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RECORD No. 1966/177

THARGOMINDAH - NOCCUNDRA AREA RECONNAISSANCE SEISMIC SURVEYS, EROMANGA BASIN, QUEENSLAND 1962 - 1963

by

J.S. DAVIES and C.S. ROBERTSON

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Note: This Record supersedes Record No. 1964/72

SUMMARY

Several seismic surveys were made by the Bureau of Mineral Resources, Delhi Australian Petroleum Ltd, Phillips Petroleum Company, and L. H. Smart Oil Exploration Company Ltd during the period from 1959 to 1963 between Eulo and the Queensland/South Australia border area of the Eromanga Basin. This report covers the seismic work done by the Bureau of Mineral Resources in 1962 and 1963 and also incorporates the results of the work done by the private oil exploration companies. It aims at providing information on the nature and structure of the rocks underlying the Mesozoic sediments of the Eromanga Basin.

The seismic results have been interpreted with reference to the geology as known from the Delhi-Santos Orientos No. 1 and Dullingari No. 1 wells near the Queensland/South Australia border and the Smart Oil Orient No. 2 well on the Grey Range.

Good to poor quality reflections were recorded east and west of the Grey Range, and two main reflection horizons (the 'C' and 'P' horizons) were correlated across unshot portions of the reflection traverses. It is believed that the 'C' horizon corresponds to an horizon within the Blythesdale Group, and the 'P' horizon corresponds to a zone containing coal measures within the Permian sediments when they are present, or the base of the Mesozoic sediments if no Permian is present.

Both east and west of the Smart Oil Orient No. 2 well, steeply dipping reflections were recorded from below the 'P' horizon, suggesting the presence of a considerable thickness of Ordovician or other pre-Permian sediments.

On the Grey Range, the Mesozoic sediments have a minimum thickness of 3000 ft. The thickness increases both to the west and to the east, reaching values of about 7000 ft near the Delhi-Santos Orientos No. 1 well and about 4300 ft near Tygarra Bore to the east.

Seismic work near Coongoola, 30 miles north-east of Cunnamulla, confirmed that there is a shallow depression between the Eulo Shelf and the Nebine Ridge. Refraction depth probing was done at a number of locations in the Eulo/Grey Range area where basement rocks were expected at reasonably shallow depths. This work indicated that the sedimentary cross-section increases to the west from Eulo to Tygarra Bore and then decreases to the Grey Range.

1. INTRODUCTION

During the latter half of 1962, the No. 1 Seismic Party of the Bureau of Mineral Resources, Geology and Geophysics (BMR) commenced a reconnaissance survey, using both reflection and refraction seismic techniques, between St George and the Queensland/ South Australia border (Plate 1). The programme was not completed in 1962, and it was decided to complete the reflection and refraction work near the Grey Range during 1963, in addition to investigating gravity anomalies in the area. The survey was completed in October and November 1963.

This report presents the results of that part of the BMR survey between the Nebine Ridge/Eulo Shelf and the Queensland/ South Australia border and also incorporates the results of work done by Phillips Petroleum Company and L. H. Smart Oil Exploration Company Limited in the Thargomindah area and Delhi Australian Petroleum Limited in the Orientos area (Plate 2). The report was prepared in 1964 and does not include any work that may have been done since then.

The main purpose of the survey was to investigate the nature of the rocks beneath the Mesozoic sediments of the Great Artesian Basin, attempting to determine whether they are sedimentary or igneous, and also to determine whether there are any large depressions or deep troughs of sediments beneath the Mesozoic rocks.

Although a large number of water holes had been drilled in the area into the shallow Mesozoic artesian aquifers, little was known of the nature of the rocks underlying the Mesozoic. However, two recent wells, the Delhi-Santos Dullingari No. 1 and Orientos No. 1 wells, penetrated Permian sediments and entered Ordovician sediments without encountering crystalline basement (Delhi Australian Petroleum Ltd, 1963a and 1963b). A third well, the Smart Oil Orient No. 2, drilled on the Grey Range, passed through the Mesozoic rocks into recrystallized greywacke of unknown age (L. H. Smart Oil Exploration Co. Ltd, 1963). In Section 5 of this report an attempt has been made to correlate the geology from these three wells using the geophysical results obtained in the area.

Thargomindah, the largest town in the area under consideration, is situated at latitude 28° south and lies about 50 miles east of the Grey Range. The town lies on the main beef road that serves the south-west cattle-raising district and has an air service once a week.

Topographically, the area is one of relatively low relief, gibber hills, and low broken ranges. Elevation decreases to the west from about 500 ft above sea level in the Eulo area to 400 ft at Thargomindah, rising again to about 500 feet over the Grey Range and gradually decreasing westwards to a height of about 350 ft above sea level in the western part of the area. The seismic datum level for the survey was taken as 300 ft above sea level.

The climate in October and November, the months in which the work in the Thargomindah-Noccundra area was carried out in both 1962 and 1963, was generally dry and hot with occasional dust storms. Periods of above century heat were not infrequent during November.

Details of the staff employed and the equipment used during the 1962 and 1963 surveys are listed in Appendix A.

2. GEOLOGY AND PREVIOUS GEOPHYSICAL WORK

Geology

The geology of the area surveyed is shown in Plate 3.

The reader is referred to Whitehouse (1954) or Mott (1952) for a comprehensive discussion of the geology of the Great Artesian Basin. Both writers consider that the southern part of the Great Artesian Basin is divided into two sub-basins separated by the Nebine Ridge and Eulo Shelf. The part of the Great Artesian Basin to the east of the Nebine Ridge is called the Surat Basin, and the part to the west, the Eromanga Basin. The Nebine Ridge and the Eulo Shelf are continuous laterally along the New South Wales/Queensland border, but are separated by a north-trending sedimentary trough to the north near Cunnamulla (Whitehouse, 1954).

At the eastern edge of the Eromanga Basin, on the Eulo Shelf, the Mesozoic section is thin, and granites, associated with slates similar to the Ordovician-Silurian slates in the neighbouring marginal area in New South Wales crop out in the Eulo-Hungerford area. An age determination made by Dr. Curtis at Berkeley University, California, on these granites, using the potassium-argon method, indicated an age of 368 million years, or Devonian. Westward from the Eulo Shelf, the Mesozoic sediments of the Eromanga Basin gradually deepen, probably reaching a maximum thickness near the Queensland/South Australia border.

Delhi-Frome-Santos Innamincka No. 1 well, 20 miles north-east of Innamincka, penetrated 6700 ft of Mesozoic sediments and passed through 320 ft of Permian sediments before entering a thick sequence of red sandstones and shales of unknown age (Delhi Australian Petroleum Ltd, 1961a). Delhi-Frome-Santos Betoota No. 1 well, near Betoota, penetrated 5750 ft of Mesozoic sediments and passed directly into greywacke, siltstones, and conglomerates, possibly the equivalent of the red beds of the Innamincka No. 1 well (Delhi Australian Petroleum Ltd, 1961b). Two more recent wells, the Delhi-Santos Orientos No. 1 and Dullingari No. 1 wells, drilled south of the Innamincka No. 1 well, penetrated greater thicknesses of Permian strata before entering unknown thicknesses of Ordovician sediments. Orientos No. 1 (Plates 2 to 4) passed through 5950 ft of Mesozoic, 1300 ft of Permian, and penetrated 4200 ft of Ordovician sediments without encountering crystalline basement (Delhi Australian Petroleum Ltd, 1963b). Dullingari No. 1 penetrated 6700 ft of Mesozoic, 2325 ft of Permian and 2450 ft of Ordovician sediments (Delhi Australian Petroleum Ltd, 1963a). However, the Orient No. 2 well drilled by L. H. Smart Oil Exploration Co. Ltd on the Chesson Anticline on the Grey Range, 110 miles east of Orientos No. 1, passed from Mesozoic sediments into recrystallized greywacke of unknown age at a depth of 3350 ft. There are no deep wells in the area between the Orientos and Orient wells. A comparison of the stratigraphies of the two wells is given in Appendix D.

One of the main objects of the seismic survey was to determine the extent of pre-Mesozoic sediments beneath the sediments of the Great Artesian Basin. From the point of view of petroleum prospects, the Permian sediments are probably the most prospective of the pre-Mesozoic rocks in eastern Australia. It was therefore of prime importance to determine the extent of the Permian sequence eastwards from their known occurrences in the Delhi-Santos Dullingari No. 1 and Orientos No. 1 wells.

