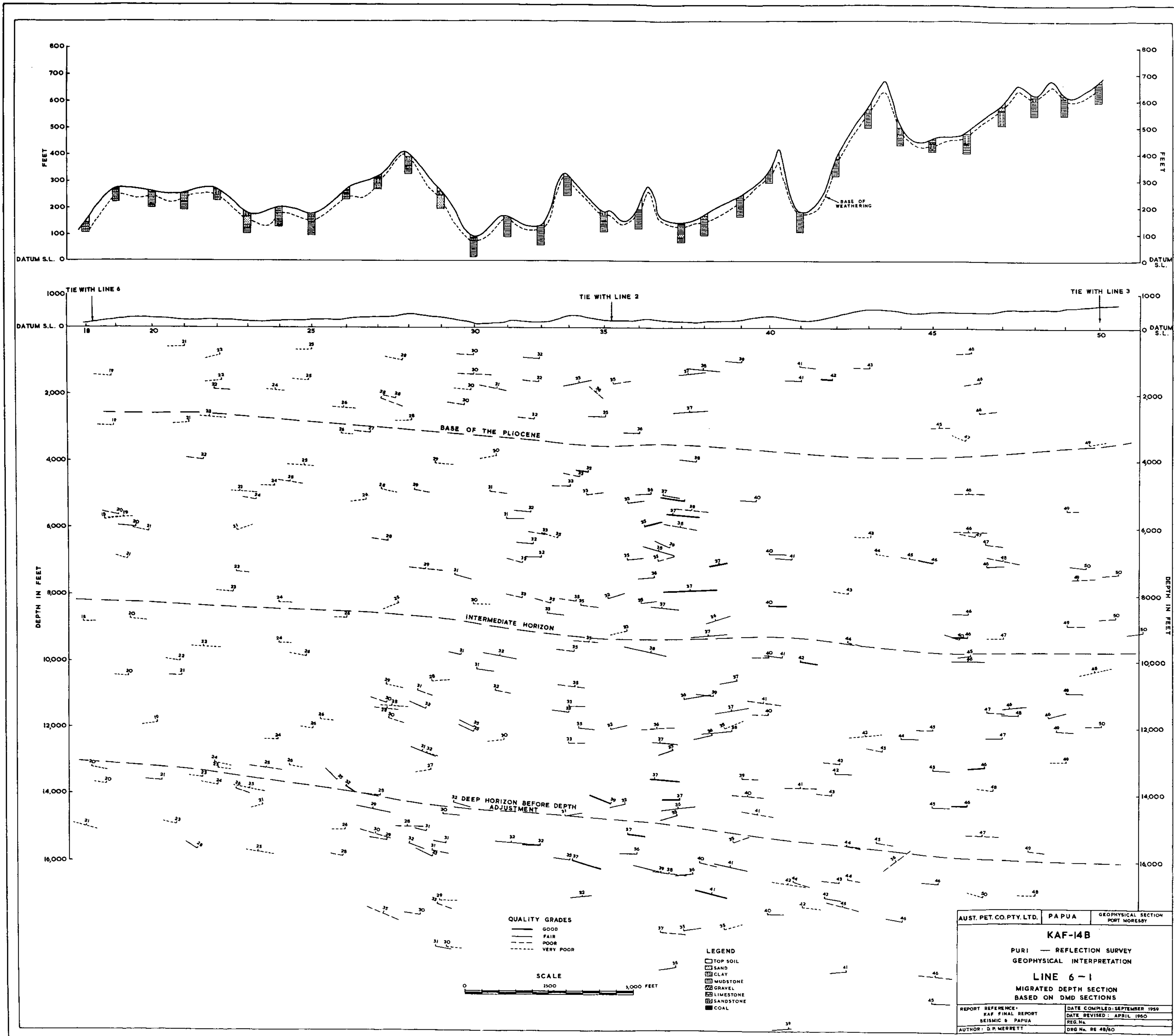
KAF -14A

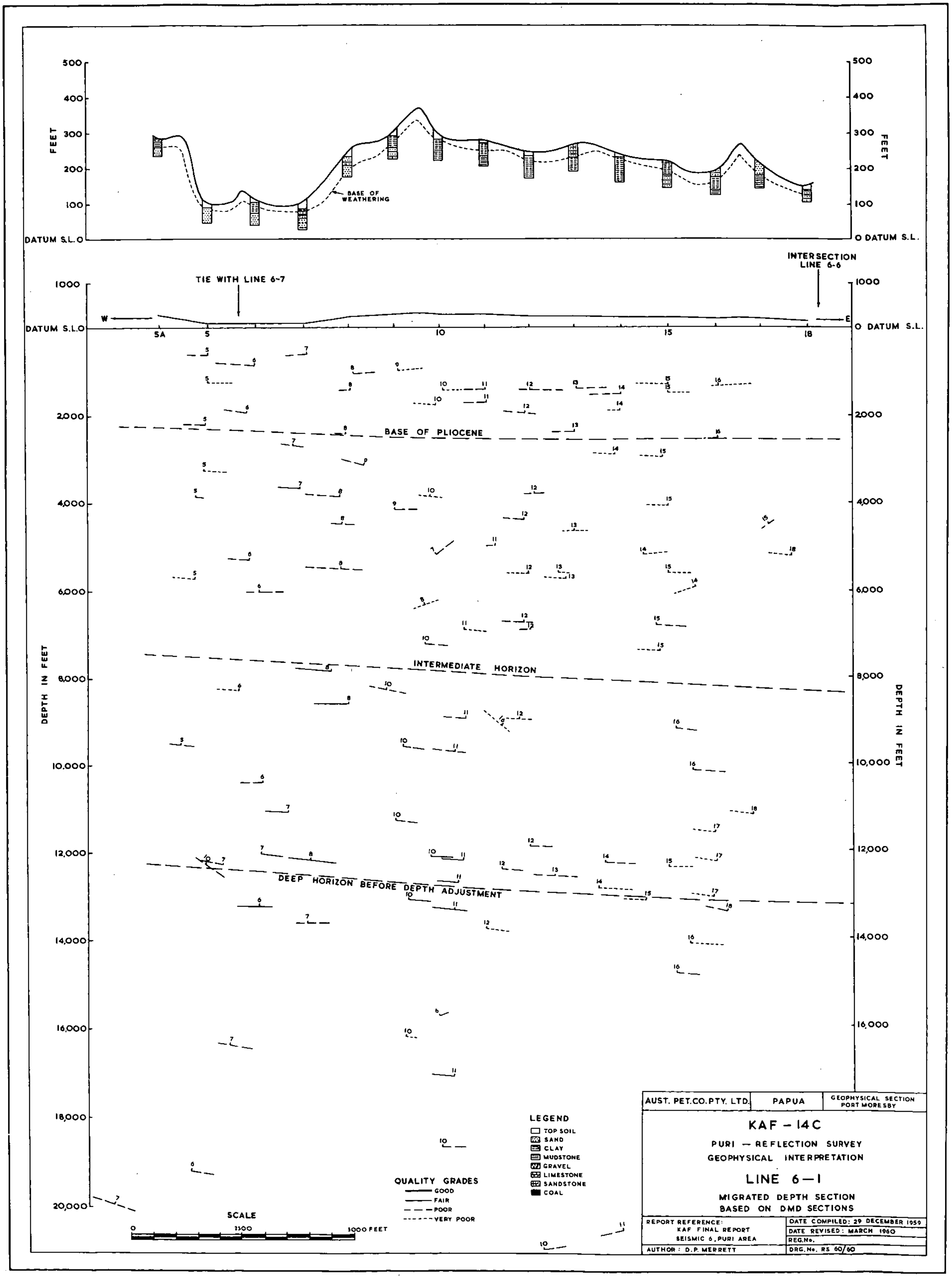
PURI – REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION

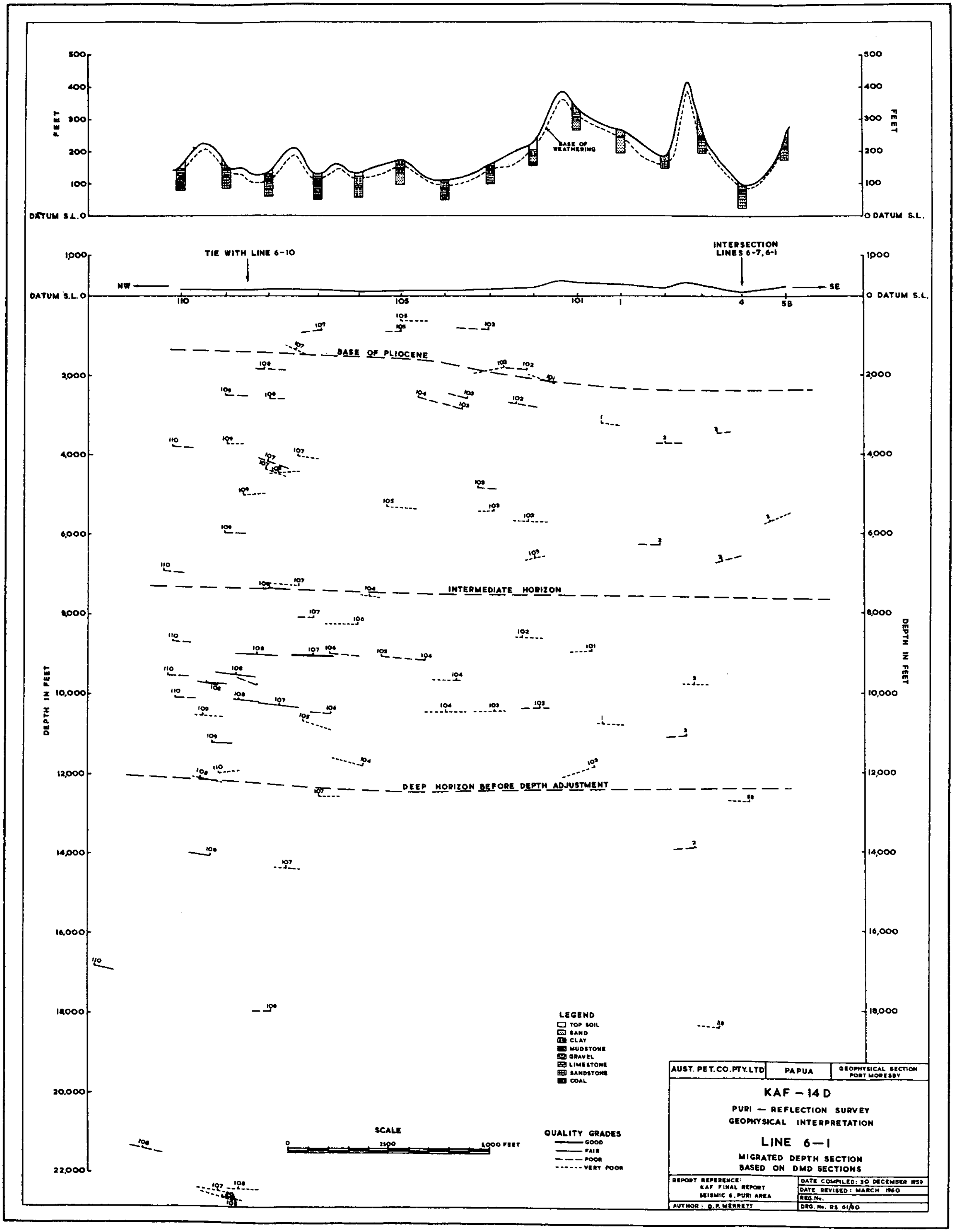
LINE 6-1

MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS

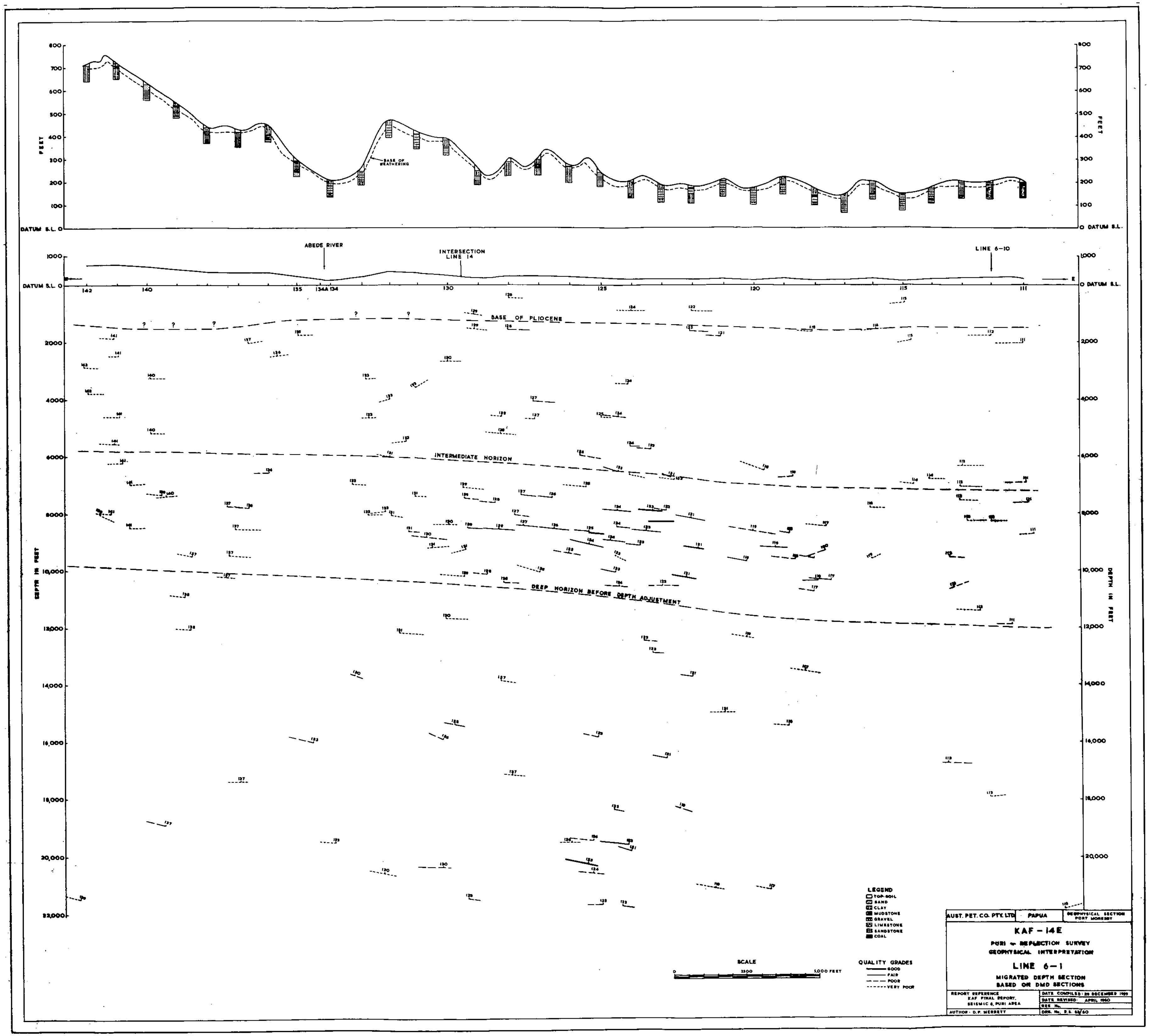
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 5, PURI AREA	DATE COMPILED: 2 DECEMBER 1959
	DATE REVISED: MARCH 1960
	REG. No.
AUTHOR: D.R. MERRETT	DWG. No. P.S. 50/60

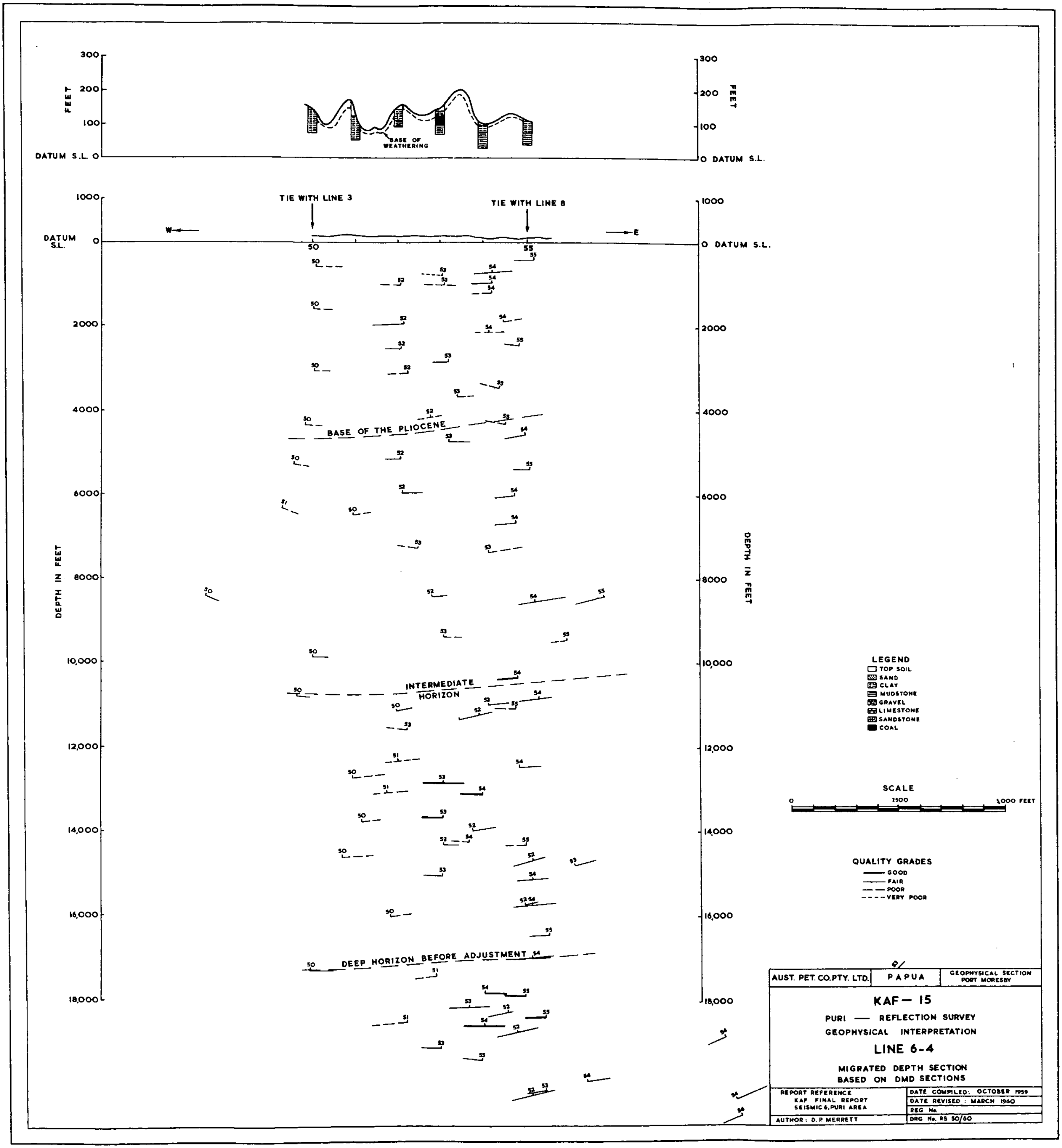

FEET
DATUM S.L.
BASE OF WEATHERING
TIE WITH LINE 6
TIE WITH LINE 2
TIE WITH LINE 3
DEPTH IN FEET
BASE OF THE PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
SCALE
0
2500
5,000 FEET
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF-14B
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6 — 1
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE:
KAF FINAL REPORT
SEISMIC 6 PAPUA
AUTHOR: D.P. MERRETT
DATE COMPILED: SEPTEMBER 1959
DATE REVISED: APRIL 1960
REG. No.
DRG No. RS 48/60


