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SURAT BASIN SEISMIC RECONNAISSANCE SURVEY, QUEENSLAND, 1959

by

K. B. Lodwick and S. J. Watson

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ABSTRACT

In October and November 1959 a seismic party from the Bureau of Mineral Resources carried out a seismic survey in the Surat Basin, Queensland at the request of Australian Oil and Gas Corporation Ltd. A traverse extending from Surat eastward to within 10 miles of Tara was shot in five-mile sections of continuous reflection profiling with approximately five-mile intervals between the sections. In addition two refraction traverses were shot near Surat to record velocities and depths of as many horizons as possible.

Reflections were of fair to good quality throughout the survey and it was possible to correlate bands of reflections from one five-mile section to the next with considerable certainty. Over most of the traverses four reflecting horizons were followed, and in a few places reflections were obtained from a still deeper fifth horizon. The reflection survey revealed a wide basin between Surat and Cabawin (about 70 miles east of Surat), with its maximum thickness of sediments under Meandarra. The sediments there appear to be at least 19,000 ft thick. A marked anticline was discovered near Cabawin.

The refraction survey, using the "Depth Probing" method, revealed a refractor with a calculated velocity of 20,180 ft/sec situated about 1000 ft below the fourth reflecting horizon.

The report includes some discussion on the probable ages of the strata in the Surat Basin, based on geophysical and geological evidence. It seems likely that the first and second horizons are Mesozoic and it is suggested that the fourth reflecting horizon represents the base of the Permian. It is also suggested that the sediments below the fourth reflecting horizon are Carboniferous and that the 20,000 ft/sec refractor may represent a Carboniferous limestone, possibly the equivalent of the Lion Creek Limestone in Queensland and the *Lithostrotion* Limestone of New South Wales.

1. INTRODUCTION

Following the 1958 experimental seismic survey in the Surat Basin, which has been described by Morton and Robertson (1959), the Bureau of Mineral Resources carried out further seismic work there in October and November 1959.

The work was requested by Australian Oil and Gas Corporation Ltd., who hold Authority to Prospect 57P. Their request was supported by the Department of Mines, Queensland.

The objects of the survey were :-

(a) to define the eastern limits of the Surat Basin, and

(b) to investigate the depth and structure of any Palaeozoic sediments which may have been deposited in a southern extension of the Bowen Basin before the Mesozoic sediments of the Great Artesian Basin were deposited.

To achieve the objects of the survey the following programme was proposed :-

(a) Shoot a seismic reflection traverse running in an easterly direction from Surat until the eastern margin of the basin was reached, or as far as time would permit. This traverse would cross the north-south trend of the Bowen Syncline almost at right angles and it was expected that dips recorded would be approximately true.

(b) Complete the refraction survey begun in 1958 on Traverse AA (Morton and Robertson, 1959) and shoot a short reflection traverse over the middle portion of this traverse.

(c) Shoot other refraction traverses at intervals along the reflection traverse running eastward from Surat; the exact sites would be determined from the reflection results.

As easterly dips had been recorded along the 1958 reflection traverse immediately east of Surat, a short reflection traverse (Traverse F, Plate 2) was shot at right angles to the main traverse, to determine true dips.

Mr. L.A. Richardson, consultant geophysicist to Australian Oil and Gas Corp., visited the party to make arrangements to photograph the seismic records for study by A.O.G. and their associates. Other visitors were Prof. E. Rudd representing A.O.G. and Mr. W. Moran of the Union Oil Co. of California (an associate with A.O.G. in the exploration of the Surat Basin) who arrived at the end of the survey to view the results of the seismic survey.

Messrs. Dunlop and Pearse of the National Film Unit, Department of Interior, photographed some of the party's operations during the early part of the survey.

2. FIELD WORK

The equipment and vehicles used by the Seismic Party are listed in Appendix A.

As the survey was to be of a reconnaissance nature it was decided that the traverse eastward from Surat would not be continuous; sufficient information on the structure of the basin would be obtained if 5-mile lengths of traverse were shot, using the continuous profiling technique, with approximately 5-mile intervals between them.

In the present report this east-west traverse has been called Traverse E between Surat and Meandarra, and Traverse G between Meandarra and Tara. The positions of the five sections comprising these two traverses are shown on Plate 2.

A $2\frac{1}{2}$-mile reflection traverse was shot approximately in the middle of Traverse AA. The topographic survey control data and the total lengths of traverses surveyed and shot are listed in Appendix B.

Throughout the survey, records were taken using six geophones per trace placed 22 ft apart in line with the traverse, and shots were fired in single shot-holes. Results of fair quality were obtained. Technical data including filter settings and common depths of shot are shown in Appendix B.

A summary of the drilling during the survey is given in Appendix C.

Thunderstorms bearing heavy rain were prevalent in the Surat area in October and November, and several days of working time were lost. As the traverses were mostly along roads, rain did not delay the party for more than a day at a time.

3. GEOLOGY

The situation and geology of the sub-division of the Great Artesian Basin known as the Surat Basin (Mott, 1952b) has been described in general terms in an earlier Bureau Record (Morton and Robertson, 1960). In that report reference has been made to papers by Mott (1952), Whitehouse (1954), and Jenkins (1958).

As the present seismic survey extended from the region of the Surat Inlier towards the eastern margin of the Great Artesian Basin, and also as there is a growing interest in the nature of Palaeozoic sediments beneath the Mesozoic formations, it may be helpful to discuss shortly the stratigraphy and structural features of the Palaeozoic formations on the eastern margin of the Great Artesian Basin.

During the Carboniferous period the marine Rockhampton and Neerkol formations were deposited in the Yarrol Basin portion of the Tasman Geosyncline in Queensland, and the environment ranged from bathyal in the early Carboniferous to neritic in the late Carboniferous. In New South Wales these deposits have probable equivalents in the Burindi and Emu Creek formations which are of marine origin (Carey and Browne, 1938). Some fresh water deposits in the Carboniferous series are known in the Drummond Range of Queensland. In New South Wales the Lower Kutting formation is considered a lateral fresh water equivalent of the Upper Burindi formation.

The down-warp of the Bowen Basin of Queensland and the Hunter Basin of New South Wales began at the end of the Carboniferous period. Whitehouse (1954) suggests that these two synclines were separated by a ridge of metamorphic rocks with its axis through Coffs Harbour. In Queensland the formations of the Bowen group were deposited and in New South Wales the great coal measures of the Hunter Valley were formed. East of the Bowen Basin in Queensland the Permian deposits of the Tasman Geosyncline are represented by the Silverwood fault block formations and the Dinner Creek formation near Rockhampton. Marine sediments are found in the Gympie area.

In New South Wales an orogenic movement called the Hunter-Bowen Thrust (plate 1) took place at the end of the Permian period. It is suspected that a contemporaneous movement occurred in Queensland on the eastern margin of the Bowen Basin; the thrusting movement here was from east to west (Hill, 1951).

The position of the Hunter-Bowen Thrust belt is indicated by Whitehouse (1954, Fig. 34) as passing beneath the Mesozoic formations of the Surat Basin, in the vicinity of Goondiwindi and Miles. On the same map Whitehouse also shows the supposed western limit of sedimentation during the Permian period; this western limit is reproduced in Plate 1 of the present report. The position of this line suggests that Permian sediments may be expected on the eastern end of the seismic traverse (near Meandarra and Tara) but not on the western end (near Surat).

After the late Permian orogeny of the Hunter-Bowen Thrust, the deposition of the Mesozoic sediments began as the whole of the Great Artesian Basin began to subside. The earlier Mesozoic sediments such as the Clematis sandstone and the Moolayemba shale are not expected to extend east of the Hunter-Bowen Thrust belt. Later Mesozoic sediments however are known to extend over the thrust belt and obscure its position.

West of Rockhampton the Bowen and Yarrol Basins are separated by the Gogango "High" of metamorphic and plutonic rocks (Hill, 1951 and Isbell, 1955). North of the Gogango "High" the boundary between the two basins is not clear, but there are suggestions of overthrusting (Hill, 1951). South of the Gogango "High", in the region of the Surat Basin, Mesozoic formations obscure the relation between the two basins. The rock underlying the southern extension of the Bowen Basin is important when considering the possibility that there may be petroleum in the Surat Basin. The relation of the Carboniferous marine sediments of the Yarrol Basin and the fresh water sediments of the Drummond Basin with the possible southern extension of the Gogango "High" is not yet clear.

4. RESULTS

Details of reduction of the results, filter settings, weathering corrections, reflection picking, and plotting are listed in Appendix B.

In the 1958 survey a velocity function was derived from a T-ΔT analysis. All the reflections recorded in this present survey are plotted on a depth scale based on that same velocity function. The curves relating depth, average velocity, and interval velocity with time, derived from T-ΔT analysis, are shown on Plate 16. These curves represent the relation of the variables in the shallower parts of the Surat Basin (near Surat). On Plate 17 similar curves derived from reflections in the deeper parts of the basin (near Meandarra) are shown. For the same reflection time the difference in depth on the two time-depth curves is very small; therefore the cross-sections of the deeper parts of the basin will still be accurate enough though they were plotted using the time-depth relation for the shallower parts of the basin.

Through the Surat-Tara area reflections of fair to good quality were recorded. In some places, however, there is a noticeable deterioration in reflection quality. On Traverse E, between shot-points 270 and 275 (Plate 6) and between shot-points 358 and 378 (Plate 8), the poor reflection quality is attributed to an erratic variation in the depth of weathering. Increased depths of shot might have resulted in better reflection quality. Variations in elevation and weathering depth, and the presence of a lateritic surface formation, seem to have caused the deterioration in reflection quality on Traverse E between shot-points 311 and 315 and between 324 and 329 (Plate 7).