A number of anticlinal or domal structures are evident at the surface in the Eromanga Basin. These have been mapped by photogeology. Although these structures generally have low flank dips, they are often of large areal extent. In the Quilpie area, gravity anomalies associated with the structures indicate that their relief may increase with depth, and seismic evidence tends to support this. The structures often correspond to topographic 'highs', for example, the Canaway and Pinkilla Anticlines north-west and west of Quilpie, and the Chesson Anticline, west of Thargomindah, are all part of the Grey Range. In fact, the Grey Range has been postulated as being the expression of a large regional basement ridge trending north-east. The Orient No. 2 well supports this contention to some extent. However, recent gravity work north of Thargomindah indicates an area of low gravity beneath the Grey Range between the Pinkilla and Chesson Anticlines, both of which coincide with gravity 'highs'.

On the Queensland/South Australia border a well-developed system of large folds exist (Sprigg, 1958). The structures are in the form of large elongated domes, e.g. at Innamincka and Betoota. The domes are up to 50 miles or more in length, 30 miles wide, and have a closure of up to 1000 ft. In general their axes trend north-east. A disconformity between the Cretaceous and Tertiary strata indicates that the folding began in the Upper Cretaceous and reached its climax in the Lower Tertiary.

Aeromagnetic surveys

The Bureau of Mineral Resources has flown a number of long airborne magnetometer traverses over the western portion of the Great Artesian Basin. Several of these crossed the area of the seismic survey, including one from Cunnamulla to Innamincka that runs approximately along the seismic traverse. The interpretation of this traverse appears in Plate 2 and shows that the magnetic basement deepens gradually from Eulo, where it is at a depth of 2000 ft, to the Queensland/South Australia border, where its depth is in excess of 13,000 ft. Another line running south-west from Quilpie shows a gradual rise in magnetic basement from 10,000 ft at Quilpie to near-surface at Tibooburra; the depth of the magnetic basement where this line crosses the seismic traverse near the Grey Range is about 8000 ft. There does not appear to be any magnetic expression of a basement ridge below the Grey Range.

Delhi Australian Petroleum Ltd carried out a more detailed aeromagnetic survey in the north-east corner of South Australia which extended into Queensland as far as longitude 142° 20' E and covers the western end of the seismic reconnaissance line (BMR, 1965). A large sedimentary basin was indicated in the border area centred just north of Innamincka, with depths to magnetic basement in excess of 15,000 ft. It was suggested that the magnetic horizon mapped in this survey could be associated with the "red beds" encountered in the Innamincka No. 1 well, rather than an igneous or metamorphic basement rock. However, the depth estimates in the vicinity of the well are of the order of 15,000 ft, which is in excess of the total depth of the well (12,600 ft) and well below the top of the "red beds", which is at 7050 ft. A comparison of the calculated depths to magnetic basement at the Orientos No. 1 and the Dullingari No. 1 wells with the sedimentary section encountered in these wells (see Plate 2) suggests that the magnetic basement lies below the Ordovician sediments.

Gravity surveys

Helicopter reconnaissance gravity surveys done by the BMR have covered the Thargomindah - Noccundra and adjacent areas. (Barlow, in preparation.)

The Bouguer anomaly contour map and the gravity feature overlay (Plate 4) indicate that the greater portion of the area under consideration is occupied by the Durham Downs Gravity Platform. This region includes a number of closed gravity 'highs', some of which can be correlated with known anticlinal features.

The Durham Downs Gravity Platform is interpreted as an area in which the post-Carboniferous sedimentary section is reduced. The sediments can be expected to be considerably reduced in thickness over structures indicated by local gravity 'highs'.

In the southern part of the Thargomindah 1:250,000 map area a gravity 'high' feature correlates with the Chesson Anticline and is consistent with the results of seismic surveys on this structure. The two separate closures in the minus-five-mgal contour indicate that the dome has two culminations and this was confirmed by seismic data (Smart, 1962), which place the more northerly culmination of the structure exactly in the centre of a gravity 'high'. The reconnaissance gravity data in this locality were supplemented to some extent by gravity readings taken on seismic traverses. Orient Nos. 1 and 2 wells have been drilled on the Chesson Anticline. The No. 1 well was drilled on the more northerly culmination. It was abandoned at 3200 ft in Cretaceous sediments of the Blythesdale Group. No. 2 well was drilled about one mile east of No. 1 well to test for Permian sediments on the eastern flank of the structure. It encountered recrystallized greywacke of possible pre-Mesozoic age at a depth of 3350 ft (Smart, 1963) as already mentioned.

Further to the east of the Durham Downs Gravity Platform an area of low gravity relief, the Norley Gravity Low, occupies the southern portion of the Toompine 1:250,000 map area. This gravity 'low' separates the Toompine Gravity Spur to the north from the Eulo Gravity High and is tentatively interpreted as an indication of an east-west belt of low density Palaeozoic granite intruded into the older rocks that compose the Eulo Shelf.

In the south-west corner of the region, in the Noccundra-Orientos area, there is a broad negative gravity anomaly, the Teneppera Gravity Low, with a magnitude of about 20 milligals. This gravity 'low' is completely bounded by steep gravity gradients, which are continuous over a considerable distance, but which change direction abruptly at several points. It is thought that the gravity gradients are the expression of a series of faults, or steeply dipping monoclines, and that the gravity 'low' possibly represents a graben containing relatively thick sediments produced by block faulting.

The Tenappera Gravity Low is bounded in the west by a narrow ridge of high gravity values running in a south-westerly direction through the centre of the Strzelecki 1:250,000 map area. This ridge, the Dullingari Gravity Ridge, is thought to be the expression of a relative thinning in the sedimentary section.

In the extreme north-east of the Strzelecki map area the gravity 'high' indicated on the contour map is interpreted as the gravity expression of the Dullingari Anticline, whose existence has been established by seismic work and the results of Dullingari No. 1 well.

Seismic surveys

Before commencing work in the Eromanga Basin from Eulo westwards in 1962, the BMR No. 1 Seismic Party did a limited amount of work between the Nebine Ridge and the Eulo Shelf to determine whether the depression between these two areas of shallow basement was of significant depth near Cunnamulla and to investigate its possible development to the north (Davies & Lodwick, 1966). At Coongoola, 30 miles north-east of Cunnamulla, a refraction depth probe was shot in a north-south direction and a five-mile reflection traverse was shot in an east-west direction. The refraction probe indicated a refractor with a velocity of 19,000 ft/s at a depth of about 3300 ft, dipping to the south. This velocity is high enough to suggest that the refractor represents either igneous or metamorphic basement. On the reflection traverse, reflections were recorded from depths of up to 2800 ft and these indicated that the sediments present had practically no dip in the east-west direction. It was concluded that there was a sedimentary depression about 3000 ft deep near Coongoola and it was inferred that the depression was unlikely to deepen to the north or north-west as had been thought possible.

A small amount of reflection seismic work, using correlation methods with shot-points one or two miles apart, has been done by Phillips Petroleum Company, in conjunction with Sunray Mid-Continent Oil Company, in the Eulo/Grey Range area. Three miles of continuous profiling was also surveyed near Thargomindah. The results indicate a thickening of the sedimentary section westward from Eulo, the section reaching a depth of 2700 ft below datum (300 ft above M.S.L.) at Thargomindah. South-west of Thargomindah a synclinal axis was located with a thickness of Mesozoic sediments of about 4900 ft. Another synclinal axis, where the thickness of section was believed to be 3300 ft, was located north-west of Thargomindah near Tygarra Bore. These synclinal axes are east of the Grey Range.

No reflections were recorded from depths below the Mesozoic in the Thargomindah area, which suggested that in this area Mesozoic sediments overlie basement, with no Palaeozoic sediments present (Phillips Petroleum Co. and Sunray Mid-Continent Oil Co., 1961).

A seismic reflection survey was conducted on behalf of L. H. Smart Oil Exploration Company Limited by Geosurveys of Australia Ltd during 1959 (Smart, 1962). The survey consisted of a number of shot-points placed at one- or two-mile intervals along traverses across the Canaway Anticline, the Pinkilla Anticline, and the Chesson Anticline of the Grey Range. The results obtained in the Chesson Anticline area (near the Orient wells) are of most interest to this report.

The reflection quality of the seismic records was generally not good, and only one reflector could be correlated over the area with certainty. Preliminary evidence suggested that this reflection horizon represents the top of the Blythesdale Group. The contour map of this reflection horizon on the Chesson Anticline indicated two closed structures or domes. More detailed shooting was conducted on the southern dome and results indicated at least 300 ft of local closure, but the total closure on the Chesson Anticline is probably much greater (Smart, 1962). No deeper reflections were recorded in this area during the survey.