FEET
DATUM S.L.
O DATUM S.L.
BASE OF WEATHERING
TIE WITH LINE 6-7
INTERSECTION LINE 6-6
W
E
5A
5
10
15
18
BASE OF PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
DEPTH IN FEET
SCALE
0
2500
5000 FEET
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
AUST. PET.CO.PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF - 14C
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6—1
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6, PURI AREA
AUTHOR : D.P. MERRETT
DATE COMPILED: 29 DECEMBER 1959
DATE REVISED: MARCH 1960
REG.No.
DRG.No. RS 60/60

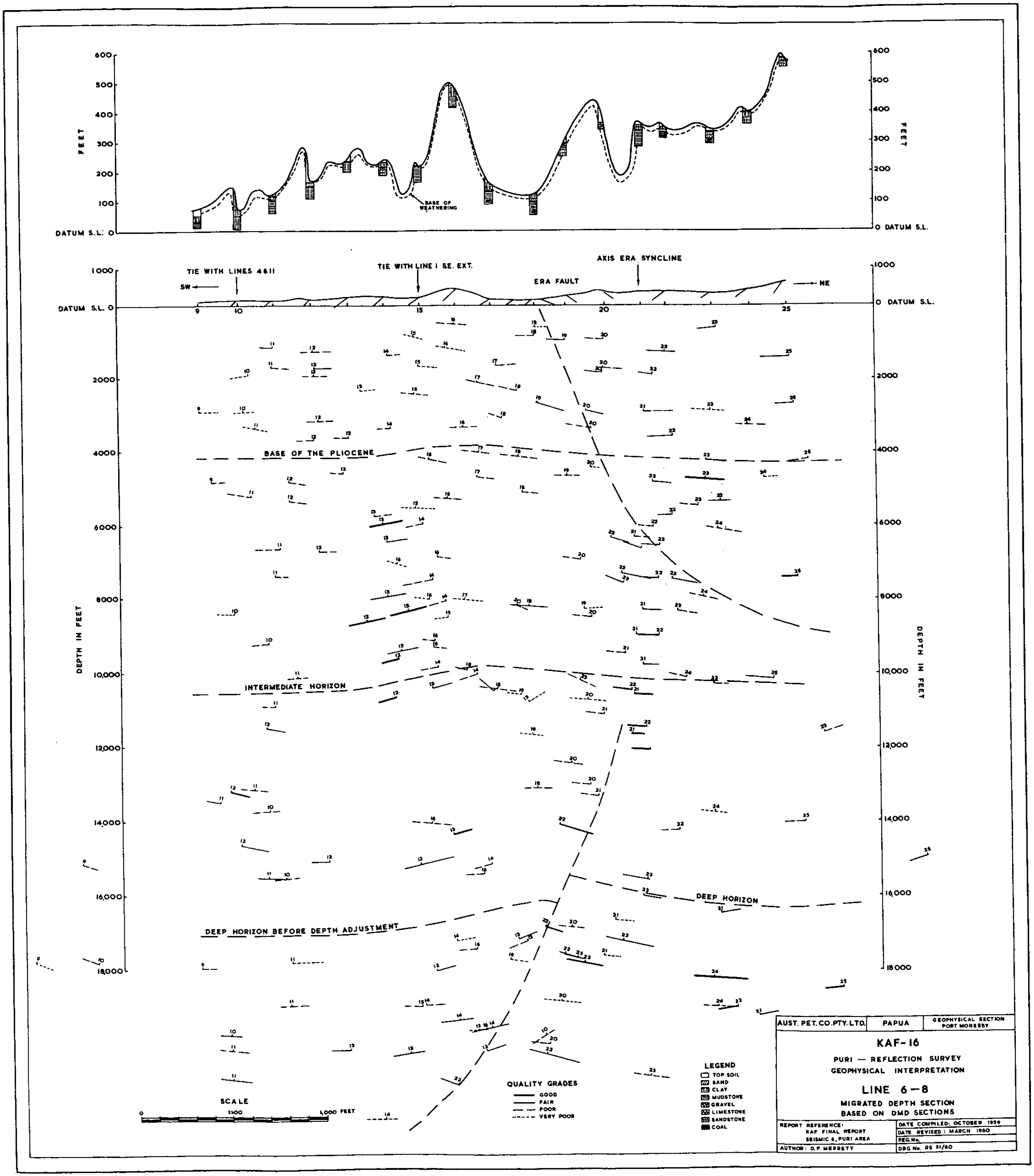


FEET
DATUM S.L.
BASE OF WEATHERING
TIE WITH LINE 6-10
INTERSECTION LINES 6-7, 6-1
NW
SE
BASE OF PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
DEPTH IN FEET
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
SCALE
0
2500
5000 FEET
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
AUST. PET. CO. PTY. LTD
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF – 14 D
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6—1
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6, PURI AREA
AUTHOR: D. P. MERRETT
DATE COMPILED: 30 DECEMBER 1959
DATE REVISED: MARCH 1960
REG. No.
DRG. No. RS 61/60