Time correlation of reflections from one shot-point to the next has been possible for certain bands of reflections over all traverses except on Traverse E between shot-points 358 and 378. Profiles of continuous reflecting horizons have been drawn through four bands of reflections beneath shot-point 192 (Plate 5), at reflection times of 499, 878, 1151, and 1296 milliseconds (corresponding to depths of 1980, 3760, 5470, and 6370 ft); these profiles have been extended to all traverses. Between shot-points 358 and 378 four phantom horizons have been drawn by averaging the dips of reflections in each of the four separate reflection bands which correspond to the bands for which correlation profiles have been drawn along the other parts of the traverses. In this report the four continuous reflecting horizons in order of increasing depth will be referred to as the first, second, third, and fourth horizons.

Reflections recorded from beneath the fourth horizon are not persistent enough over the length of the traverse to give accurate structural information about the strata they represent. On Traverse G, however, beneath shot-points 446 and 466 (Plate 10) reflections of good quality were recorded from beneath the fourth reflecting horizon, and it has been possible between shot-points 450 and 461 to follow a fifth continuous reflecting horizon.

Reflection bands across the five-mile intervals of unshot traverse can be correlated with confidence, but correlation of individual troughs is not possible owing to rapid changes in character of reflections.

It is considered that the correlation of the reflecting horizons shown on the diagrams is sufficiently accurate to present a regional structural cross-section of the Surat Basin. The continuous reflecting horizons are shown on the appropriate cross-sections (see list of ILLUSTRATIONS at the beginning of this report).

The positions of suggested small faults are also shown. The criteria for recognition of faulting are disturbances in the alignment of a reflection, associated with abnormal dips and an increased number of troughs. On the reflection cross-section along Traverse AA (Plate 3) a diffraction pattern provides positive evidence of a fault. It is not possible from the reflections, however, to recognise any significant change in depth of the strata, so that fault is regarded as small. The faulting suggested on Traverses E and F is likewise considered to be small.

Between shot-points 446 and 466 and again between shot-points 489 and 497 on Traverse G, where the reflections indicate steeply dipping strata, a migrated cross-section has been drawn (Plate 12). This was done by migrating the depth points, beneath each pair of shot-points in turn, by an amount dependent on the average angle of dip over arbitrary lengths of a continuous reflecting horizon.

The results and an interpretation of the refraction shooting on Traverses AA and E are shown on Plates 14 and 15 respectively and are summarised in the following table :

TRAVERSE AA			TRAVERSE E		
Refractor	Velocity (ft/sec)	Depth (ft)	Refractor	Velocity (ft/sec)	Depth (ft)
V1	10,700	1200	V1	12,225	3240
V2	12,900	3950	V2 recorded as second event.	13,250	4100
V3	18,380	6380	V3	20,180	8100

The velocities V1 and V2 on Traverse E are sufficiently different to suggest that they are from different layers. It is not certain,however, which of these refractors corresponds to V2 on Traverse AA.

The fault indicated by the diffraction pattern on Traverse AA (Plate 3) has confused the timing of the refracted energy on the V3 refractor, and although a simple interpretation of the refraction results is shown on Plate 12, the correct interpretation is probably more complicated. The confusion arises mainly in the interpretation of the apparent velocities of 16,400 ft/sec recorded from shot-point 127, and 22,000 ft/sec recorded from shot-point 75. It is suggested that these two velocities are recorded from variably-dipping segments of the V3 refractor resulting from a disturbance by faulting. An alternative suggestion is that there may be a refractor of intermediate velocity between V2 and V3.

A tentative interpretation of the refraction results along Traverse AA was presented by Morton and Robertson (1959). At that time recording had been done from only one direction and the interpretation presented depended to some extent on the dip of a reflection from a single record taken at shot-point 60. It appears from the reflection cross-section (Plate 3) that this reflection represents only a local dip and arises from a disturbance by faulting.

5. INTERPRETATION

Plate 13 shows a generalised cross-section of the Surat Basin from Surat eastward nearly to Tara, derived from the seismic reflection cross-sections of Traverses E and G. This cross-section was obtained by projecting Traverses E and G on to a straight line joining Surat and Tara, and plotting beneath the projected position of each shot-point the appropriate depth of each of the five horizons shown on the reflection cross-sections. The vertical scale is exaggerated approximately 4 times (see scales on Plate 13).

Formations above the fourth horizon in the Surat Basin are almost certainly of sedimentary origin and show little indication of tectonic disturbance. This follows from the persistence and quality of reflections above it on all traverses. Reflections recorded in many places along Traverses E and G indicate that the geological formations are also of sedimentary origin for at least 5000 to 6000 ft below the fourth horizon. The appearance of the cross-section suggests that this horizon may be at the level of a major change in the stratigraphic sequence of the Surat Basin.

The fourth horizon gradually deepens from 6300 ft near Surat to 9300 ft at shot-point 311 on Traverse E (average gradient approx 106 ft/mile). The gradient increases to about 330 ft/mile between shot-points 311 and 370. The fourth horizon remains at an approximately constant depth of 14,000 ft from shot-point 370 to shot-point 422, then rises to the east at a rate of approximately 370 ft/mile to a depth of about 10,700 ft beneath shot-point 457. Between shot-points 457 and 463 it rises sharply from 10,700 ft to 6800 ft with a gradient of approximately 2600 ft/mile. The fourth horizon cannot be traced beyond shot-point 463, but after an interval of five miles of traverse which was not shot, it is thought to be this same horizon which re-appears dipping eastward at a gradient of 800 ft/mile between shot-points 492 and 496.

The structure indicated by the fourth horizon is :

(a) a syncline with its axis beneath Meandarra, which occupies approximately the same position as the Mesozoic structure known as the Meandarra Syncline (Jenkins, 1958).

(b) an anticlinal structure with its axis between shot-points 466 and 490, which it is proposed to call the Cabawin Anticline.

From a study of the reflections between shot-points 457 and 464, it is suggested that there is an angular unconformity either at or immediately above the fourth horizon. Reflections above the fourth horizon near shot-point 463 suggest that the horizon is truncated,and this is interpreted as an erosional surface on the crest of the Cabawin Anticline. In some other parts of Traverses E and G, particularly on the gently dipping western limb of the Meandarra Syncline between Surat and shot-point 311, reflections indicate a slight unconformity either at or immediately above the fourth horizon.

Geological and Geophysical evidence provide some information on the possible nature of the sediments represented by the seismic reflection cross-sections, and also on the possible ages of the formations forming the Cabawin Anticline. However a stratigraphic bore will have to be drilled in order to elucidate the problems that derive from the present survey.

A comparison of the depths of the fourth horizon (Plate 5) and the 20,180-ft/sec refractor (Plate 15) suggests that they do not represent the same stratigraphic horizon, as the calculated depth of the refractor is 920 ft (14 per cent of the calculated depth) deeper than the fourth horizon. The refraction results on Traverse AA are not considered to be as reliable as those on Traverse E, so the apparent close correspondence between the 18,380-ft/sec refractor and the fourth horizon on Traverse AA is regarded as fortuitous.

The high-velocity refractor (20,180 ft/sec) recorded on traverse E is expected to lie within strata of sedimentary origin. The velocity recorded might well be attributed to a crystalline limestone according to tables of common velocities of rocks (Dobrin, 1952). There are, however, some notable examples of high-velocity horizons which detract from the probability of this suggestion. On the Cooroorah Anticline near Comet a velocity of over 18,000 ft/sec was attributed to cemented (siliceous) sandstone (Morton and Moss, 1960) and at Roma a high interval velocity of 18,000 ft/sec in the Timbury Hills No. 2 Bore was attributed to shale (Smith and Lodwick, 1960).

The Permian sediments of the Bowen Group were deposited in a syncline (the Bowen Basin) which began its subsidence in the late Carboniferous or early Permian. Subsidence continued with the deposition of the Permian Bowen Group, but the synclinal structure of the later Permian sediments is not as well developed as that in the Carboniferous and early Permian sediments. A comparison of the third and fourth horizons on the generalised cross-section of Traverses E and G west of the Cabawin Anticline (Plate 13) illustrates this decrease in intensity of the synclinal structure. A stratigraphic history such as that described would account for the presence of faults in the fourth horizon which are not recognisable in the strata above it. An example of this is the fault indicated on Traverse AA.

Whitehouse (1954, p.16) doubts that there are Mesozoic sediments thicker than 10,000 ft anywhere in the Great Artesian Basin. It is therefore suggested that the fourth horizon represents the base of the Permian Bowen Group and that at least some, and possibly all, of the strata between the third and fourth horizons are Bowen Group. This suggestion implies that the sediments below the fourth horizon are Carboniferous.

In Queensland the crystalline Lion Creek limestone is well known in the Carboniferous sequence between the Rockhampton and Neerkol formations, and has a probable equivalent in the _Lithostrotion_ Limestone of New South Wales. It is possible that the high-velocity refractor recorded on Traverse E represents this Limestone.

From the limited information at present available east of the Cabawin Anticline it appears that strata similar to those existing west of the Cabawin Anticline are present. No further interpretation of the cross-section east of the Cabawin Anticline will be attempted until more information is available.

Available bore information in the Surat Basin indicates that the first and second horizons represent Mesozoic strata. There is no indication on the reflection cross-sections, however, of the depth of the stratigraphic boundary between the Permian and the Mesozoic strata. Seismic surveys now in progress may give a clearer picture of Permian tectonics particularly on and near the Cabawin Anticline and thus give a clear indication of this boundary.

The following interpretation is suggested for the stratigraphic history of the Surat Basin after the deposition of strata below the fourth horizon:

During the period (Permian?) when sediments between the third and fourth horizons were deposited, rapid subsidence took place in a belt of limited width (the Meandarra Syncline between shot-points 311 and 363). This belt probably represents a southern extension of the Bowen Basin. West of shot-point 311 the subsidence was much more gradual. After an earth movement in the late Permian (the Hunter-Bowen Thrust) subsidence was not confined to the Meandarra Syncline, but took place throughout the Surat Basin. At first, sedimentation continued in the low-lying parts while the higher ground was still being eroded. Later, during the deposition of sediments represented by the third and second horizons, sediments of almost constant thickness were deposited over the whole of the Surat Basin and probably the whole of the Great Artesian Basin (of which the Surat Basin is a part).