Seismic results in the Chesson Anticline area and the results of work done further to the north in the areas of the Pinkilla and Canaway Anticlines suggested that the Grey Range is an anticlinal flexure resulting from a buried ridge of basement rocks with Mesozoic sediments draped over the buried ridge. The results of Orient No. 2 well appeared to confirm this conclusion (Smart, 1963) if the recrystallized greywacke in which the well finished was regarded as basement, or indicative of intrusive basement rocks nearby.

A seismic survey consisting of reflection and refraction work was done for Delhi Australian Petroleum Ltd in the region of the Queensland/South Australia border during 1962 (Delhi, 1962). Reflection traverses were shot in the Orientos area. Refraction traverses were run from Tibooburra northwards into the Orientos area and from the east of the Orientos area westwards past the Delhi-Santos Dullingara No. 1 well. Continuous profiling was employed for all reflection shooting. Refraction work consisted of continuous profiling with shots made from both directions to record one deep refractor and of direct and reverse profiles at intervals along the continuous traverses to measure the thicknesses and velocities of all the various layers. Well velocity surveys were conducted in the Dullingari No. 1 well (Delhi, 1963a) and in the Orientos No. 1 well (Delhi, 1963b).

Two strong bands of reflected energy were recorded and were presented in the form of sub-surface structure contour maps (Delhi, 1962). The two reflection bands were labelled the 'C' and 'P' horizons.

The 'C' horizon is semi-persistent in the Orientos area. The main structural feature on the 'C' horizon is a SE-trending anticline near Orientos with about 500 ft of closure provided by an east-trending 'low' on the south. This was the Orientos Anticline discovered during seismic surveys in 1961 (Smart, 1961c).

The 'P' horizon is the most persistent reflection band in the area. An anticlinal closure similar to that mapped on the 'C' horizon is present, but with additional structural complexity and stronger dips.

The refraction work was done on parts of three main lines, lines 4, 5, and 6 as shown in Plate 2. Line 4 was essentially a north-south line extending from Tibooburra northwards into the Orientos area and refraction work was done on its northern end. The southern end of the refraction line shows a very thin sedimentary section above a high-velocity refractor. This refractor is identified with the unconformity at the base of the Permian at the Orientos and Dullingari wells. A northward thickening of geological section is indicated by this refractor and by additional layers indicated by short profiles shot to record all refractors. This thickening is gradual over most of the line but with a sharp increase in the thickness of sedimentary section on the northern end. To the north of this sudden thickening of section, an additional layer with a velocity of about 14,000 ft/sec is present. This layer is interpreted as wedging out to the south and it is thought to represent Permian and possibly Triassic sediments (Delhi, 1962).

Line 5 is a short line running north-westerly across the Orientos structure. Essentially, the structure as indicated by the reflection work (Delhi, 1962) was confirmed by the refraction work.

Line 6 was shot east-west across the Orientos and Dullingari areas extending about 90 miles eastward from Dullingari No. 1 well. Eastwards from a point south of Orientos the line generally indicates relatively flat-lying sediments thinning and increasing in westerly dip towards the eastern end. This increase in dip is related to the Grey Range uplift, which evidently extends to this area. An anticlinal feature was indicated on Line 6 about 20 miles south-west of Orientos No. 1 Well (Delhi, 1962). West of this 'high', steep west dip, accompanied by a fault with downthrow to the west, was observed as far as a synclinal axis about 6 miles south-east of Dullingari No. 1 well. The Dullingari structure was mapped by both the reflection and refraction methods. Thickening of the Permian section on each side of the structure is indicated by refraction data (Delhi, 1962).

3. OBJECTIVES AND PROGRAMME

Objectives

The main purpose of the survey was to investigate the nature of the rocks beneath the Mesozoic artesian sediments of the Eromanga Basin, attempting to determine whether they are sedimentary or igneous and, if large troughs of sediments are indicated, to determine the broad structural features of these troughs. After reference to the known geological and geophysical data in the area, specific objectives were outlined as follows before commencement of the survey in 1962:

(a) To confirm the gradual deepening of basement from Eulo to Thargomindah.

(b) To investigate the extent of Mesozoic and Palaeozoic sediments in the syncline already shown to exist between Thargomindah and the Grey Range.

(c) To confirm that the Grey Range is a basement ridge in this area, and to determine the possibility of Palaeozoic sediments being present on its crest.

(d) To investigate the possible broad synclinal area between the Grey Range and Nappamerry in order to determine the thickness of Mesozoic sediments and to examine any structures within it.

(e) To investigate the reasons for poor reflection quality when shooting on duricrust and to determine optimum shooting techniques for these areas of duricrust.

Programme

To achieve these objectives the following programme was proposed:

1. A refraction probe to measure the velocity of granitic basement near Eulo.

2. A refraction probe to measure the depth and velocity of basement rock near Yandunburra, about 40 miles west of Eulo.

3. A refraction probe to measure the depth and velocity of basement rock near Thargomindah.

4. A group of noise tests to be shot on the duricrust, followed by testing of patterns of shot-holes and geophones, to determine the best shooting technique on the duricrust areas. It was desirable that this testing be done in an area where there was a reasonable depth of sediments, so that reflections might be recorded.

5. A reconnaissance reflection traverse from Noccundra to about 15 miles east of Nappamerry (where it should tie in with the seismic work done by Delhi Australian Petroleum Ltd). This was to be shot using the method of five-mile traverses of continuous profiling with five-mile gaps between each traverse.

6. A continuous reflection traverse from about five miles east of Nockatunga across the Grey Range to within 25 miles of Thargomindah.

7. A refraction traverse on the Grey Range to record all refractors down to basement.

Owing to lack of time during 1962, the programme was not completed until 1963, when some additional work to investigate the structural significance of Bouguer anomalies between Noccundra and Thargomindah was also carried out. Several changes were made to the original programme during the course of the survey in 1962 and 1963 for various reasons. These are summarized below:

Proposals (1), (2), and (3). These portions of the programme were carried out as planned in 1962. They became refraction Traverses I, J, and K, and their locations are shown in Plate 2.

Proposal (4). In general, the area of the survey was west of the Grey Range and consisted of sandhills and the channel country of the Wilson River and Cooper Creek. The only occurrences of duricrust are elevated remnants and are apparently spurs of the Grey Range. These duricrust remnants were dissected by gorges and were not easily accessible for vehicles. The site for the noise tests was selected across a low range of hills and is shown as Traverse O (near Noccundra) in Plate 2. However, the terrain and the surface formation were not typical of duricrust; most subsurface layers were only of medium hardness and did not contain a very hard layer of siliceous shale. This work was completed in 1962.

Proposal (5). As a result of the B.M.R. gravity work west of Thargomindah, the programme was altered so that, instead of shooting the reconnaissance traverse towards Nappamerry, which would have been parallel to the Bouguer anomaly contours (see Plate 4), a traverse was surveyed south-west from Noccundra towards Orientos to investigate the negative Bouguer anomaly in this area. Further, because of the Delhi Australian Petroleum Ltd work in this area it was only necessary to extend the traverse as far west as Tenappera waterhole. The location of this traverse (Traverse N) is shown in Plate 2. To effect a better tie with the Delhi refraction work, a short traverse (Traverse P in Plate 2) was shot south of Paddy Paddy waterhole. Proposal (5) was carried out in its modified form in 1962.

Proposal (6). Owing to lack of time, only 15 miles of this traverse were completed in 1962. However, including work done in 1962 and 1963, Traverse L was shot continuously for reflections from a point about eight miles north-east of Nockatunga as far as the Orientos No. 2 well. A five-mile section of continuous profiling was also shot about 10 miles south-east of Orient No. 2 (Plate 2) on the eastern flank of the Grey Range in 1963.

Proposal (7). In 1963, a refraction traverse (Traverse Q) was surveyed through the position of Orient No. 2 well as planned.

Before commencement of the survey in 1963 it was decided that, in addition to completing the programme planned for 1962, some additional work would be carried out.

Additional work planned for and carried out in 1963, together with objectives, are summarized below:

1. Two five-mile sections of continuous reflection profiling in the Noccundra - Nockatunga area to investigate the structural significance of a gravity 'high' near Nockatunga were shot as part of Traverse L (Plate 2).

2. A refraction traverse (Traverse R) was surveyed near Tygarra Bore to investigate the depth and velocity of basement rock in the synclinal feature that had been indicated by reflection work (Phillips, 1961) and gravity data (Barlow, in preparation). If the recorded depth to the basement refractor was significantly deeper than the previous estimate of the sedimentary section, then about two miles of reflection profiling was to be done. A mile and a half of reflection profiling was done on Traverse R.

3. A refraction traverse (Traverse S) with some associated reflection work was carried out to the north-east of Thargomindah to investigate the significance of a gravity 'low'.