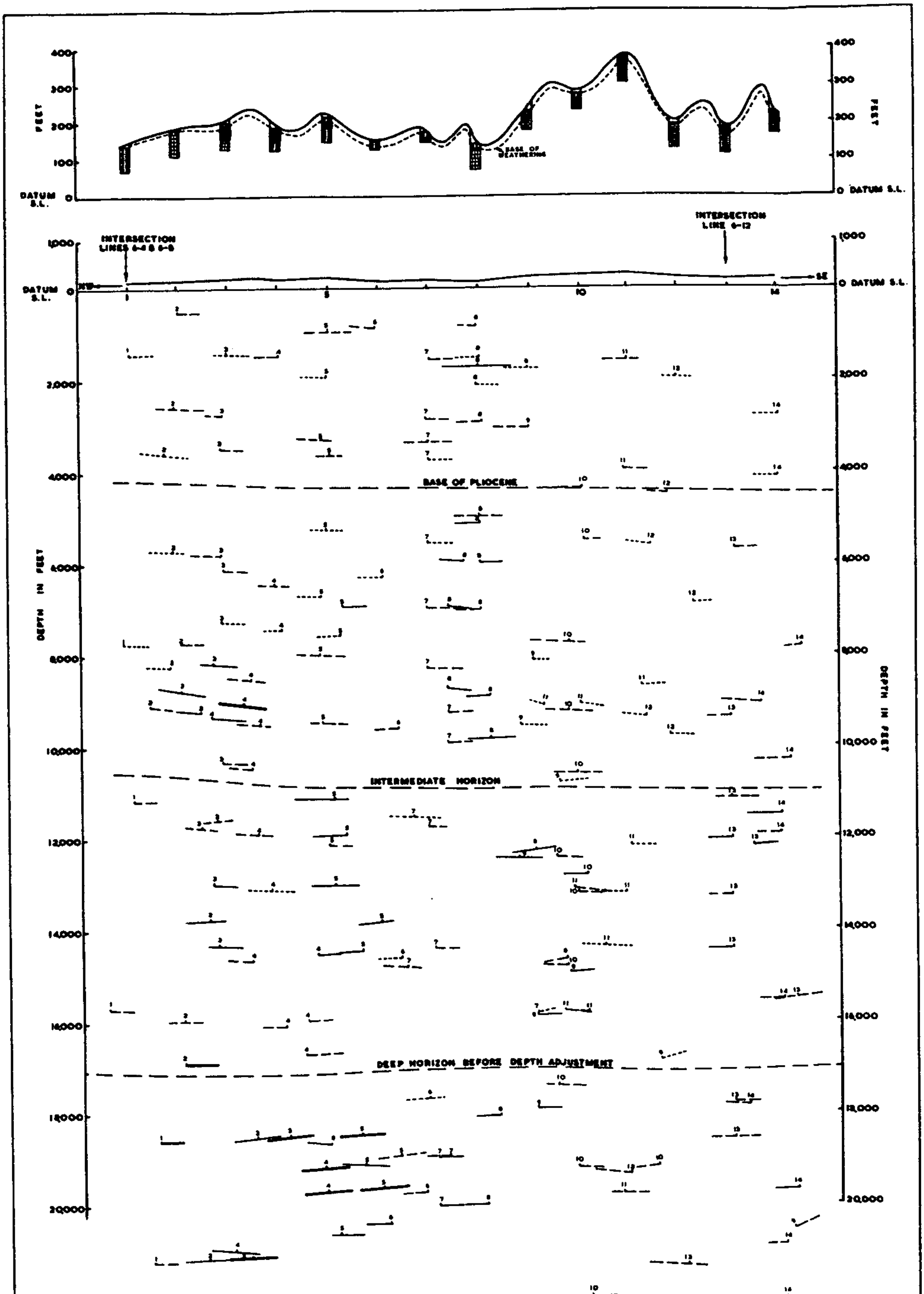

FEET
DATUM S.L. 0
BASE OF WEATHERING
ABEDE RIVER
INTERSECTION LINE 14
LINE 6-10
DATUM S.L.
BASE OF PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
DEPTH IN FEET
LEGEND
TOP-SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
SCALE
1,000 FEET
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF - 14E
PURI REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-1
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE KAF FINAL REPORT, SEISMIC 6, PURI AREA
DATE COMPILED: 20 DECEMBER 1959
DATE REVISED: APRIL 1960
REG No.
DRG. No. P.S. 63/60
AUTHOR: D.P. MERRETT



FEET
300
200
100
DATUM S.L. 0
BASE OF WEATHERING
0 DATUM S.L.
TIE WITH LINE 3
TIE WITH LINE 8
W
E
DATUM S.L.
50
55
BASE OF THE PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON BEFORE ADJUSTMENT
DEPTH IN FEET
1000
2000
4000
6000
8000
10,000
12,000
14,000
16,000
18,000
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
SCALE
0
2500
5,000 FEET
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF — 15
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6-4
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE
KAF FINAL REPORT
SEISMIC 6, PURI AREA
AUTHOR: D. P. MERRETT
DATE COMPILED: OCTOBER 1959
DATE REVISED: MARCH 1960
REG No.
DRG No. RS 50/60



FEET
DATUM S.L. 0
BASE OF WEATHERING
TIE WITH LINES 4&11
TIE WITH LINE I SE. EXT.
AXIS ERA SYNCLINE
ERA FAULT
SW
NE
DATUM S.L. 0
DEPTH IN FEET
BASE OF THE PLIOCENE
INTERMEDIATE HORIZON
DEEP HORIZON
DEEP HORIZON BEFORE DEPTH ADJUSTMENT
SCALE
0 2500 5,000 FEET
QUALITY GRADES
GOOD
FAIR
POOR
VERY POOR
LEGEND
TOP SOIL
SAND
CLAY
MUDSTONE
GRAVEL
LIMESTONE
SANDSTONE
COAL
AUST. PET. CO. PTY. LTD.
PAPUA
GEOPHYSICAL SECTION PORT MORESBY
KAF-16
PURI — REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION
LINE 6—8
MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS
REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6, PURI AREA
AUTHOR: D.P. MERRETT
DATE COMPILED: OCTOBER 1959
DATE REVISED: MARCH 1960
REG. No.
DRG No. RS 51/60