It is suggested that the Cabawin Anticline is an expression of the Hunter-Bowen Thrust. The reasons for this suggestion are :-

(a) it is of approximately the right age; the anticlinal movement is strongly noticeable in the pre-Mesozoic sediments but barely noticeable in Mesozoic sediments.

(b) it lies approximately on the line of the Hunter-Bowen Thrust suggested by Whitehouse (1954) (Plate 1).

If the sediments between the third and fourth horizons are in fact Permian the seismic results show that the Permian sedimentation extends west of the line suggested by Whitehouse (1954) (see Plate 1) but gradually becomes thinner westward.

6. CONCLUSIONS

The following summarises the interpretation of the results of the 1959 seismic survey in the Surat Basin :-

(a) Below the fourth horizon much earth movement has taken place. It is likely that the fourth horizon represents an unconformity. The main structure in the Surat Basin indicated by this horizon is a syncline (Meandarra Syncline) with its western limb dipping gently to the east from about 6000 ft near Surat to about 9300 ft at shot-point 311 some 10 miles west of Glenmorgan; east of shot-point 311 the gradient increases, and the fourth horizon reaches a depth of over 14,000 ft beneath Meandarra. The gradient of the eastern limb of the syncline is very much steeper than the western limb, and the fourth horizon rises to a depth of 6800 ft at shot-point 464 about 8 miles west of Tara. The eastern limb of the Meandarra Syncline forms the western limb of the Cabawin Anticline which, it is suggested, represents the extension of the Hunter-Bowen Thrust belt beneath the Great Artesian Basin. Reflections believed to come from the fourth horizon were recorded between shot-points 490 and 496, and mark the eastern limb of the Cabawin Anticline. There remains, however, some uncertainty about whether these reflections do come from the fourth horizon. This horizon cannot be plotted continuously across the crest of the Cabawin Anticline. It is suggested that an erosional interval in which part of the crest of the Cabawin Anticline has been removed is the reason for this discontinuity of the fourth horizon across the Cabawin Anticline. Sediments below the fourth horizon appear to be affected by small faults of which little expression is apparent in sediments above it.

(b) Reflections recorded from beneath the fourth horizon indicate that the rocks below it are sedimentary, and over 5000ft thick. Thus, the total thickness of sediments in the deepest part of the Surat Basin appears to be over 19,000 ft.

(c) A refractor with a velocity of approximately 20,180 ft/sec has been recorded, probably from below the fourth horizon, about 10 miles east of Surat. It is tentatively interpreted as a crystalline limestone.

(d) It is suggested that the sediments between the third and fourth horizons are, in part at least, of Permian age and represent the southern extension of the sediments of the Bowen Basin. The maximum thickness (6000 ft) of these sediments recorded on the Surat-Tara traverses, is less than the thickness of the Bowen Group in the north of the Bowen Basin. (Bryan and Jones, 1954, Table M). This is in agreement with the suggestion (Whitehouse, 1954) that in its southern part the Bowen Basin overlaps a ridge of metamorphic rocks with its axis through Coffs Harbour.

(e) The sediments below the fourth horizon are tentatively interpreted as Carboniferous representing the equivalent of the Rockhampton and Neerkol formations in Queensland and the Burindi and Kuttung Formations in New South Wales. If this is true, the sediments of the Yarrol Basin may extend southward beneath the Bowen Basin to New South Wales and westward to the Nebine Ridge.

(f) The Mesozoic formations of the Great Artesian Basin indicated by the first and second horizons are almost horizontal, and show little expression of the buried structure across the Cabawin Anticline.

Further seismic surveying may clarify some of the problems in understanding the structure of the Surat Basin, such as :-

(a) The significance of the Permian fault blocks in the Texas area of southern Queensland.

(b) The relation between the sediments of the Surat Basin and the granite batholiths which have been reported both at the Nebine Ridge and Block 16, Roma.

(c) The relation between the sediments of the Surat Basin and the metamorphic sediments in the bores, near Roma, above which gas has been found.

It is important, however, that stratigraphic bores should be drilled at sites selected to provide a complete stratigraphic column. This knowledge would greatly increase the value of the existing and future seismic results.

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APPENDIX "A"

STAFF AND EQUIPMENT

STAFF:

Party Leader:	K.B. Lodwick and S.J. Watson
Geophysicists:	K.F. Fowler, A. Turpie
Assistant Geophysicist:	J.K.C. Grace
Surveyors:	C. Samundsett) Department of J. Coman) Interior
Clerk:	W. Rossendell
Observer:	G.L. Abbs
Shooter:	H. Wischmann
Toolpusher:	L. Sprynskyj
Drillers:	B. Findlay, K. Suehle
Mechanics:	G.C. Bennett, I.D. Pirie

EQUIPMENT:

Seismic amplifiers:	T.I.C. Model 521
Seismic oscillograph:	T.I.C. 10" 50-trace, mixing on 24 traces
Magnetic recorder:	Electro-Tech. DS-7
Geophones:	T.I.C. 20-cycle for reflection T.I.C. 6-cycle for refraction
Drills:	2 Failing 750 rotary drills
Water tankers:	2 Commer 3-ton 4x4 2 International 3-ton 4x4
Shooting truck:	1 Commer 3-ton 4x4

APPENDIX "B"

TABLE OF OPERATIONS

Sedimentary basin:	Surat Basin, part of Great Artesian Basin
Area:	Surat to Tara
Camp sites:	Base camp at Surat. Temporary accommodation at Meandarra and Tara.
Established camp:	5th October 1959
Surveying commenced:	6th October 1959
Drilling commenced:	6th October 1959
Shooting commenced:	8th October 1959
Miles surveyed:	67
Topographic survey control:	Lands Dept. Q'ld. 2-mile series.
	Levels : Police Stn., Surat. Main Roads and Railway levels.
Total footage drilled:	22,713 ft
Explosives used:	4.4 short tons Geophex
Datum level for corrections:	700 ft above Mean Sea Level
Weathering velocities:	2500 ft/sec
Sub-weathering velocities:	7000 ft/sec (see cross-sections)
Weathering corrections:	After Vale *et al.* 1960, Records 1960/13.
Source of velocity distribution:	$T-\Delta T$ analysis 1958 survey.

REFLECTION SHOOTING DATA:

Shot-point interval:	1320 ft
Geophone group:	6 detectors in line of traverse 22 ft apart
Geophone group interval:	110 ft
Holes shot:	189
Miles traversed:	$47\frac{1}{4}$
Common shooting depths:	80 to 100 ft in west, 100 to 140 ft in east
Usual recording filter:	L_2H_2
Usual playback filter:	L_2H_3
Common charge sizes:	10 to 20 lb

Grading system:	Based on that of Gaby (1949)

Remarks:

Centre and end times for all reflections were picked from the playback record. Cross-sections were plotted using the unmigrated continuous correlation method except on Plate 12. On Plate 12 depth points of each reflection horizon were migrated.

Instrumental Difficulties:

Some individual amplifiers showed occasional phase shifts. In a few cases there were time differences between the dips computed from the original and the corresponding playback records. This was attributed to a momentary jamming of the magnetic tape either during recording or playback.

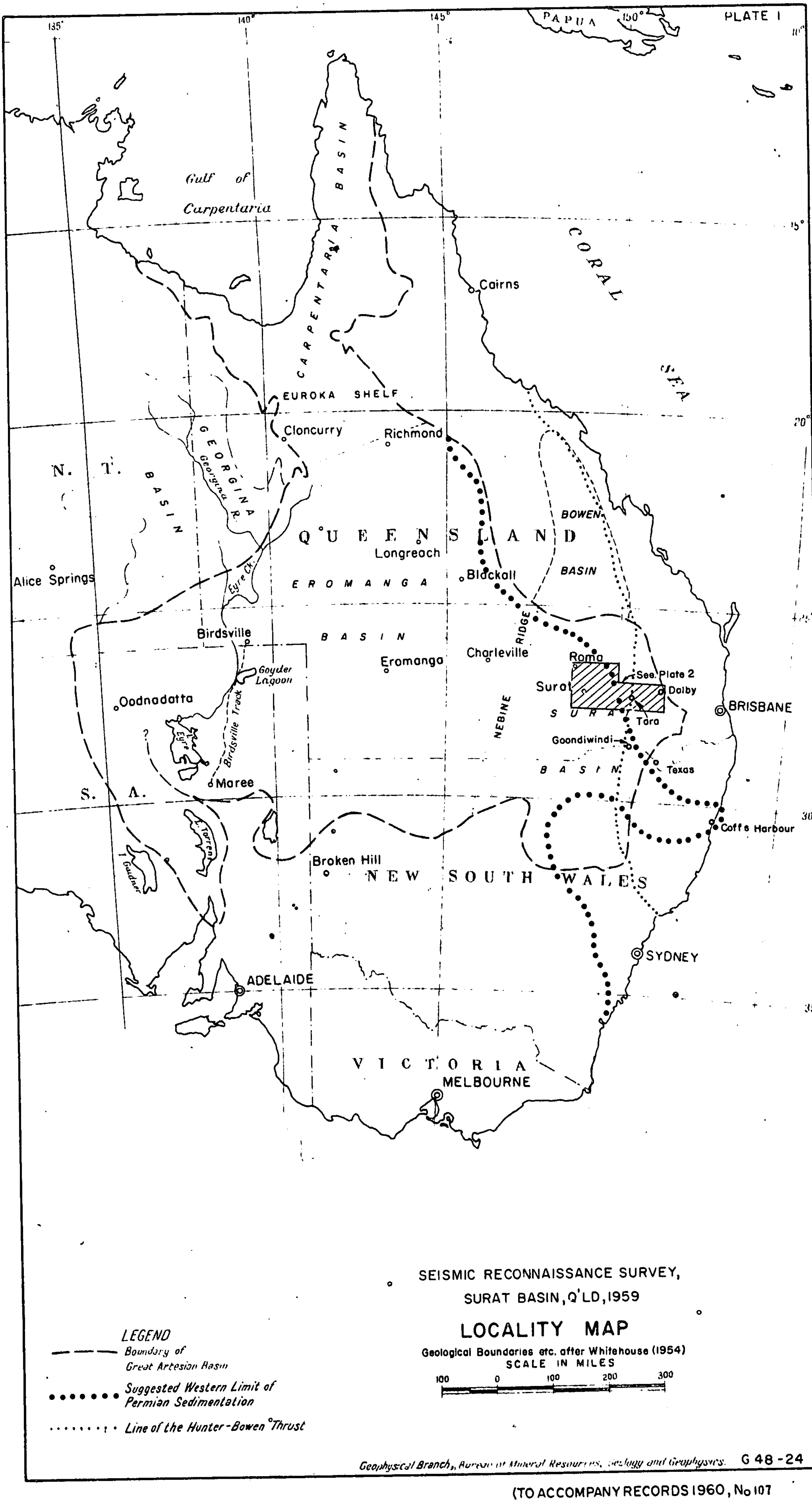
REFRACTION SHOOTING DATA:

Geophone group:	2 bunched
Geophone group interval:	220 ft
Holes shot:	12
Usual recording filter:	L_0H_3
Number of refraction traverses:	2
Charge sizes:	40 to 400 lb
Maximum shot-geophone distance:	7 miles
Weathering control:	from reflection work
Weathering and elevation corrections:	After Vale et al. 1960. Records 1960/13.
Reduction and presentation of results:	Five velocities and profiles of the refracting layers have been calculated using a method by Barthelmes (1946) which has been adapted for use by Bureau seismic parties by Vale and Smith (1960). Depths of refractors have been calculated by assuming that a single layer, having a velocity equal to the average velocity derived from reflection shooting at the appropriate depth, overlies the refractor. The average velocity curves derived from reflection shooting in the Surat Basin are shown on Plates 16 and 17.

APPENDIX "C"

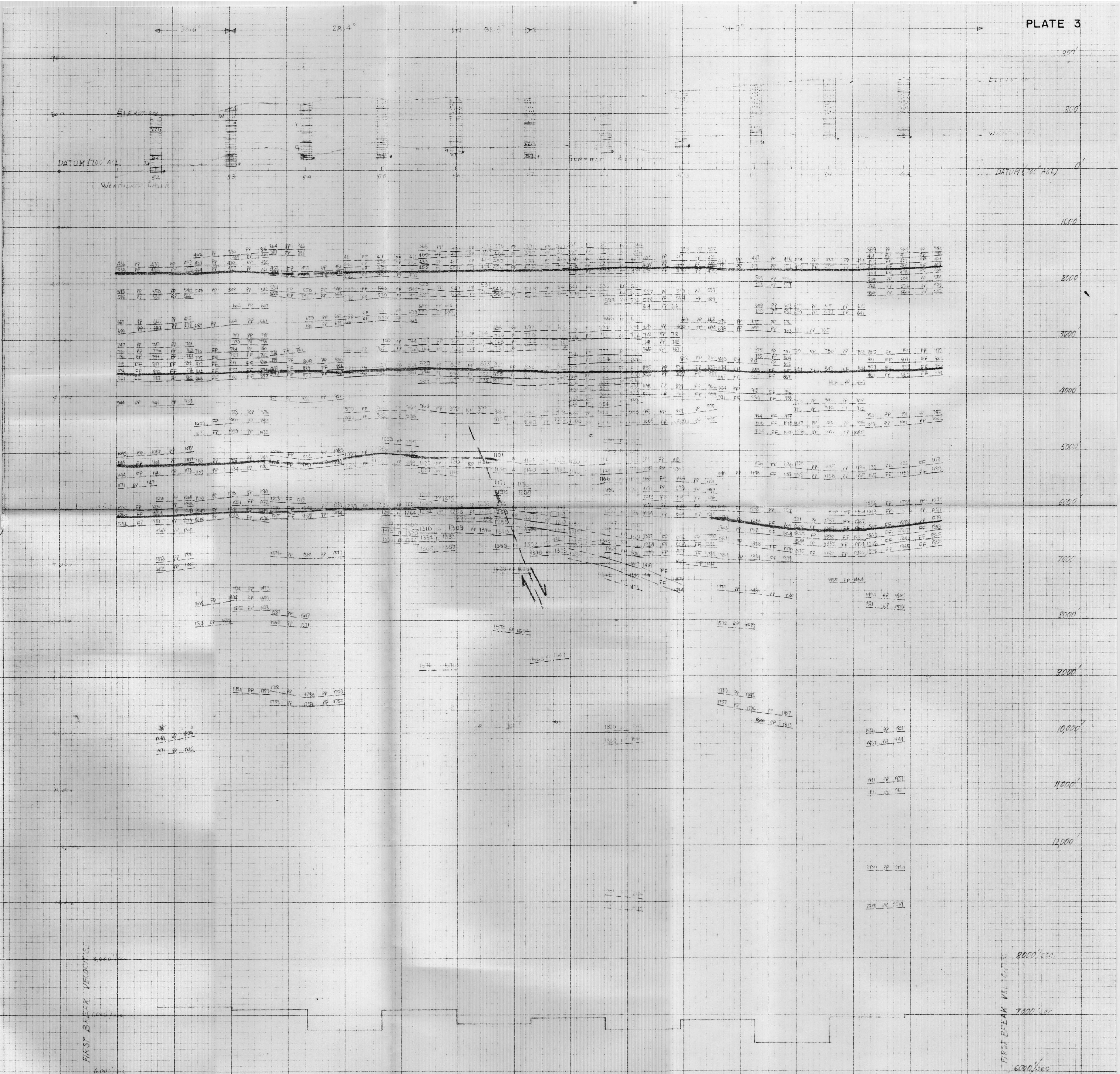
NOTES ON SEISMIC SHOT-HOLE DRILLING

Number of operations shifts = 79	=	672½ hrs
Overtime (equipment maintenance)	=	56 hrs
" (drilling)	=	nil
Total overtime	=	56 hrs
Number of holes drilled	=	239
Total footage	=	22,713 ft
Greatest footage drilled in one day (two rigs)	=	1050 ft
Least " " " " " " "	=	108 ft
Average " " " " " " "	=	567 ft
Drilling time	=	286 hrs
Travelling and rigging time	=	244½ hrs
Time lost owing to rain	=	43 hrs
" " waiting on water	=	14½ hrs
" " standing by recorder	=	23 hrs
" " " " surveyor	=	20½ hrs
" " on repairs to rigs and equipment	=	41 hrs
Total time lost	=	142 hrs
Deepest hole drilled	=	148 ft
Average depth	=	95 ft
Average penetration rate	=	79 ft/hr
Bentonite used	=	25½ bags



(TO ACCOMPANY RECORDS 1960, No 107


PLATE 2
SEISMIC RECONNAISSANCE SURVEY, SURAT BASIN, Q'LD., 1959
LAYOUT OF TRAVERSES
SCALE IN MILES
4 0 4 8 12 16
ROAD
SEISMIC TRAVERSE SHOWING YEAR OF SURVEY
A (1958)
RAILWAY
REFERENCE TO AUSTRALIAN 4 MILE MILITARY MAP SERIES
CORAL SEA
QUEENSLAND
CAIRNS
Townsville
CHARTERS TOWERS
LONGREACH
Rockhampton
BUNDABERG
MARYBOROUGH
GYMPIE
BRISBANE
Windorah
Charleville
Quilpie
ROMA
SURAT
DALBY
150°00'
27°00'
TO INJUNE
EUTHULLA
1950 SURVEY TRAVERSES
TO MITCHELL
ROMA
WARDOBY
BLYTHDALE
Wallumbilla
YULEBA
Drillham
Bungil
Creek
CONDAMINE
HIGHWAY
TRAV. A (1958)
TRAVERSE AA (1958-59)
River
Balonne
SURAT
TRAV. F
TRAVERSE B (1958)
TRAVERSE E (REFRACTION)
E (1959)
TRAVERSE E (1959)
GLENMORGAN
Condamine
TO CONDAMINE
Undulla
Creek
TRAVERSE G (1959)
MEANDARRA
HANNAFORD
CABAWIN
SOUTH GLEN
TULLAGRIE
TARA
PERTHTON
GORANBA
BUNGYBAH
WERANGA
KUMBARILLA
SULERA
DUCKLO
DULEEN
KUPUNN
NANDI
DALBY
MACALISTER
JAPUNYAL
PIRRINUAN
KARINGAL
YARRALA
CONDAMINE HWY.
BUNDY-CONDAMINE HWY.
TRAV. D (1958)
"Warroon"
"Echo Hills"
TRAVERSE BB (1958)
(REFRACTION)
"Roylend"
Telegraph Line
"Coomo"
TRAV. C (1958)
Condamine
River
CECIL PLAINS
HORRANE
NANGWEE
TO OAKEY
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G48-10
TO ACCOMPANY RECORDS 1960, No. 107