4. RESULTS

The table of operations (Appendix B) lists the statistics of surveying, drilling, recording, and geophone layout.

Drilling

Drilling conditions, though variable over the area of the survey, were seldom difficult. On Traverses N and P, loose sands, clay, and gravel were encountered; it was not generally possible to shoot more than one or two shots in a hole before it fell in at shallow depths. This made it difficult to determine the best depth of shot by uphole shooting.

On Traverse L, between Noccundra and the Grey Range, the formations penetrated were slightly silicified shales and sandstones and clays. The water table was penetrated at depths ranging from 45 to 60 ft and it was necessary to drill the shot-holes to about 75 ft.

Some of the shot-holes were drilled using air. The falling in of surface gibbers along Traverse O caused some drilling difficulties. The deeper formations along Traverse O were partially silicified shales and sandstones and soft clay.

East of the Grey Range the formations penetrated along Traverse L (Shot-points 451-466) were mainly sandy clays and shales. Surface gibbers were encountered on the most westerly shot-points. The holes were air-drilled to 75 ft into blue clay. On Traverse R, near Tygarra Bore, shot-holes were drilled to 100 ft using air with water injection. The formations penetrated were sand and clay. A water-bearing gravel was encountered at about 45 ft between Shot-points 512 and 514. On Traverse S, 20 miles north-east of Thargomindah, the formations were mainly red clay, hard shale, and white, yellow, and black clays. Shot-holes were drilled to 90 ft into the black clay using water and mud.

Shooting

The weathering thicknesses on Traverses N and P varied erratically and it was not possible to select an approximately constant depth of shot or a particular marker bed in which to place the shot. The near-surface formations were unconsolidated alluvial clays and sands, which might be expected in the flat channel country of the rivers flowing into Lake Eyre. The reflection quality ranged from poor to good with shot depths ranging from about 70 to 140 ft.

In the Noccundra-Nockatunga area along Traverse L (Shot-points 209-226 and 237-250), fair quality reflections were recorded with the shot in black clay at depths ranging between 60 and 105 ft. The depths of weathering varied from about 15 to 40 ft.

Shooting conditions were good on the western flank of the Grey Range along Traverse L (Shot-points 261-351), where the depth of weathering remained reasonably uniform at about 30 to 50 ft over many miles of traverse. Poor to good quality reflections were recorded. Better results were obtained in 1963 using five-hole patterns parralel to the traverse, with holes 60 ft deep and loaded with 2½ lbs of explosive per hole as compared with single holes, drilled to about 80 ft and loaded with 10 to 20 lbs of explosives, which were mostly used during the 1962 part of the survey,

On Traverse O, good to poor quality reflections were recorded with shot depths of about 100 ft; the shots had to be deeper as the elevation increased in order to maintain reasonable reflection quality.

On the eastern flank of the Grey Range, shooting conditions were variable along Traverse L (Shot-points 451-466) and Traverses R and S. Poor to fair quality reflections were recorded over Traverses L and R and reflections were very poor along Traverse S.

Noise tests

A noise spread was shot on Traverse O in 1962 and was followed by some experimenting with shot-hole patterns and multiple geophones. The noise test was not sufficiently well controlled to enable a detailed analysis of the noise to be made, which would give relative amplitudes of the various noise events and the signal. However, sufficient information was obtained to calculate suitable geophone and shot-hole spacing. Shot-hole patterns consisting of five holes at 11-ft intervals parallel to the traverse, and geophone patterns consisting of 12 geophones in line, also spaced at 11-ft intervals, were tried. Some improvement in reflection quality resulted, but this was not considered sufficient to warrant using this technique for the other traverses shot in 1962.

At the start of the 1963 seismic survey shot-hole patterns consisting of five holes at 30-ft intervals parallel to the traverse, and geophone patterns consisting of 8 geophones at 20-ft intervals in line along the traverse were used on Traverse L. The results obtained from this set-up were good.

A noise test was made on Traverse L at SP317 to determine the optimum size for geophone groups and shot-hole patterns. The leval of seismic noise recorded relative to signal was not excessive, as some reflection signals could be observed on the noise profile recorded with single geophones. Reflection signals generally exhibited fairly high frequencies, of the order of 60 c/s. Frequencies of the stronger noise events were mostly about 20-30 c/s, while apparent noise velocities ranged from 1000 ft/s upwards, the most important events having apparent velocities of about 2500 ft/s. The value chosen as a suitable cut-off wave number (k_c) for spatial filtering by geophone and shot-hole groups was 0.006. Using the formula $k_c = 1/2ne$, where n = number of geophones or holes and e = spacing between them, this value suggested that for a group of eight geophones the spacing between geophones should be at least 10 ft in order to attenuate the organized noise effectively. Similarly the spacing for a group of five holes should be at least 17 ft. In order to compute the maximum permissible spacings that could be used without attenuating the reflection signals, the apparent velocities, wavelengths, and frequencies were measured for the shallowest reflections in the area. These spacings were found to be about 20 ft for a group of eight geophones and 30 ft for a group of five shot-holes. Comparisons were then made using geophone and shot-hole groups with the minimum and maximum spacings as defined above. It was found that the arrangement using the wider spacings gave perhaps slightly better results and it was decided to continue using eight geophones per trace at 20-ft intervals and five holes at 30-ft intervals in line parallel to the traverse and offset 50 ft from it. The use of sixteen geophones per trace in two similar, parallel groups of eight was also tried, but the improvement in results was insufficient to justify the extra effort.

Reflection traverses

Uphole times were used for computation of weathering corrections, and reflection data were corrected for elevation differences to a datum of 300 ft above mean sea level using elevation velocities shown in Appendix B. In order to establish velocity and time-depth relationships, $t:\Delta t$ analyses of reflections were used.

The only reliable well velocity information available at the time of writing this report was derived from a calibrated sonic log of Orientos No. 1 well (Delhi, 1963b), the results of which are shown in Plate 17. Corrected reflection times in the Orientos area were converted to depths using velocity information derived from a combination of the sonic log and the well velocity survey that was run in the hole.

The coefficient of reflection was calculated from the sonic log in the Orientos No. 1 well using the approximate formula $R = (V_2 - V_1)/(V_2 + V_1)$, with a sampling interval of two milliseconds one-way time. The reflection coefficient is shown plotted against depth in Plate 17 and was used in correlating principal reflection events recorded near Orientos No. 1 with the lithology of the well.

Comparison of velocity distributions between Orientos and Eulo indicate the presence of a horizontal velocity gradient. For the purposes of interpretation, four distinct velocity distributions have been adopted for use between Orientos and Eulo. The comparison of the time-depth curves of the four velocity distributions are shown in Plate 18. At a reflection time of one second there is a depth difference of 1000 ft between curves 1 and 4 (Plate 18), which justifies the use of different velocity distributions for the interpretation.

The reflection cross-sections along Traverses N, P, O, L, R, and S are shown in Plates 5 to 10, respectively. The record cross-sections are presented in variable-area trace form and were produced in the BMR playback centre.

Throughout the area, two main reflecting horizons were recorded which were correlatable, at least within the same energy band, along Traverses N, P, O, L, and R. They were designated the 'C' horizon and the 'P' horizon and have been marked as such on the end shot-points of each reflection-time section (Plates 5, 6, 7, 8, and 9). These two reflections ranged in quality from poor to good, but were consistently recognizable on the records.

As well as the 'C' and 'P' horizons, two other reflections were recorded earlier than the 'C' horizon; these were called the 'A' and 'B' horizons (Lodwick & Jones, 1964). These two reflections were recorded east and west of the Grey Range but were neither so strong nor so characteristic as the 'C' and 'P' horizons. West of SP126 on Traverse N (Plate 5), where the sedimentary section is relatively thick, a further reflection appears between the 'C' and 'P' horizons.

Refraction results

The time-depth graphs and interpretation of the six refraction probes on Traverses Q, R, S, K, J, and I are shown in Plates 11, 12, 13, 14, 15, and 16 respectively. The velocities and depths below datum (300 ft above sea level) calculated on each traverse were:

Traverse	Refractor velocity (ft/s)	Depth below datum (ft)
Q	17,650	3000
R	19,600	4300
S	18,800	4000
K	18,750	3900
J	18,500	2700
I	19,500	800

5. INTERPRETATION

The 'C' and 'P' reflecting horizons

Private companies that have done seismic work in the Eromanga Basin have generally been able to recognize two persistent reflections similar to the 'C' and 'P' reflecting horizons that were recognized in the BMR surveys and the same nomenclature has generally been used in designating these horizons.