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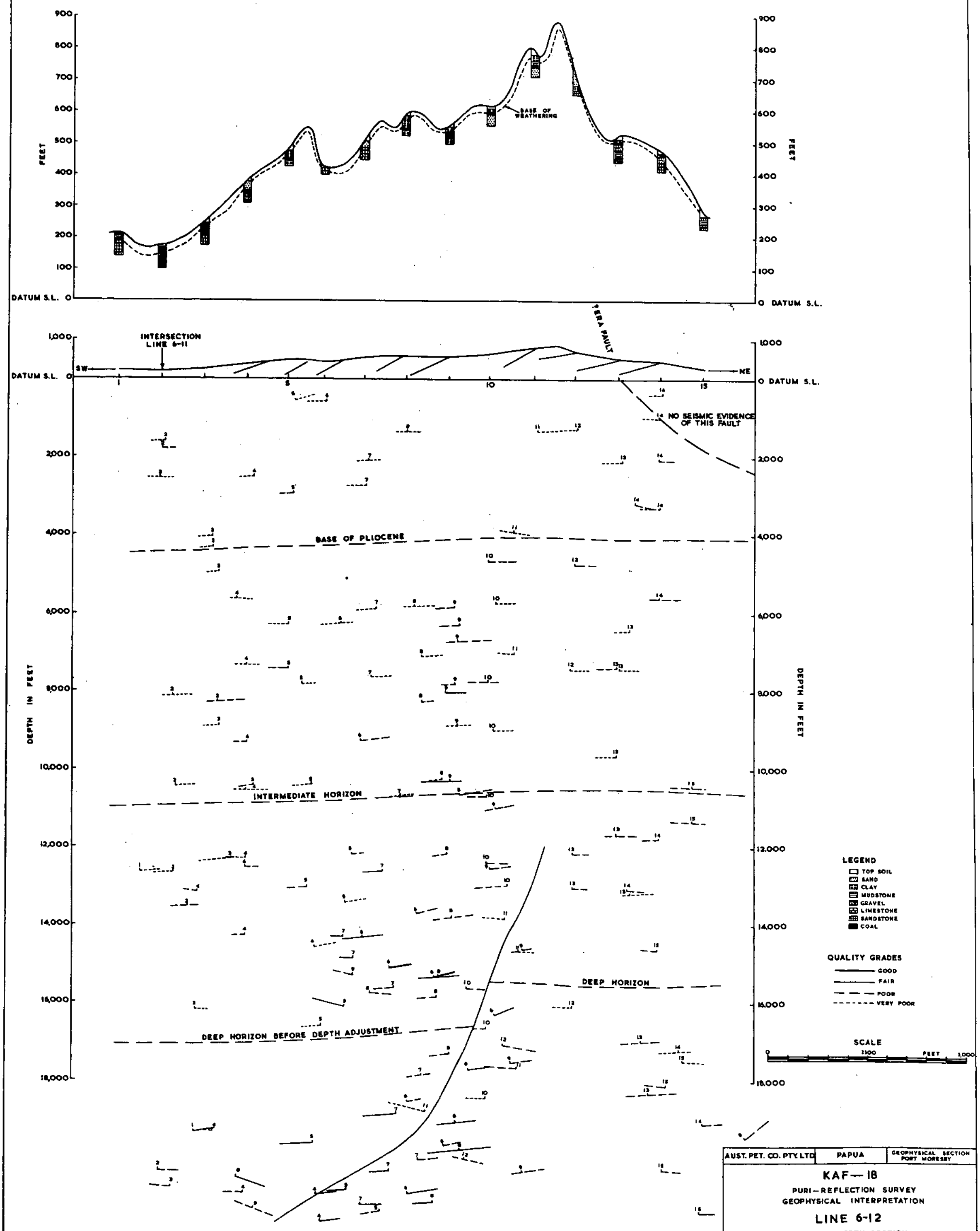
KAF-17

PURI – REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION

LINE 6-11

MIGRATED DEPTH SECTION
BASED ON DMO SECTIONS

REPORT REFERENCE KAF FINAL REPORT SEISMIC 6, PURI AREA	DATE COMPILED: 2 DECEMBER 1959
	DATE REVISED: MAY 1960
	REG. No.
AUTHOR: D.P. MERRETT	DRG. No. 25 64/60



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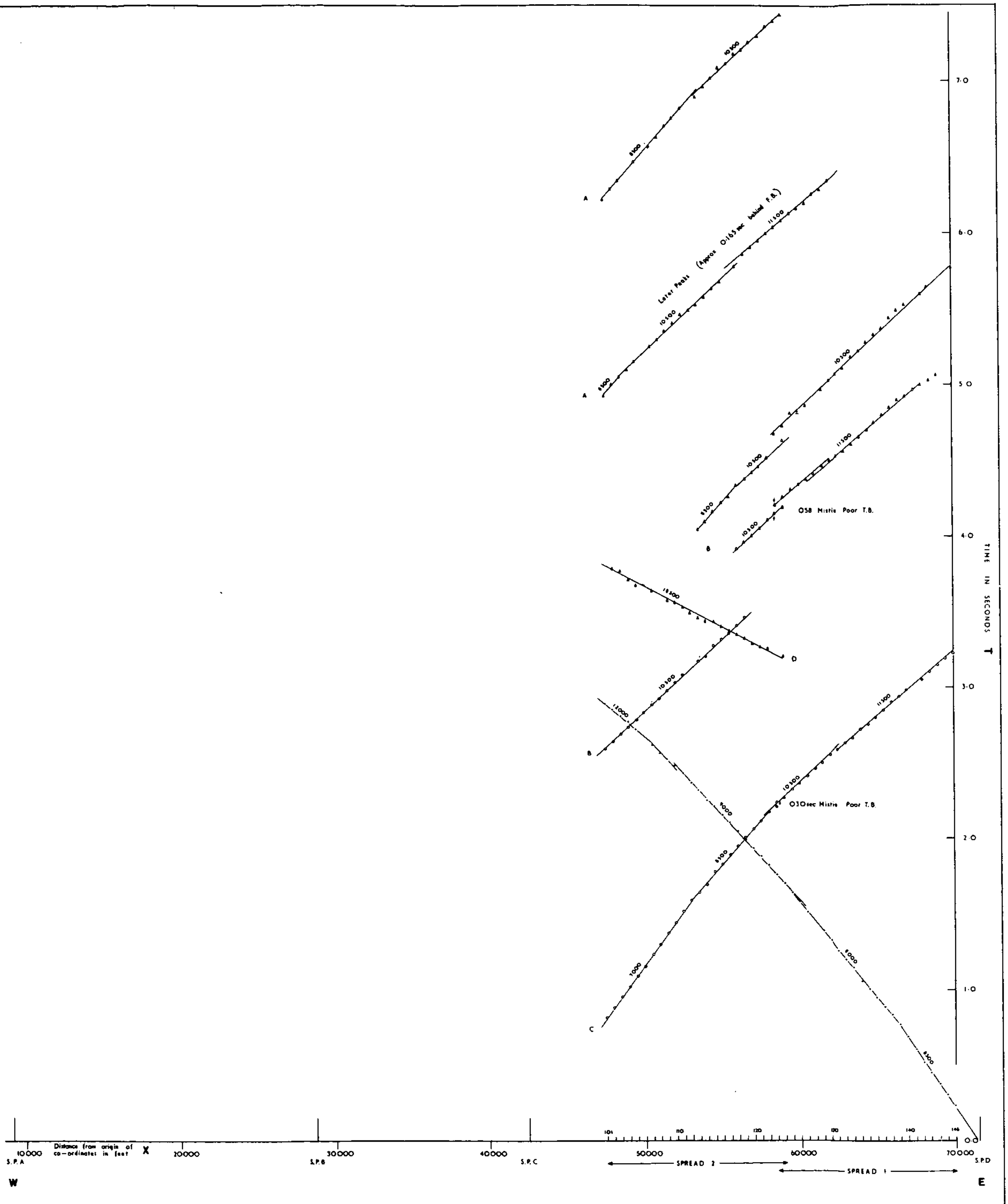
KAF—18