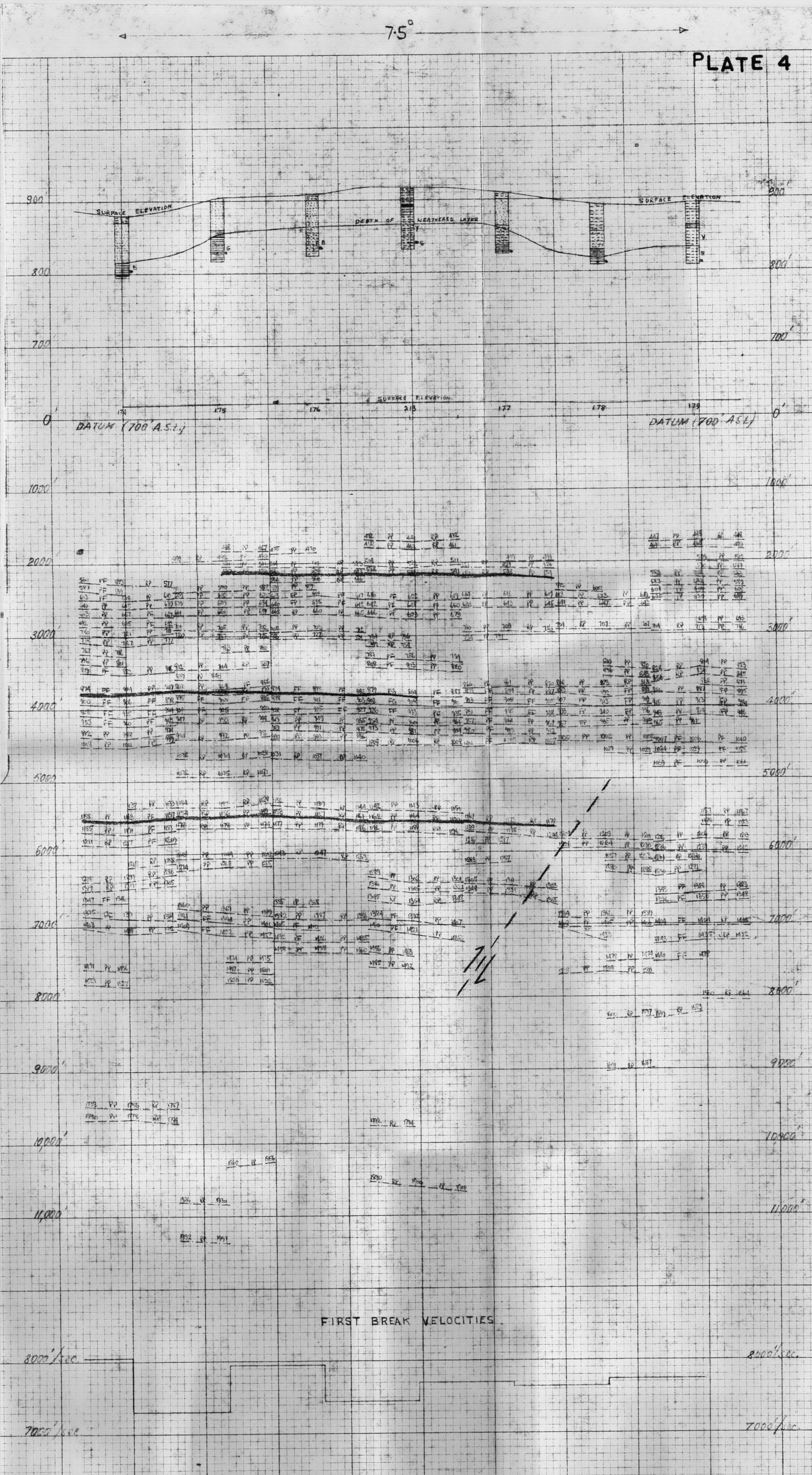
SURAT, TRAVERSE AA

SEISMIC REFLECTION CROSS - SECTION

To accompany Records 1960, No 107

G48-11

PLATE 4



SURAT, TRAVERSE F

SEISMIC REFLECTION CROSS-SECTION

To accompany Records 1960, No.107

G 48-12

PLATE 5

SURAT, TRAVERSE E

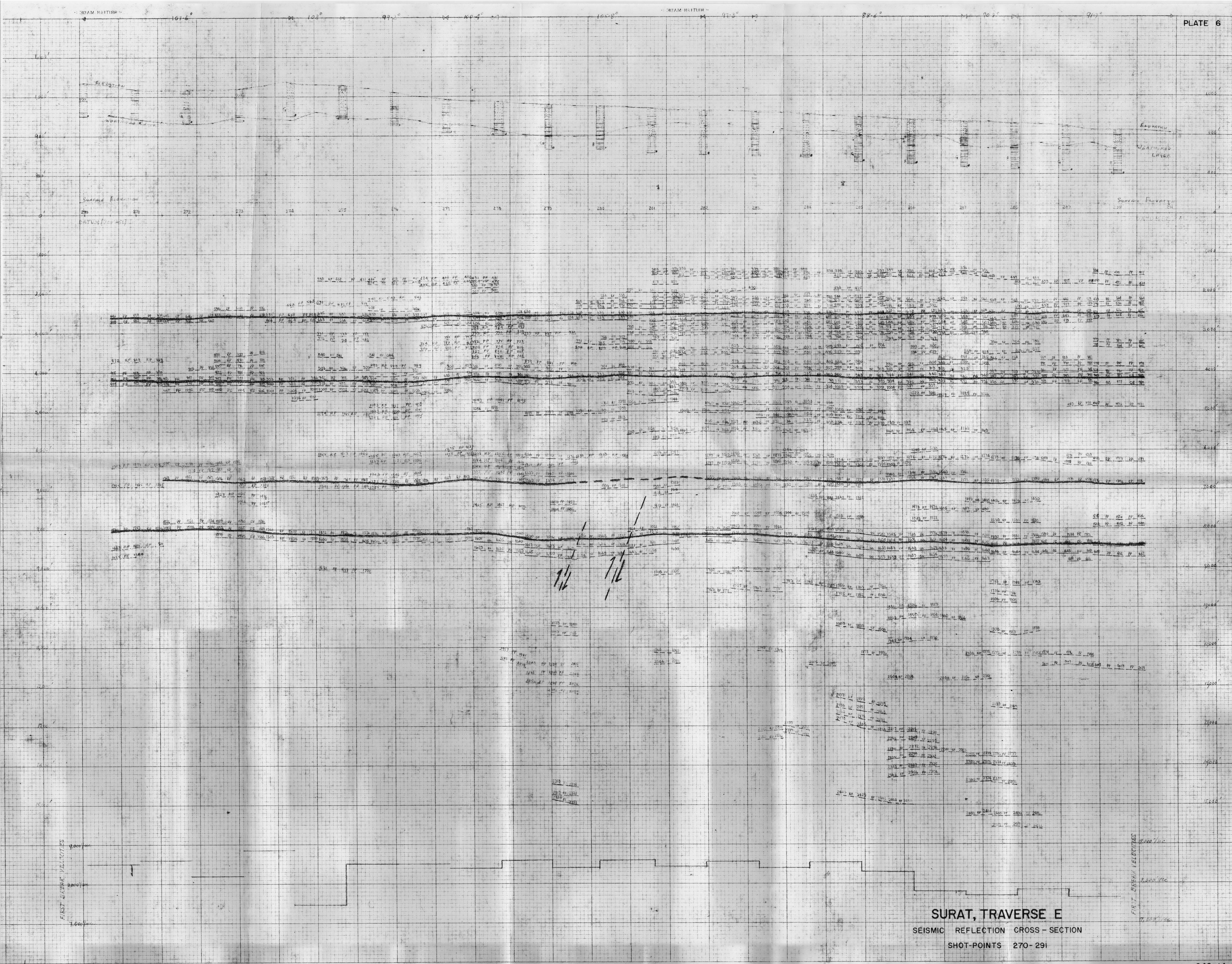
SEISMIC REFLECTION CROSS-SECTION

SHOT-POINTS 192-248

G 48-13

To accompany Records 1960, No 107

PLATE 6



SURAT, TRAVERSE E

SEISMIC REFLECTION CROSS-SECTION

SHOT-POINTS 270-291

To accompany Records 1960, No107