The 'C' horizon has generally been correlated with an horizon in the Blythesdale Group of the Mesozoic artesian sequence, but the stratigraphic correlation of the 'P' horizon has been less certain. At the Innamincka No. 1 well, the 'P' horizon was correlated (Delhi, 1961a) with the top of the Palaeozoic rocks below the unconformity at the base of the Permian sediments, which were about 300 ft thick. After the drilling of the Betoota No. 1 well, the 'P' horizon was interpreted (Delhi, 1961b) to represent a similar unconformity at the base of the Mesozoic sediments, there being no Permian present at Betoota. More recently, Dullingari No. 1 and Orientos No. 1 wells have disclosed greater thicknesses of Permian sediments (1300 ft at Orientos), and the 'P' horizon has been shown to correlate with some thick coal seams within the Permian. It appears therefore that the stratigraphic correlation of the 'P' horizon depends on the thickness of Permian sediments present, but it may be said that it generally lies at, or just below, the base of the Mesozoic section.

The Orientos No. 1 well is only 40 miles west of the BMR survey area and is considered a convenient reference point for the correlation of seismic results in the area under consideration. A comparison of theoretical reflection times derived from the sonic log of Orientos No. 1 well with actual reflection times taken from a seismogram (Delhi Line 5, SP51) shot near the well, is shown in Appendix D . The comparison shows that at the Orientos No. 1 well the 'C' reflection correlates with the Transition Beds at the top of the Blythesdale Group, and that the 'P' reflection correlates with coal seams near the top of the Permian. Ordovician sediments were encountered at 7086 ft below BMR datum in the well, and the sonic log showed a velocity of 19,500 ft/s in them (Plate 17). The thickness of Permian sediments penetrated was 1300 ft.

Correlation of 'C' and 'P' horizons with refractors

Continuous refraction profiling was also carried out by Delhi Australian Petroleum Ltd together with a number of refraction depth probes at intervals along the continuous lines in order to measure the thickness and velocity of the various layers present. The results of the depth probe located 15 miles south-east of Orientos No. 1 on Delhi Line 4 are shown in Appendix D. The V4 refractor (18,380 ft/s) was followed continuously to the Orientos No. 1 well, where it was calculated to be at 7186 ft below datum. This depth compares quite well with the depth to the top of the Ordovician in the well, and hence this refractor may be taken to correlate with the Ordovician sediments. That the refraction velocity (18,380 ft/s) was low compared with the vertically measured sonic log velocity (19,500 ft/s) could possibly be explained by the fact that the Ordovician beds are dipping at 70 degrees.

The average depth below datum of the 'C' reflection near the location of this depth probe is 5030 ft, which suggests the V3 refractor correlates with the 'C' reflection horizon. The average depth to the 'P' reflection horizon near the probe is 6750 ft. The 'P' horizon is well above the top of the Ordovician or V4 refractor (7500 ft). The 'P' horizon at the probe can be correlated continuously to near Orientos No. 1 well (Delhi Line 5, SP51). The 'C' horizon at the probe was also correlated continuously to near the well.

For a distance of about 18 miles to the east of this probe no reflection profiling was done; however, the 'P' reflection can very likely be correlated with a persistent reflection at the western end of BMR Traverse N (SP59), which could be followed for 100 miles to the east and which was regarded as the 'P' reflection on the BMR traverses. This reflection can be recognized on reflection records shot by the BMR near another refraction probe on Delhi Line 6. This refraction probe, shot near the southern section of BMR Traverse P, yielded the results shown in Appendix D. BMR SP1025 of Traverse P is close to Delhi SP 253 at the centre of this refraction probe (Delhi Line 6). At this point the 'P' reflection is probably coincident with the V4 refractor at about 6400 ft. It is also apparent that the 'C' reflection at SP1025 of Traverse P is almost coincident with the V3 refractor.

From the foregoing discussion, it appears that we are justified in taking the 'C' reflection recorded throughout this survey area as representing an horizon in the Blythesdale Group. It is also apparent that the 'P' reflection is close to the top of the Ordovician on Traverse P and that the Permian section must be either fairly thin or non-existent. Eastwards from this point the 'P' reflection is considered to be associated with the angular unconformity at the base of the Mesozoic sediments. Westwards it is associated with coal seams near the top of the Permian sediments.

Reflection between 'C' and 'P' horizons

A third reflection was recorded between the 'C' and 'P' horizons on the western portions of Traverse N, but was not so persistent or so characteristic as the two main reflections. This reflection was also recorded on Delhi Line 5 at SP51 near Orientos No. 1 at a depth of 5380 ft, which agrees very closely with the depth to the top of Triassic recorded in the well (see Appendix D). From a study of the reflection coefficient derived from the sonic log of Orientos No. 1 (Plate 17), it appears that this reflection may represent an horizon in the Lower Jurassic Walloon Coal Measures. The reflection may be tentatively correlated at least as far east as SP126 on BMR Traverse N, although the reflection is not continuous.

Comparison of refraction velocities in the east and west of the area

The V4 refractor velocities (18,380 ft/s to 19,550 ft/s), representing Ordovician rocks in the Orientos area, are found to be of the same order as those velocities measured in the Thargomindah - Eulo area on the eastern flank of the Grey Range. The velocity measured at a refraction probe near Eulo (Traverse I, Plate 16), where there are known granite outcrops, was 19,500 ft/s. West of Traverse I, four other refraction probes (Traverses J, K, S, and R; Plate 2) recorded velocities ranging between 18,500 ft/s and 19,600 ft/s. These velocities are high enough to suggest that they represent basement rock of igneous or metamorphic origin, but it is also possible that they represent equivalents of the Ordovician sediments found in the Orientos well. Reflections have been recorded from below the high velocity refractors as far east as the Grey Range, suggesting that they represent the Ordovidian sediments to this point. Somewhere between the Grey Range and Eulo, granite or metamorphic rocks replace these Ordovician sediments.

Artesian Basin profile across survey area from east to west

The refraction depth probing by the BMR described in this report and the reflection spot correlation work by Phillips Petroleum Co., between Eulo and the Grey Range, indicate an increase in thickness of Mesozoic sediments from zero near the granite outcrops at Eulo westwards past Thargomindah to a synclinal axis near Tygarra Bore, 25 miles north-east of Thargomindah (Phillips, 1961). On Traverse I, six miles south-west of Eulo, a high velocity refractor, probably representing granite, was recorded at only 800 ft below datum (300 ft above sea level). At Yandunburra, 30 miles east of Thargomindah, a pre-Mesozoic refractor was recorded at a depth of 2700 ft below datum on Traverse J (Plate 15). Eight miles north-east of Thargomindah a pre-Mesozoic refractor was recorded at a depth of 3900 ft below datum on Traverse K (Plate 14). Near Tygarra Bore, refraction work on Traverse R indicated that the base of the Mesozoic was 4300 ft below datum (Plate 12).

West of Tygarra Bore, reflection and refraction work, together with the results from Orient No. 2 well, indicate that the Mesozoic sediments thin towards the Grey Range, their base being at 3173 ft below datum at the Orient No. 2 well on the Grey Range.

West of the Grey Range the structure of the artesian sedimentary basin is indicated by the 'C' and 'P' reflections on BMR Traverses L and N, the Delhi refraction lines, and reflection work in the Orientos-Dullingari area. The results of this work indicate that the basin deepens generally westward from the Grey Range to near the Queensland/South Australia border. The post-Ordovician sediments, i.e. Mesozoic and Permian sediments, increase in thickness to about 7000 ft at the western end of Traverse N and 9000 ft in the Dullingari No. 1 well.

The Permian sediments, which have a maximum thickness of about 3000 ft in the Dullingari-Orientos area, thin out to the east as described in more detail in a later section. The main Permian basin probably extends no further east than the western end of Traverse P (Plate 2), although there may be some limited local occurrences east of this.

The Grey Range structure and the extent of pre-Permian sediments

As previously discussed, the 'P' reflection east of SP 1025 on Traverse P is thought to be associated with the angular unconformity considered to exist at the base of the Mesozoic section. Prior to the BMR seismic work in the Grey Range area, it was thought that the recrystallized greywacke encountered at the bottom of Orient No. 2 well represented basement. However, steep easterly dipping reflections were recorded by the BMR from below the 'P' reflection on most of Traverse N and on Traverse L east and west of the Grey Range, and these raise serious doubts on whether basement was in fact reached.