PURI—REFLECTION SURVEY
GEOPHYSICAL INTERPRETATION

LINE 6-12

MIGRATED DEPTH SECTION
BASED ON DMD SECTIONS

REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6, PURI AREA	DATE COMPILED: 2 DECEMBER 1959
	DATE REVISED: MAY 1960
	REG No.
AUTHOR: D.P. MERRETT	DRG No. RS 148/50



LEGEND

- o First breaks shooting East
- + First breaks shooting West
- Δ Later peaks

HORIZONTAL SCALE

0 — 10,000 feet

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KAF-19

PURI — SEISMIC SURVEY

T—X DIAGRAM
Experimental Refraction Line 6-4

REPORT REFERENCE: KAF FINAL REPORT SEISMIC & PAPUA	DATE COMPILED: FEBRUARY 1960
	DATE REVISED:
	REG No
AUTHOR: D.R.MERRETT	DRG No RS 138/60

LEGEND

- o First breaks
- □ First troughs
- △ Later peaks

Velocities in ft/sec

HORIZONTAL SCALE

0 — 10,000 feet

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KAF – 20

PURI – SEISMIC SURVEY

TOPO SHOTS
REFRACTION LINE 6-4

REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA	DATE COMPILED: FEBRUARY 1960
	DATE REVISED:
	REG No
AUTHOR: D.P. MERRETT	DRG No RS 137 /60