G48-14

PLATE 7

SURAT, TRAVERSE E

SEISMIC REFLECTION CROSS - SECTION

SHOT-POINTS 311-333

To accompany Records 1950 No.117

G48-15

SURAT, TRAVERSE E

SEISMIC REFLECTION CROSS-SECTION

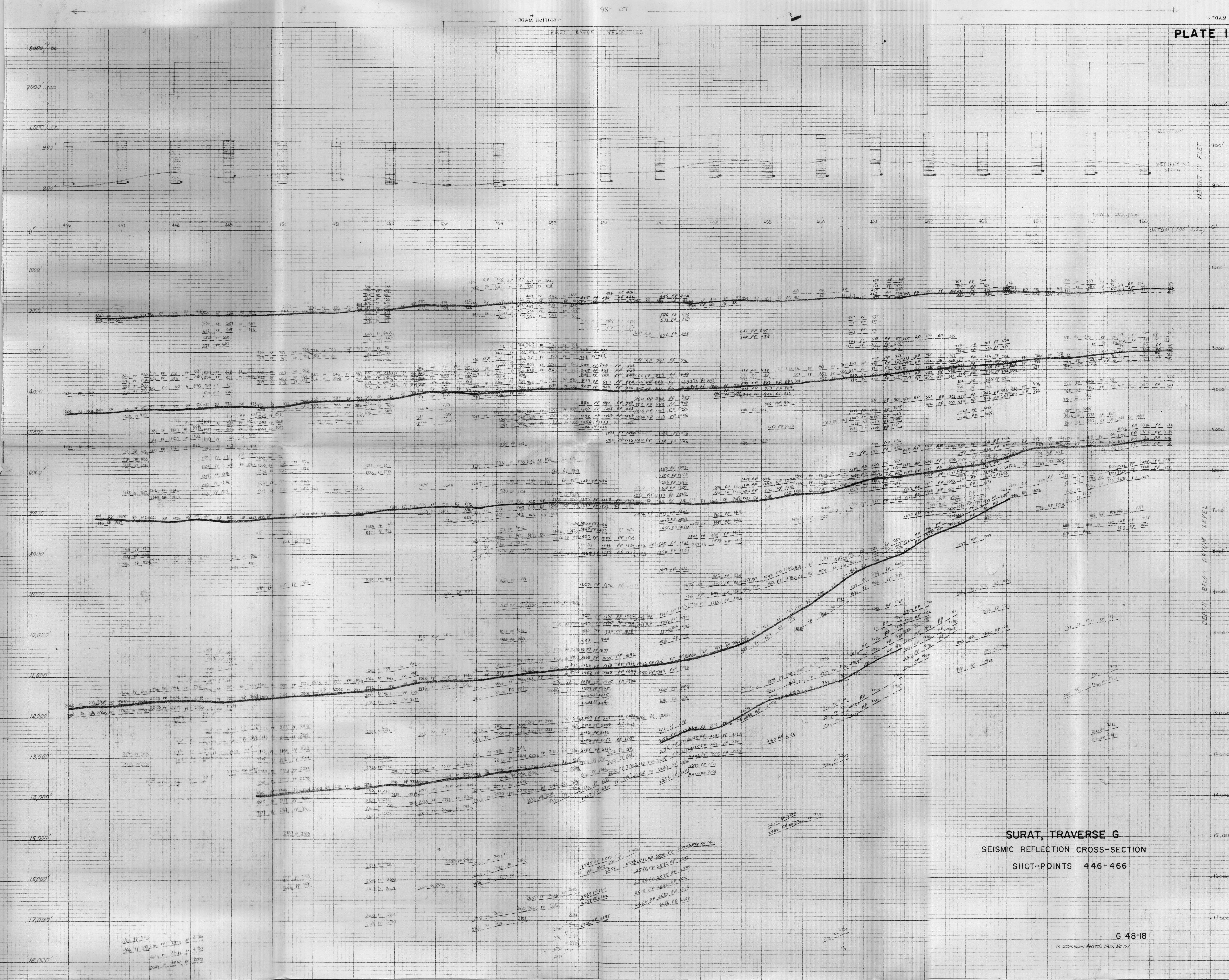
SHOT-POINTS 358-378

To accompany Records 1960, No107

G48-16

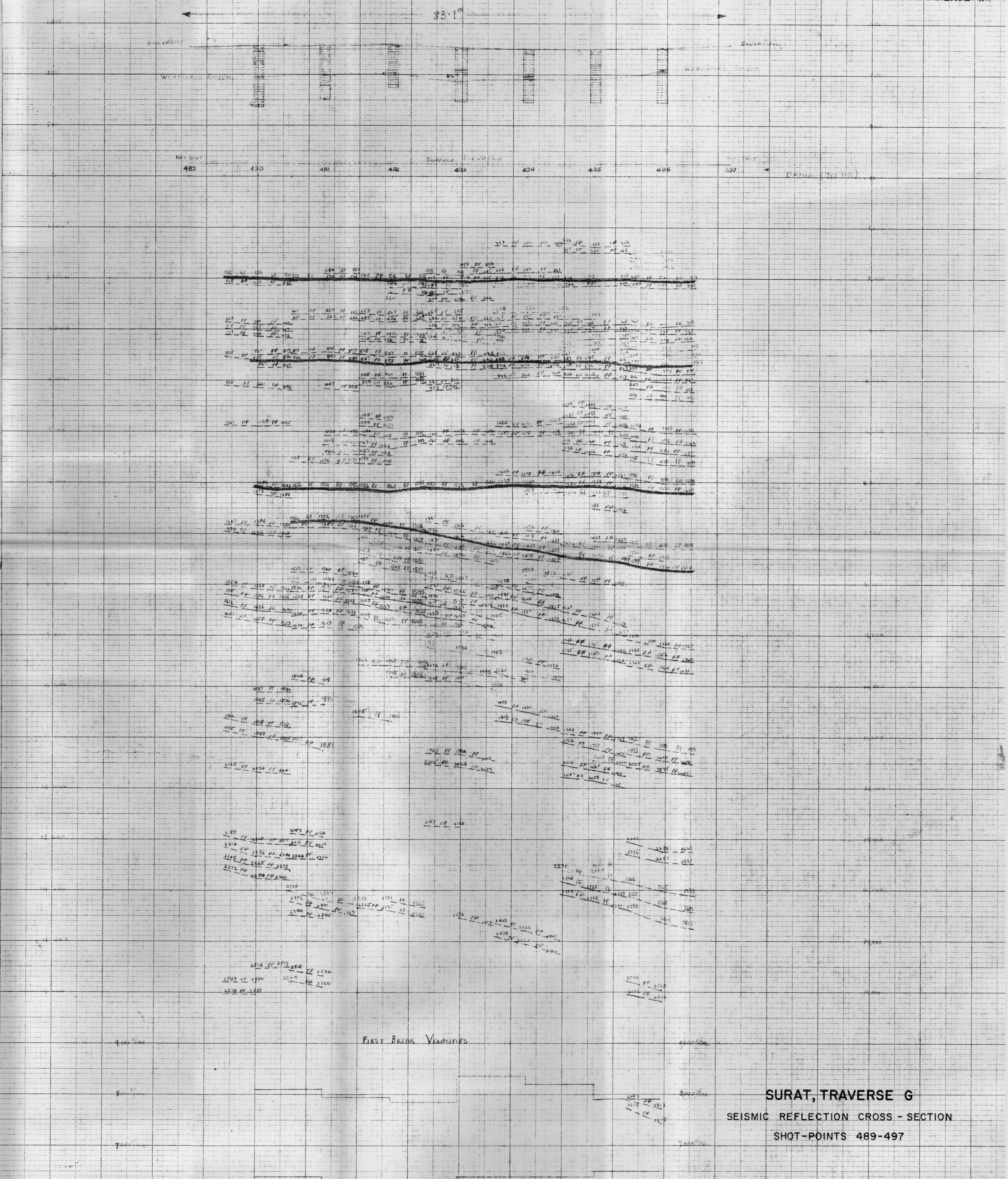

PLATE 9
FIRST BREAK VELOCITIES
98·1°
SURFACE ELEVATION
DEPTH OF WEATHERED LAYER
DATUM 1700' A.S.L.
NO REFLECTIONS
DATUM
SURAT, TRAVERSE G
SEISMIC REFLECTION CROSS-SECTION
SHOT POINTS 402-422
G 48-17