Between SP328 and SP 351 on Traverse L (Plate 8), deep easterly dipping reflections were recorded from below the 'P' horizon at times varying from 1.0 second beneath SP328 to 2.16 seconds beneath SP342. For example, one such dipping reflection truncated at the unconformity beneath the 'P' horizon near SP337 and recorded at a time of 0.79 second can be followed about 3½ miles to the east with about 20° dip to SP351, where it has a reflection time of 1.85 seconds (Plate 8). These steeply dipping events below the 'P' reflection are considered to represent sediments and to indicate the existence of large thicknesses of Ordovician sediments beneath the Grey Range. Steep easterly dips were also recorded east of the Grey Range along Traverse L between SP451 and SP466, indicating the possible extent of Ordovician rocks into this area (Plate 9). The deep events were commonly recorded at times of up to two seconds and sometimes up to three seconds, the quality diminishing with depth. No reliable reflections were recorded from below these events, which might indicate the depth of igneous basement. However, it appears that the steeply dipping sediments extend to depths of at least 15,000 ft.

Between BMR Traverse L (SP451-SP466) and Eulo little or no reflection energy was obtained from below the 'P' horizon. This suggests that the Ordovician sediments are considerably thinner or do not exist in this area (see reflection Traverses R and S, Plate 10). From the foregoing discussion it is believed that Ordovician sediments present in the Orientos area extend eastwards to the Grey Range, becoming much thinner on the eastern flank of the Range and finally wedging out against Devonian granite four or five miles west of Yandunburra (Plate 2).

Thus, if the Grey Range is underlain by a considerable thickness of Ordovician sediments, the earlier interpretation of this feature as a relatively shallow basement ridge with Mesozoic sediments draped over it (Smart, 1962) is incorrect. Seismic work in 1962 and 1963 has confirmed the presence of a major anticlinal feature in the Mesozoic sediments with axis near the Orient wells on the Grey Range. This feature has a relief of over a thousand feet in the Mesozoic section and interrupts the general trend of thickening of the Mesozoic sediments westwards from Eulo to the Queensland/South Australia border. The density contrast between Mesozoic and Ordovician sediments would be sufficient to account for the positive gravity anomaly near the Orient wells. Magnetic basement (Plate 2), which represents an unknown horizon much deeper than the base of the Mesozoic, shows no positive feature near the Grey Range. This suggests that the Grey Range anticline is caused by an erosional 'high' in the Ordovician sediments rather than a basement uplift. The recrystallized greywacke encountered at a depth of 3350+ ft in Orient No. 2 well may be Ordovician in age. However, the eastern limit of sedimentation moved a considerable distance to the east between Permian and Jurassic times and it is not known how far east the equivalent of the Triassic beds encountered in the Dullingari and Orientos wells extend. It is possible, therefore, that the greywacke beneath the Jurassic Blythesdale Group in Orient No. 2 well is Triassic in age.

The detailed structure of Mesozoic and Permian sediments

The detailed structure of the Mesozoic and Permian sediments will be considered from west to east across the survey area, starting in the region of the Dullingari No. 1 and Orientos No. 1 wells, where the depths of the various formations are definitely known.

Eastwards from Dullingari No. 1 the Permian and Mesozoic sediments thicken, as shown in Plate 2, into a syncline with axis about six miles from Dullingari No. 1. In this syncline the Permian has a maximum thickness of over 3000 ft compared with thicknesses of 2300 ft and 1300 ft in Dullingari No. 1 well and Orientos No. 1 well, respectively. The top of the Permian (below K.B.) occurs at a depth of 6718 ft in Dullingari No. 1 and 5964 ft in Orientos No. 1. In both wells the Permian is overlain by Triassic sediments and the Jurassic Walloon Coal Measures. Between the synclinal axis about six miles east of Dullingari and an anticlinal axis on Delhi Line 6 about 20 miles south-west of Orientos No. 1 well the sediments exhibit fairly steep west dip. About four miles west of the anticline there is a fault with a downthrow of 300 ft to the west which affects the top of the Ordovician but which probably does not extend up as far as the Mesozoic sediments. East of this anticline on Delhi Line 6, easterly dip is observed for about 16 miles into a broad syncline. North of Delhi Line 6 near Orientos No. 1 well there is a SE-trending anticline (the Orientos Anticline) with about 500 ft of closure, which has been indicated on the interpretive cross-section in Plate 2. This cross-section is somewhat diagrammatic rather than accurate, because of the horizontal projection of data over distances of up to 12 miles on to the cross-section line.

The western end of BMR Traverse N is on the eastern limb of the broad syncline that occurs west of Orientos. The depths of the 'C' and 'P' horizons beneath SP59 at the western end of Traverse N are about 5450 ft and 7550 ft, respectively, below seismic datum. On the last few records at the western end of Traverse N there are definite events which occur up to about 0.15 second beyond the 'P' horizon and which are more or less conformable with the 'P' and 'C' horizons. These events disappear rather abruptly near SP61. If they are genuine reflections it may be inferred that the top of the Ordovician is about 1500 ft below the 'P' horizon west of SP61, since there is a strong unconformity between the Permian and Ordovician. Lodwick and Jones (1964) have suggested that this may be so. However, this would conflict with the evidence of the V4 refractor, which was followed continuously from Orientos No. 1 well along Delhi Lines 5 and 6 to the vicinity of Traverse N. This refractor is associated with an unconformity at the top of the Ordovician at the Orientos well. Near the western end of Taverses N it is recorded from about the same depth as the 'P' horizon, not 1500 ft below it as would be expected if the Permian extended 1500 ft below the 'P' horizon.

About 13 miles east of the western end of Traverse N, the western segment of BMR Traverse P coincided with a refraction depth probe on Delhi Line 6. At this point the 'P' horizon and the V4 (Ordovician) refractor occurred at about the same depth, within the limits of error of the surveys, and there was no evidence of reflections from below the 'P' horizon. It seems safe to assert, therefore, that on the western segment of Traverse P the Permian section is thin or non-existent.

From the western end of BMR Traverse N (SP59) eastwards to SP152, about 18 miles south-west of Noccundra, the 'C' and 'P' horizons indicate that the component of dip along the traverse is generally westerly. Depths of these horizons at SP152 are about 3800 ft and 5200 ft, respectively, so that over the interval between SP59 and SP152 the 'C' horizons rise about 1650 ft and 2250 ft, respectively. There is thus a considerable thinning of the Blythesdale Group and/or other post-Ordovician pre-Blythesdale sediments over this interval. The westerly dip over the interval is mostly gradual and continuous, but between SP94 and SP96 the 'C' and 'P' horizons exhibit steeper apparent west dip. It is probable that this feature indicates a fault with a downthrow to the west of about 400 ft. An alternative explanation would be that there is a monoclinal fold between these two shot-points.

The westerly segment of Traverse P, situated south of SP106 on Traverse N, also indicates westerly dip. The easterly segment of Traverse P, which was surveyed south-west from SP125 on Traverse N, indicated little or no dip in the south-west direction. From SP152 eastwards along Traverse N to SP196, about three miles south-west of Noccundra, the 'C' and 'P' horizons indicate more or less horizontal sediments with little change in depth. From SP196 to SP199 at the eastern end of Traverse N, south-westerly dip is indicated.

Because of poor record quality it is difficult to correlate reflections with certainty across the three-mile gap in the traverse between SP199 and SP209. However, it is considered probable that the 'C' and 'P' horizons occur at reflection times of about 960 and 1170 milliseconds at SP199 and at reflection times of about 860 and 1090 milliseconds at SP209. The decrease in reflection times of about 90 milliseconds corresponds to a rise of about 500 ft. The amount of westerly dip inferred between these two shot-points is similar to that observed between SP196 and SP199.

Record quality is poor between SP209 and SP212. This, together with phase changes and possibly faulting in the vicinity of SP211, makes it difficult to follow the 'C' and 'P' horizons in this area. Near SP213 there is a marked interruption in both of these reflections. A diffraction pattern curving downwards to the east from a time of 1.25 seconds on the cross-section near SP213 indicates that the absence of the 'C' and 'P' horizons is caused by faulting. However, the fault in the vicinity of SP213 apparently causes very little vertical displacement in the 'C' horizon and probably only a small displacement of the 'P' horizon downwards to the east. East of this fault, beneath SP214, a strong reflection is observed beneath the 'P' reflection and apparently conformable with it. At SP214 the 'P' reflection is recorded at 1.14 seconds (corrected time) while the later reflection occurs at 1.25 seconds. East of SP215 and deeper reflection becomes indistinct although it could be present at least as far as SP220. Because of its strong character near SP214 and SP215 it is unlikely that it is a multiple of a weak, shallower reflection (the 'B' horizon, see below) which occurs at about 0.62 second or half the reflection time of the deeper event. If it is a primary reflection it may indicate that there is a local development of Permian sediments beneath the Mesozoic in this area east of SP214. The Permian, if present, could be 900 ft thick. The facts suggest that the fault near SP213 could have been a major one in pre-Mesozoic times, but that displacement was slight and diminishing in the Mesozoic. The gravity results give no indication of the existence of the fault. The gravity gradient is downwards to the south-west in this area, whereas the fault has a downthrow to the north-east.