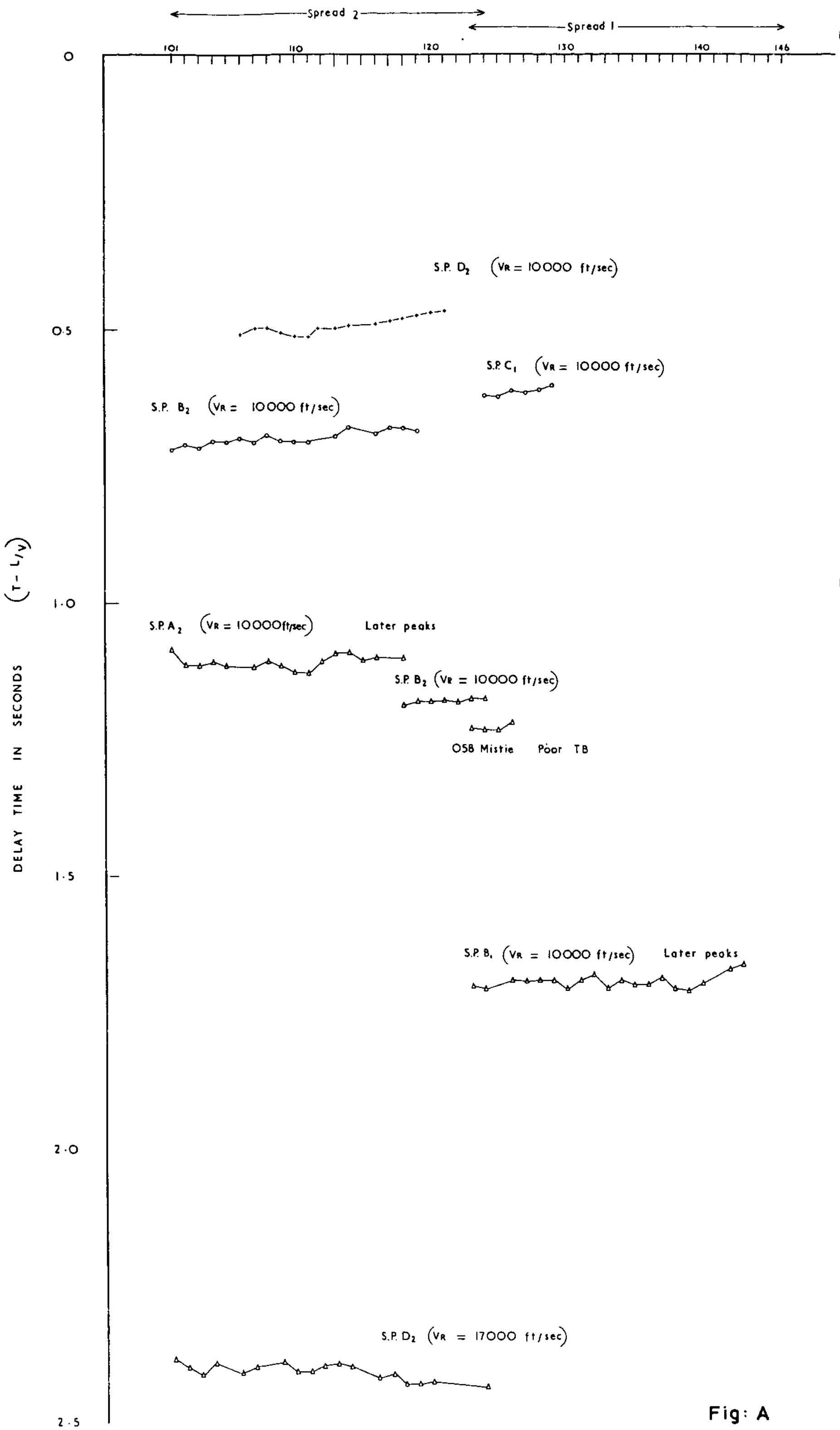


Fig: A

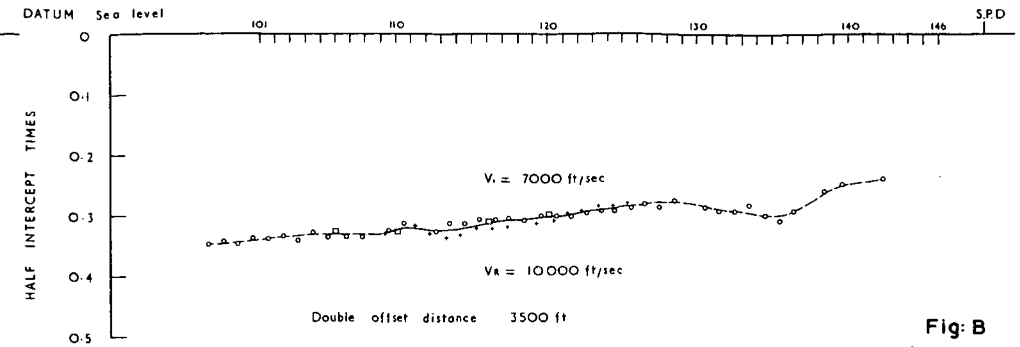


Fig: B

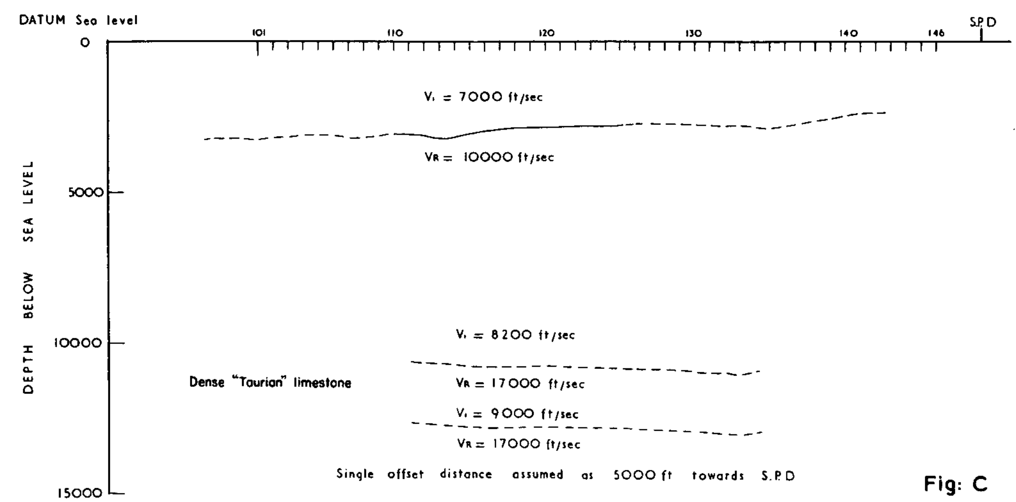


Fig: C

LEGEND

- Reverse control
- One-way shooting only
- ∘ First arrivals shooting to the East
- • " " " " " West
- Δ Later peaks
- □ Half intercept times

HORIZONTAL SCALE

0 — 10000 feet

Green Refractor VR=10 000 ft/sec
Blue Refractor VR=17000 ft/sec

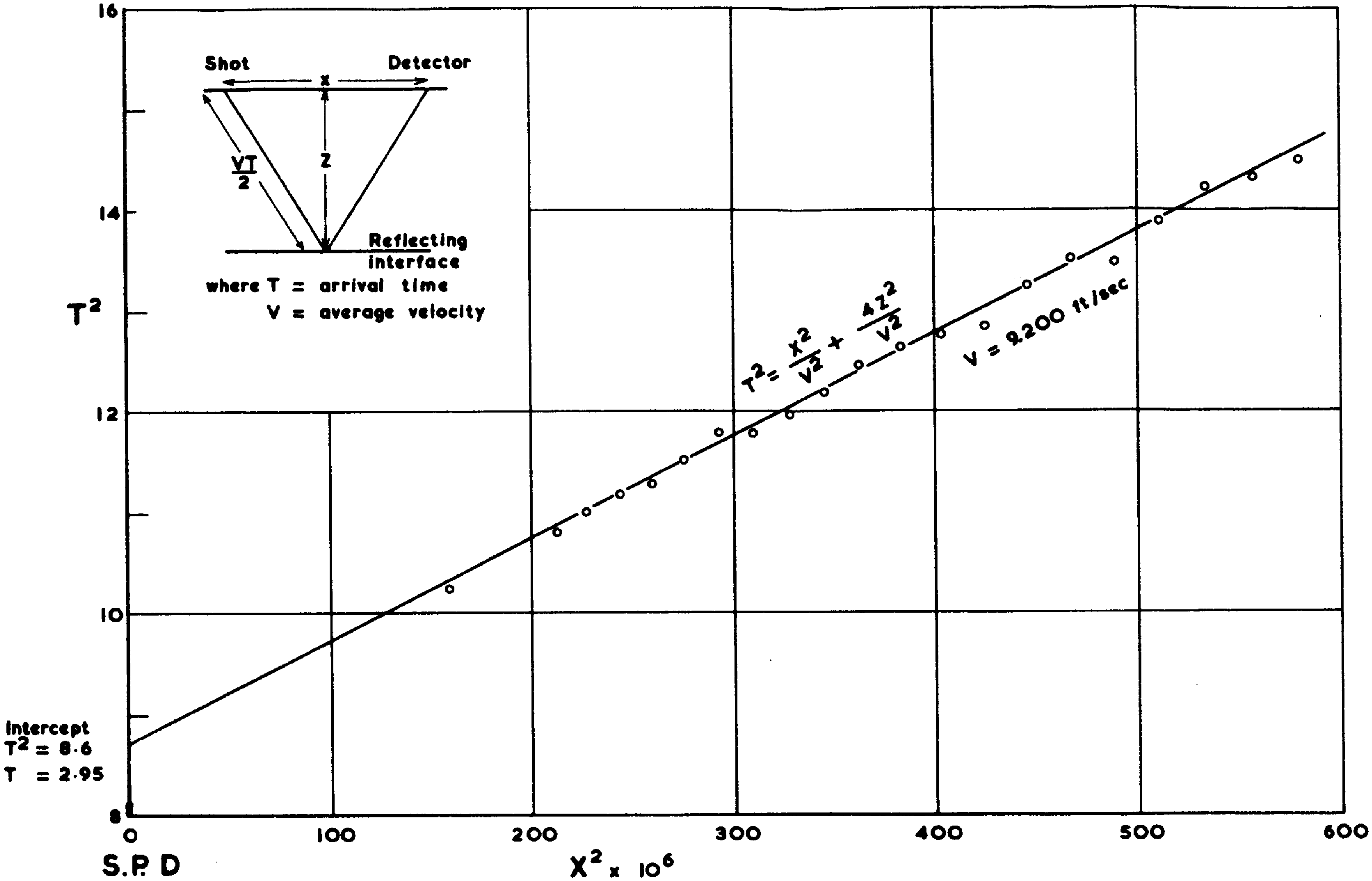
AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

KAF-21

PURI — SEISMIC SURVEY

Experimental Refraction Line 6—4 Delay time, Half Intercept time, Depth profiles for Green and Blue Refractors

REPORT REFERENCE: KAF FINAL REPORT SEISMIC & PAPUA	DATE COMPILED. FEBRUARY 1960
	DATE REVISED:
	REG No
AUTHOR: O.P. MERRETT	DRG No RS 143/60



AUST. PET. CO. PTY. LTD.	PAPUA	GEOPHYSICAL SECTION PORT MORESBY

KAF -22

PURI — SEISMIC SURVEY

$T^2 - X^2$ DIAGRAM

Experimental Line 6-4

REPORT REFERENCE: KAF FINAL REPORT SEISMIC 6 PAPUA	DATE COMPILED: FEBRUARY 1960
	DATE REVISED:
	REG No
AUTHOR: D.P. MERRETT	DRG No RS 131/60