PLATE 10



SURAT, TRAVERSE G
SEISMIC REFLECTION CROSS-SECTION
SHOT-POINTS 446-466

PLATE II



SURAT, TRAVERSE G

SEISMIC REFLECTION CROSS - SECTION

SHOT-POINTS 489-497

To accompany Records 1960, No 107

G48-19

PLATE 12

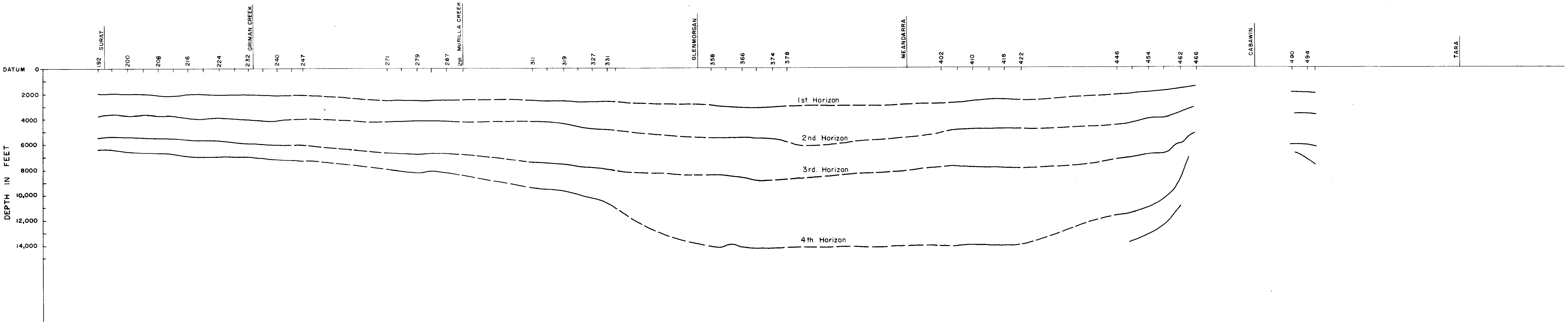
SURAT, TRAVERSE G

MIGRATED SEISMIC REFLECTION CROSS-SECTION

SHOT-POINTS 446-496

To accompany Records 1960, No 107

G 48-20

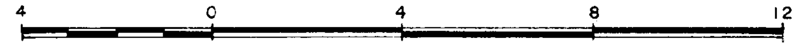


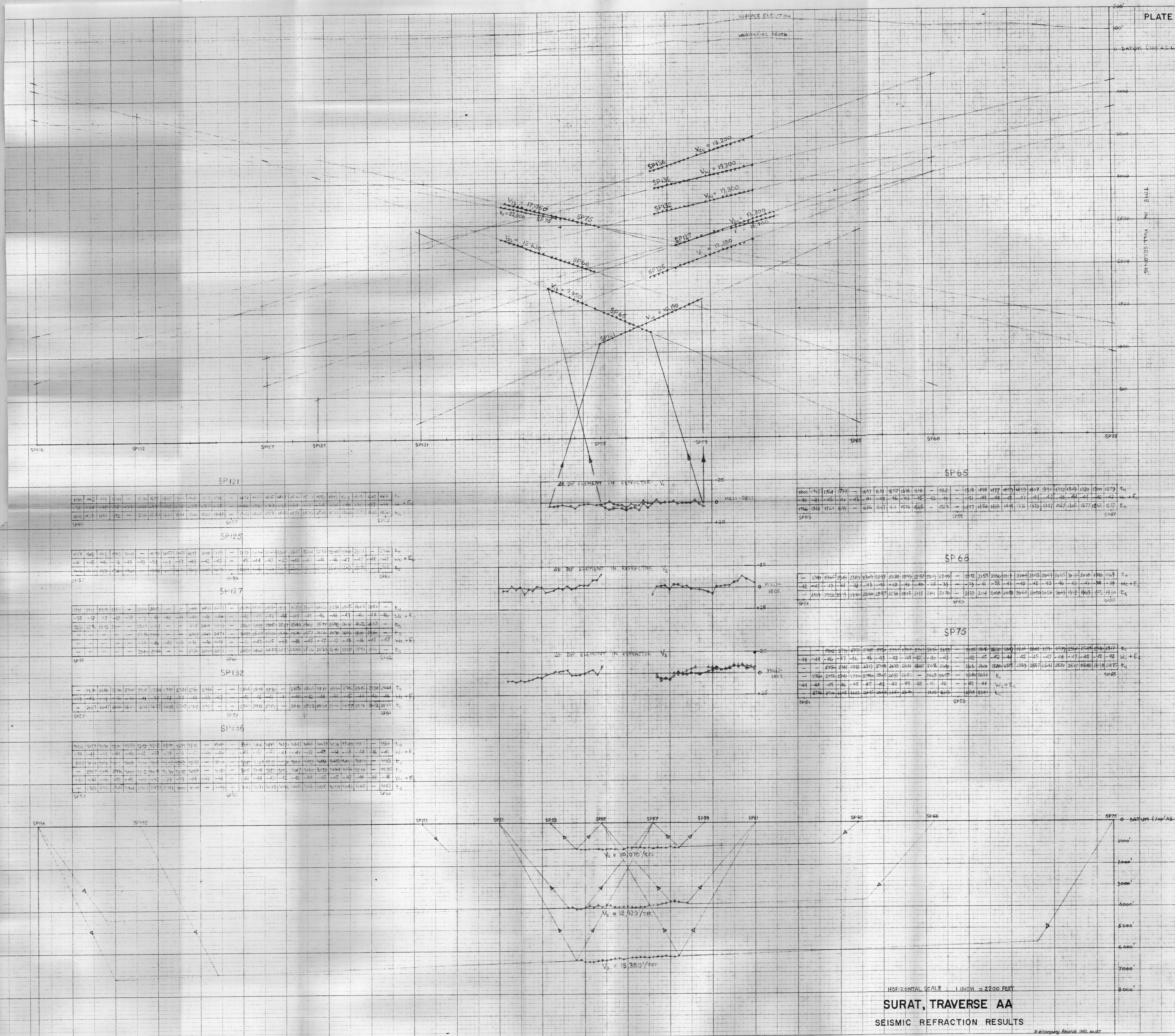
SURAT, 1959

GENERALISED CROSS-SECTION

SURAT - TARA

SCALE IN MILES





HORIZONTAL SCALE : 1 INCH = 2200 FEET

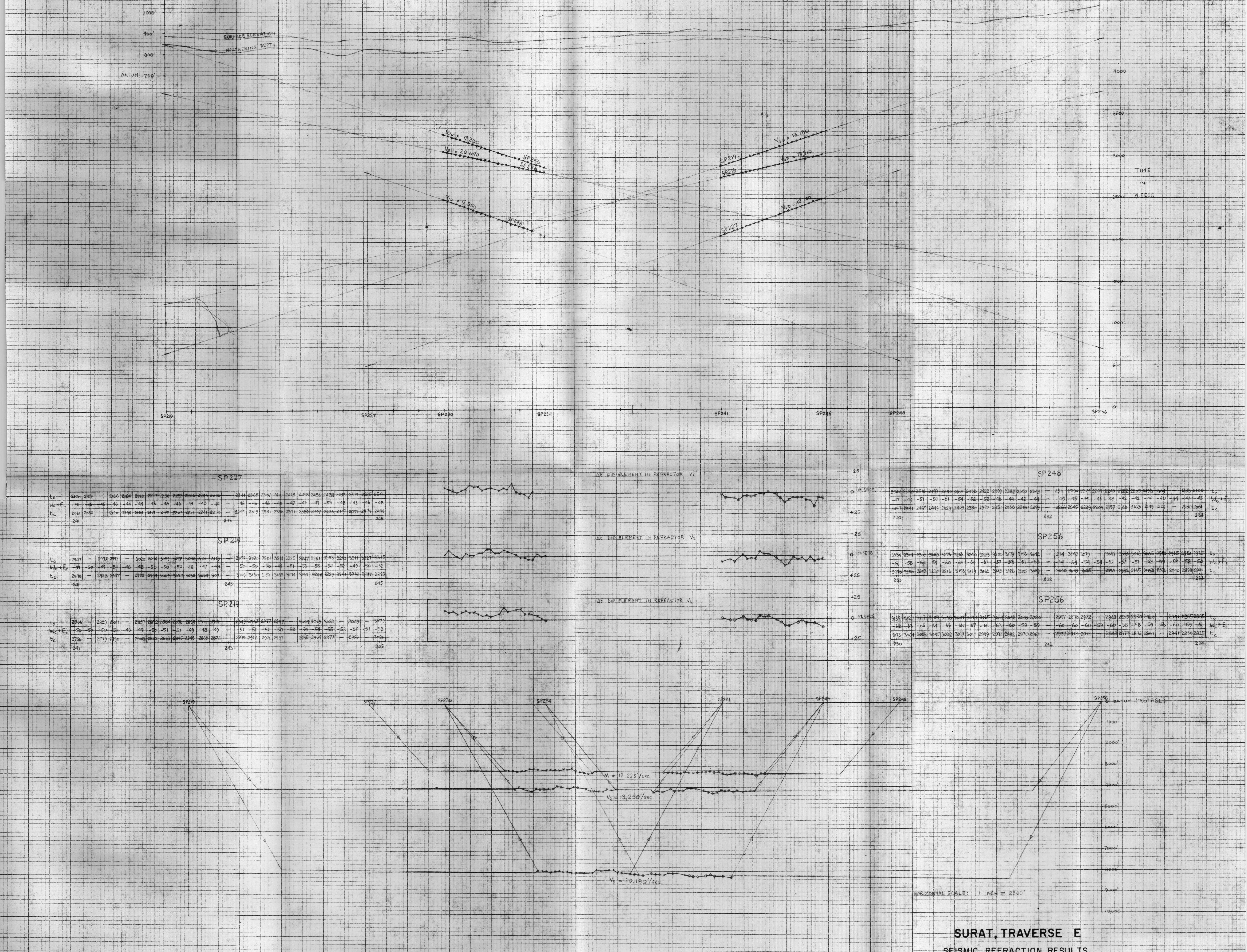
SURAT, TRAVERSE AA

SEISMIC REFRACTION RESULTS

To accompany Records 1960, No.187

G48-22

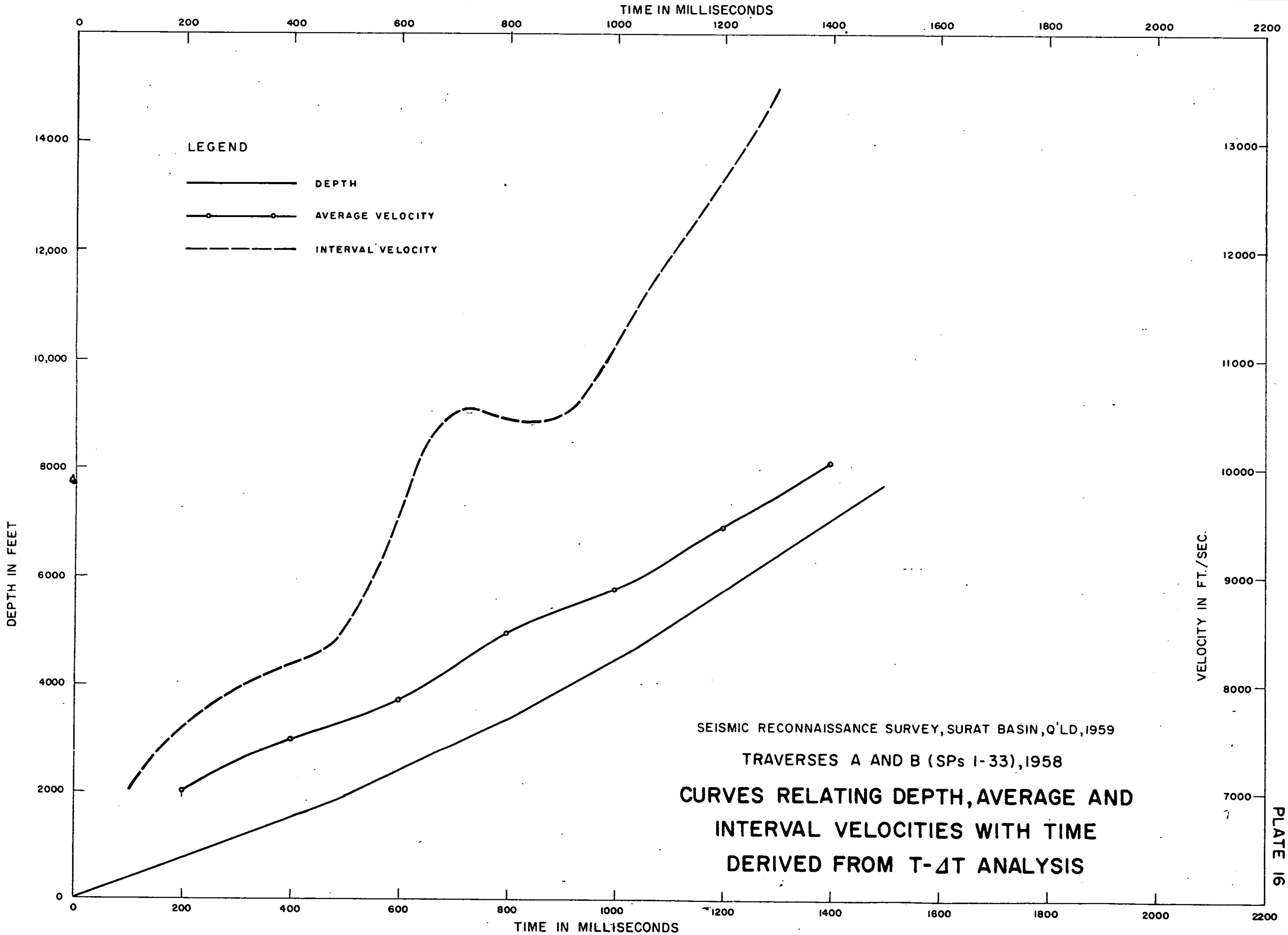
PLATE 15



SURAT, TRAVERSE E

SEISMIC REFRACTION RESULTS