On Reflection Traverse O, which was surveyed approximately east-west near the western end of Traverse L (Plate 2), the 'C' and 'P' horizons west of SP1020 (Plate 7) indicate only gentle dip to the west. However, near SP1020 on this traverse a fault is indicated, with downthrow probably to the east; the fault is very likely the same as that observed on Traverse L near SP213 less than two miles away. On the eastern side of the fault on Traverse O, the 'C' horizon is too indistinct to pick with any certainty. A strong, deeper event that occurs at about 1.27 seconds between SP1020 and SP 1021 might be the 'P' reflection, or, perhaps more likely, it might be the same event as was recorded at 1.25 seconds east of the fault on Traverse L.

Near SP218 on Traverse L (Plate 8) the 'C' and 'P' horizons indicate the existence of an anticlinal fold axis, the reflections generally dipping away to the east and west from this point towatds SP237 and SP191. This fold has a relief of about 500 ft in the traverse direction, but is faulted near its crest (SP213). Nevertheless, its possibilities as a closed structure that might allow petroleum accumulations should be borne in mind.

At SP226 the depth of the 'C' and 'P' horizons are about 3650 ft and 5300 ft, respectively, and the thickness of the zone between them is thus 1650 ft. Because of the poor reflection quality on the records from SP237 to SP239 it is difficult to correlate the 'C' and 'P' horizons accurately across the four-mile gap that exists between SP226 and SP237. From SP239 eastwards the 'C' and 'P' horizons are more easily recognizable. At SP239 the depths of these horizons are about 3850 ft and 5100 ft; the thickness of the zone between the two horizons has decreased to 1250 ft, compared with 1650 ft at SP226. Relatively steep westerly dips recorded on the record from SP238 at about the level of the 'P'horizon, which do not appear to be matched by similar dips on any of the shallower events, suggest that most of the thinning occurs in the vicinity of SP238. Curved events recorded near the level of the 'P' horizon under SP237 are very likely diffractions, indicating that there is probably faulting in this area. The thinning in the zone between the 'C' and 'P' horizons may thus be caused partly by pinching out of some of the lower formations against a westerly-dipping Ordovician erosional surface and partly by faulting. On the other hand the steeply dipping events recorded at SP237 and SP238 may also indicate faulting rather than a dipping horizon, so that the thinning may be entirely caused by faulting in the lower part of the section. There is no evidence that faulting or other disturbances beneath these shot-points extend upwards as far as the 'C' horizon, although the 'C' reflection is admittedly very indefinite in this area. The most likely picking of the 'C' and 'P' horizons at SP237 suggests that the gentle easterly dip observed from SP225 to SP226 continues across the four-mile gap to SP237.

Eastwards from SP239 to SP250 the 'C' and 'P' horizons are practically horizontal, with only slight rises of the order of 50 ft near SP240 and SP242. It is again difficult to correlate the 'C' and 'P' horizons accurately across the four-mile gap between SP 250 and SP261 because the records on either side of the gap show considerable differences in frequency characteristics. However, it does appear probable that the 'P' horizon is about 200 ft deeper at SP261 than at SP250.

Between SP223 and SP261, Traverse L crosses one end of an elongated gravity 'high', whose amplitude is about 3 milligals where the traverse crosses the anomaly. There is a small structural 'high' centred near SP242, which is near the centre of the gravity anomaly. This structural 'high' is bounded by a fault on the south-western side near SP237 and by inferred north-easterly dips between SP250 and SP261 on the north-easterly side. However, the structural 'high' centred near SP242 is much smaller than that centred on SP218 and there is no gravity 'high' to correspond to the latter feature (see gravity contours, Plate 2). It seems doubtful, therefore, whether the gravity anomalies in the Nockatunga - Noccundra area reflect structure in the Mesozoic sediments faithfully. However, the gravity 'high' may be related to pre-Permian structure that has been responsible for the existence of a small anticlinal structure in the Mesozoic sediments.

From SP261 eastwards to SP340 on the Grey Range both 'C' and 'P' horizons indicate westerly dip. Between SP261 and SP308 the 'C' and 'P' horizons indicate average dips along the traverse of about 55 ft and 80 ft per mile. East of SP308 dips become somewhat steeper and these horizons indicate average dips of about 120 and 140 ft per mile.

Several apparent faults occur on this portion of Traverse L. There is probably a fault near SP309. Record quality is poor, but at the level of the 'P' horizon a downthrow of about 300 ft to the west appears to be indicated. A minor fault may occur near SP320, the downthrow side being to the east in this case. A more obvious fault is seen on the record cross-section near SP324 at the level of the 'C' horizon. Between SP325 and SP323 there is an event with a moveout of 0.12 second, which may be a diffraction associated with the 'C' reflecting horizon. The 'P' reflection shows an increase in westerly dip between SP322 and SP324, which is evidently related to the fault. The throw of the fault is probably of the order of 300 ft to the west. Steeper westerly dips over a short interval near SP337 are probably also indicative of faulting with a downthrow to the west, the vertical displacement being of the order of 200 ft.

At SP340, where the 'C' and 'P' horizons are at their shallowest depths for Traverse L, the depths of these horizons below datum are about 2000 ft and 2700 ft, respectively. Eastwards from the area between SP340 and SP351, which was close to Orient No. 2 well (Plate 2), reflections indicate a gentle easterly dip. The anticlinal axis near SP340 is part of the Chesson Anticline (Smart, 1962).

At SP351 the 'P' horizon was recorded at a depth of about 3000 ft below datum or 3173 below the surface. This is within 200 ft of the depth at which Orient No. 2 well passed from Mesozoic to probable pre-Mesozoic sediments (3350 ft below surface), so that in this area the 'P' horizon may be said to be associated with an horizon near the base of the Mesozoic sediments or the unconformity at the base of the Mesozoic.

A refraction depth probe was shot on Traverse Q, which was surveyed more or less parallel to the gravity contours and the Grey Range near Orient No. 2 well and SP351. A refractor with a velocity of 17,650 ft/s was recorded from a depth of about 3000 ft below datum. This refractor almost certainly represents the greywacke encountered at the bottom of Orient No. 2 well.

The 'C' horizon (i.e. the top of the most persistent phases of the 'C' reflection on Traverse L) was recorded from a depth of about 2350 ft below datum or 2523 ft below surface at SP351. Results of Orient No. 2 well indicate that the 'C' horizon in this area is somewhere in the upper part of the Blythesdale Group, which was encountered from 2270 ft to 3350 ft below the surface. However, at the eastern end of Traverse L the 'C' reflection has several cycles earlier than the phases picked along the length of Traverse L. The onset of these earlier cycles would correspond to a depth not more than 200 ft below the top of the Blythesdale Group and within the Cretaceous Transition Beds.

Near the eastern end of Traverse L, two reflections from above the 'C' horizon, designated the 'A' and 'B' horizons, can be recognized. Neither of these reflections is very persistent. Where they occur, they are, as would be expected, conformable with the 'C' horizon. At SP346 the 'A' horizon occurs at a depth of about 1050 ft, probably in the Tambo Formation. The 'B' horizon occurs at about 1650 ft, probably in the Roma Formation.

A five-mile segment of Traverse L was shot beginning about ten miles south-east of Orient No. 2 well (Plate 2). The 'C' and 'P' horizons were recorded on this segment at about the same times as at SP351. Easterly dips were indicated (Plate 9).

Traverse R

Refraction Traverse R was surveyed near Tygarra Bore to investigate the depth and velocity of basement rock in the synclinal feature indicated by the previous reflection work and gravity data (Plate 2). The results of the depth probe on the traverse indicate a 19,600-ft/s refractor at a depth of about 4300 ft below datum (Plate 12).

The 'C' and 'P' horizons were recognizable on a short reflection profile shot on Traverse R (Plate 10). Reflections indicated near-horizontal strata, the 'C' and 'P' horizons having depths of about 3000 ft and 4000 ft, respectively. No reflections were recorded from below the 'P' horizon. The above results suggest that Mesozoic sediments extend to a depth approaching 4300 ft with the high-velocity refractor representing granitic basement.