To accompany Records 1960, No. 107



SEISMIC RECONNAISSANCE SURVEY, SURAT BASIN, Q'LD, 1959

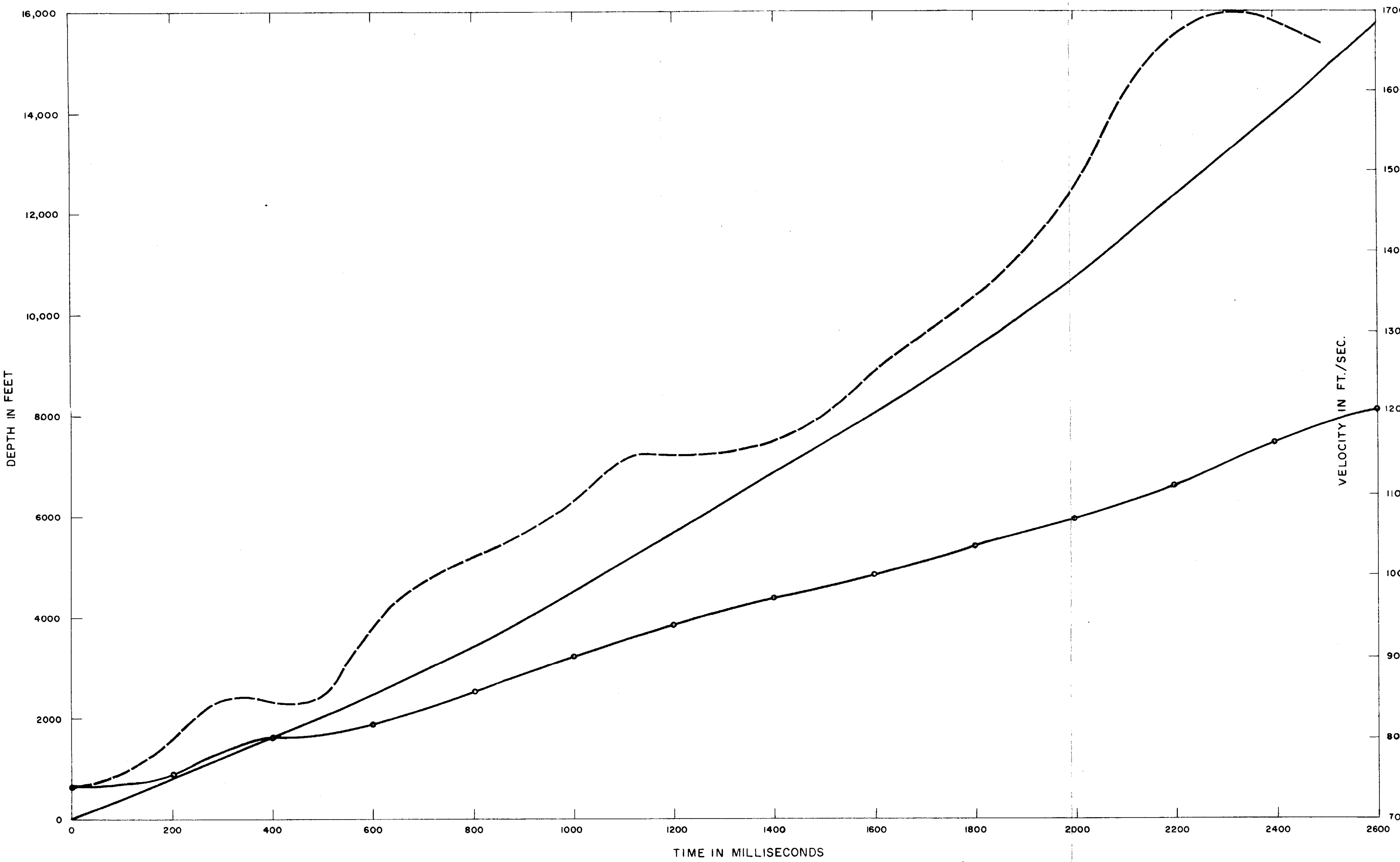
TRAVERSES A AND B (SPs 1-33), 1958

CURVES RELATING DEPTH, AVERAGE AND INTERVAL VELOCITIES WITH TIME DERIVED FROM T-ΔT ANALYSIS

PLATE 16

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G48-9

To accompany Records 1960, No 107



LEGEND

DEPTH

AVERAGE VELOCITY

INTERVAL "

SEISMIC RECONNAISSANCE SURVEY, SURAT BASIN, Q'LD, 1959

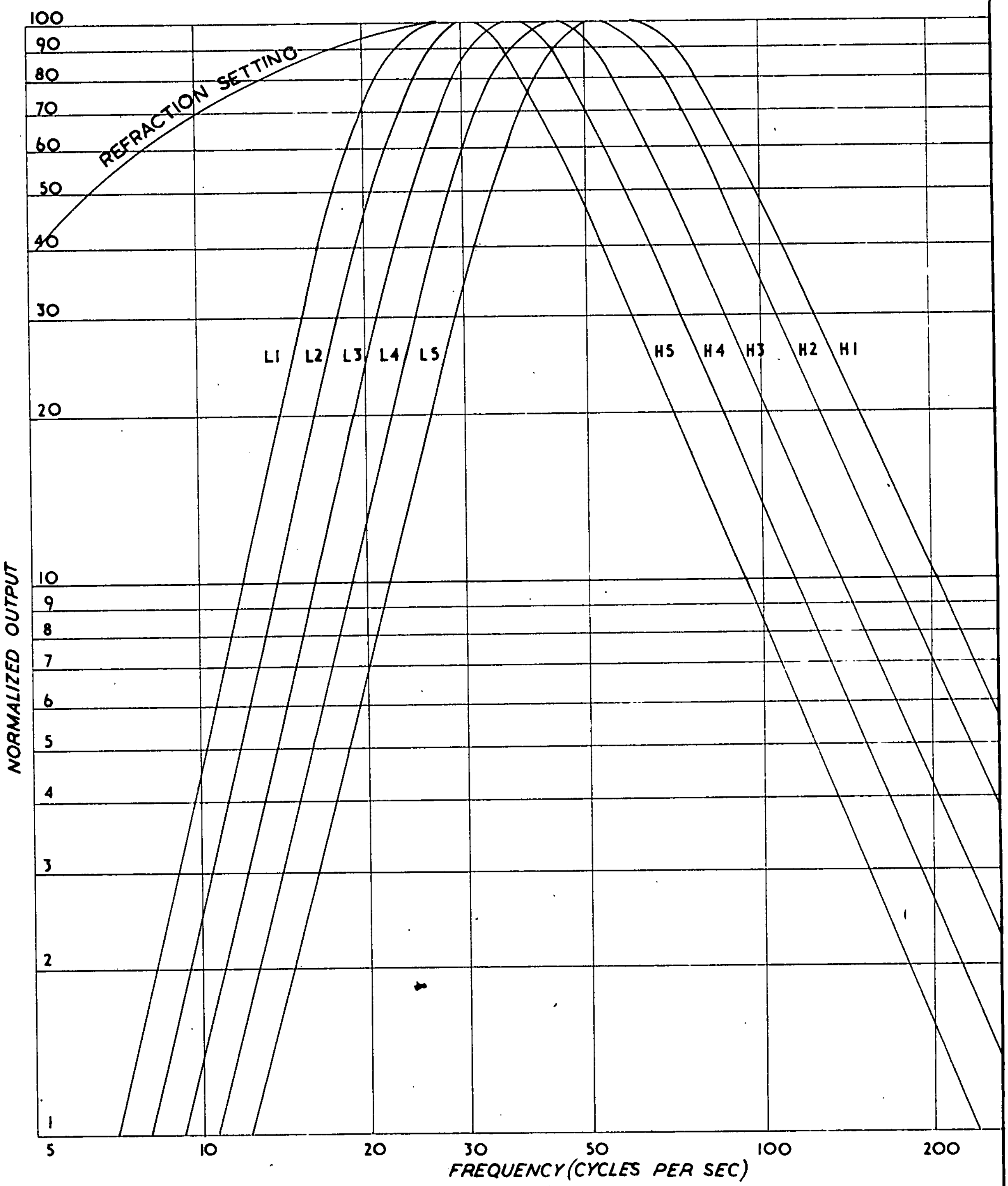
TRAVERSE G (SPs 402-422), 1959

CURVES RELATING DEPTH, AVERAGE AND INTERVAL VELOCITIES WITH TIME DERIVED FROM T-ΔT ANALYSIS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G48-8

To accompany Records 1960, No 107

PLATE 18



FILTER CURVES

T.I.Co AMPLIFIER BAND PASS TYPE 521

SURAT, QLD

G 48-25

TO ACCOMPANY RECORDS 1960. No 107