Traverse S

Traverse S was surveyed in a north-easterly direction about 18 miles north-east of Thargomindah (Plate 2). A refraction depth probe was carried out on it to investigate the significance of a gravity 'low' in this area. The results (Plate 13) indicate that a high-velocity refractor (18,800 ft/s) exists at about 4000 ft below datum. One and a half miles of reflection traverse were also surveyed on Traverse S (Plate 10). Results were very poor but it does appear that near-horizontal reflections were recorded up to at least 0.9 second. This suggests that the Mesozoic sediments extend to a depth approaching 4000 ft.

A high-velocity refractor with similar velocity to that recorded on Traverse S was recorded at about the same depth on Traverse K about 12 miles south of Traverse S. The decrease in Bouguer anomaly values of about 10 milligals between these two traverses thus appears to bear no relation to the relief of the high-velocity refractor, which might represent granitic basement, but which could also represent Ordovician sediments, as indicated by the high velocities recorded for these sediments in the Orientos No. 1 well. The gravity 'low' could be caused by a depression in igneous basement, but unfortunately the seismic results are inconclusive on this matter. It could also be caused by density variations within the igneous basement.

6. CONCLUSIONS

The main objective of the survey, to investigate the nature of the rocks beneath the Mesozoic sediments of the Eromanga Basin, was achieved in that it was possible to show that these rocks produced reflections with locally persistent dip angles, indicating that in all probability they are sedimentary rather than igneous. Permian sediments, which may be expected to be more or less conformable with the Mesozoic sediments, are absent over most of the survey area. There is a possibility that up to 1500 feet of Permian sediments exist near the western end of Traverse N and perhaps also in other small depressions west of Nockatunga, but such occurrences have not been definitely established.

Reflections from below the gently dipping Mesozoic and possible Permian sediments indicate relatively steep dips ranging from 25 to 50 degrees or more, so that there is a strong unconformity at the base of the Mesozoic-Permian sediments. Since Ordovician sediments were recorded below such an unconformity in Orientos No. 1 well it seems likely that the sediments immediately below the unconformity in the survey area are also Ordovician, but nothing definite is known concerning their age. It is concluded that these pre-Permian sediments are present east of the Orientos area as far as the Grey Range, extending to depths of at least 15,000 ft. They apparently become much thinner on the eastern flank of the Grey Range and probably wedge out against granite east of Thargomindah.

The survey confirmed that basement depth increases westwards from zero near Eulo towards Tygarra Bore, where the base of the Mesozoic was indicated by refraction work to be 4300 ft below datum. From a synclinal axis in this area the Mesozoic sediments become thinner to the west towards the Grey Range. However, the survey showed that the Grey Range anticline does not result from a relatively shallow basement ridge, but rather from an erosional 'high' in the pre-Permian sediments, which are well developed in this area.

West of the Grey Range a broad syncline is developed. Dip is generally westward from the Grey Range to a synclinal axis about 15 miles east of Orientos No. 1 well, the base of the Mesozoic increasing from a depth of 3000 ft on the Grey Range to about 7000 ft at the western end of Traverse N. The westerly dip is interrupted by a reversal of dip between Noccundra and Nockatunga, which results in an anticlinal axis a few miles east of Noccundra. Although this anticline is faulted near its axis it must be considered as a possible structure suitable for the accumulation of hydrocarbons. Apart from the Grey Range structure itself, no other significant anticlinal features were revealed by the survey, but several faults that might result in hydrocarbon traps were indicated. It was outside the scope of the present survey to attempt to establish closure on any of the possible traps indicated.

It was not possible to carry out a detailed investigation of seismic techniques for use in duricrust areas as had been planned because of the lack of typical, hard duricrust layers in the accessible parts of the survey area.

The seismic survey showed that a gravity 'high' near Nockatunga had little or no structural significance as far as the Mesozoic sediments were concerned. The seismic method proved inconclusive regarding the cause of a gravity 'low' 18 miles north-east of Thargomindah, largely because the refraction velocities of granitic basement and pre-Permian sediments in the area can be quite similar.

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* Unpublished report on a Commonwealth-subsidized operation

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APPENDIX 'A'

Staff and Equipment

Staff

	1962	1963
Party leader	K. B. Lodwick	J. S. Davies
Geophysicists	J. S. Davies	P. Jones
	P. Jones	G. A. Allen
Surveyors	W. Lamond	B. E. Malony
		T. McDiarmid
Observer	R. Krege	G. S. Jennings
Shooter	J. Ryman	R. D. E. Cherry
Toolpusher	B. G. Findlay	B. G. Findlay
Drillers	R. O. Larter	R. O. Larter
	A. Zoska	A. Zoska
Drilling assistants		E. Cherry
		B. Peut
Mechanics	T. V. Buckley	T. Clark
	B. C. Gunn	D. McIntyre
Clerk	W. Rossendell	W. Rossendell

Equipment

	1962	1963
Seismic amplifiers	Texas Instruments 8000 Explorer	H. T. L. 7000B
Seismic oscillograph	TRO-6 SIE 6-inch 27-trace	Electro-Tech ER66, 6-inch 27-trace
Magnetic recorder	Electro-Tech DS7-7	Electro-Tech DS7-7
Geophones	Electro-Tech EVS2 - 20 c/s for reflection work	Hall-Sears H.S.J. (approx. 900) for reflection work
	T.I.C. - 6c/s for refraction work	Electro-Tech 4.5 c/s (104) for refraction work
Drills	2 Mayhew 1000, 1 Failing 750 rig	2 Mayhew 1000, 1 Carey rig
Water tankers	2 International 3-ton 4 x 4	3 Bedford RLHC3, 4 x 4 with 600-gallon cylindrical tanks
	1 Bedford, 3-ton, 4 x 4 RLHC3	1 Bedford RLHC3, 4 x 4 with 800-gallon flat tank

	1962	1963
Shooting truck	1 Bedford RLHC3, 3-ton, 4 x 4	Bedford RLHC3, 4 x 4 with 600-gallon cylindrical tanks
Recording truck	International AA120, 4 x 4	International AA120, 4 x 4 with BMR Ansair cab
Geophone trucks	2 Landrover LWB	2 Landrover LWB

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APPENDIX 'B'

Table of Operations

	1962	1963
Sedimentary basin	Eromanga Basin	Eromanga Basin
Area	Thargomindah - Noccundra	Thargomindah - Noccundra
Camp site	Base camp at Noccundra	Base camp at Orient Tank
	Temporary accommodation at Thargomindah	Temporary accommodation at Thargomindah and Noccundra
Established camp	28th September	7th October
Surveying commenced	3rd October	8th October
Drilling commenced	5th October	9th October
Shooting commenced	8th October	9th October
Survey terminated	29th November	29th November
Miles surveyed	80	50-2/3
Topographic survey control	Lands & Survey Dept Qld. Australia 1:250,000 map series	Lands & Survey Dept Qld. 4-mile series
	Main roads bench-mark, Thargomindah. Main roads levels	Levels - Main roads bench-mark, Thargomindah. Main roads levels
Total footage drilled	22,160 ft	37,584 ft
Explosives used	6.6 short tons Geophex	0.725 short tons Dupont 2.945 short tons Geophex
Datum level for corrections	300 ft above Mean Sea Level	300 ft above Mean Sea Level
Weathering velocities	2000 ft/s, 2200 ft/s	1800 ft/s, 2000 ft/s 2200 ft/s, 2500 ft/s
Sub-weathering or elevation velocities	7000 ft/s, 6600 ft/s	6300 ft/s, 6600 ft/s 7000 ft/s, 7500 ft/s 8000 ft/s
Source of velocity distribution	$t:\Delta t$ analysis, 1962 survey	$t:\Delta t$ analysis, 1962 and 1963 survey
	Orientos No. 1 well, sonic log and well velocity survey	Orientos No. 1 well, sonic log and well velocity survey
<u>Reflection shooting data</u>		
Shot-point interval	1800 ft	1320 ft and 1800 ft
Geophone group	6 detectors in line of traverse, 22 ft apart	8 detectors in line of traverse, $19\frac{1}{4}$ ft apart
		16 detectors in two rows of eight along traverse, detectors $19\frac{1}{4}$ ft apart
Geophone group interval	150 ft	110 ft and 150 ft
Holes shot	157	133 (includes single holes and patterns)

	1962	1963
Miles traversed	54-1/3	32-1/3
Common shooting depths	50 to 80 ft in west (Trav. L) 80 to 120 ft in east	60 to 90 ft
Usual recording filter	K22 - K92	K18 - K120
Usual playback filters	K22 - K55	K24 - 66K, K30 - 75K
Common charge sizes	10 to 20 lbs	5 x 2½ lbs; 5 x 5 lbs; 9 x 5 lbs Single holes 10 to 20 lbs

Comparison of stratigraphies of the Orientos No. 1 and Orient No. 2 wells

APPENDIX C

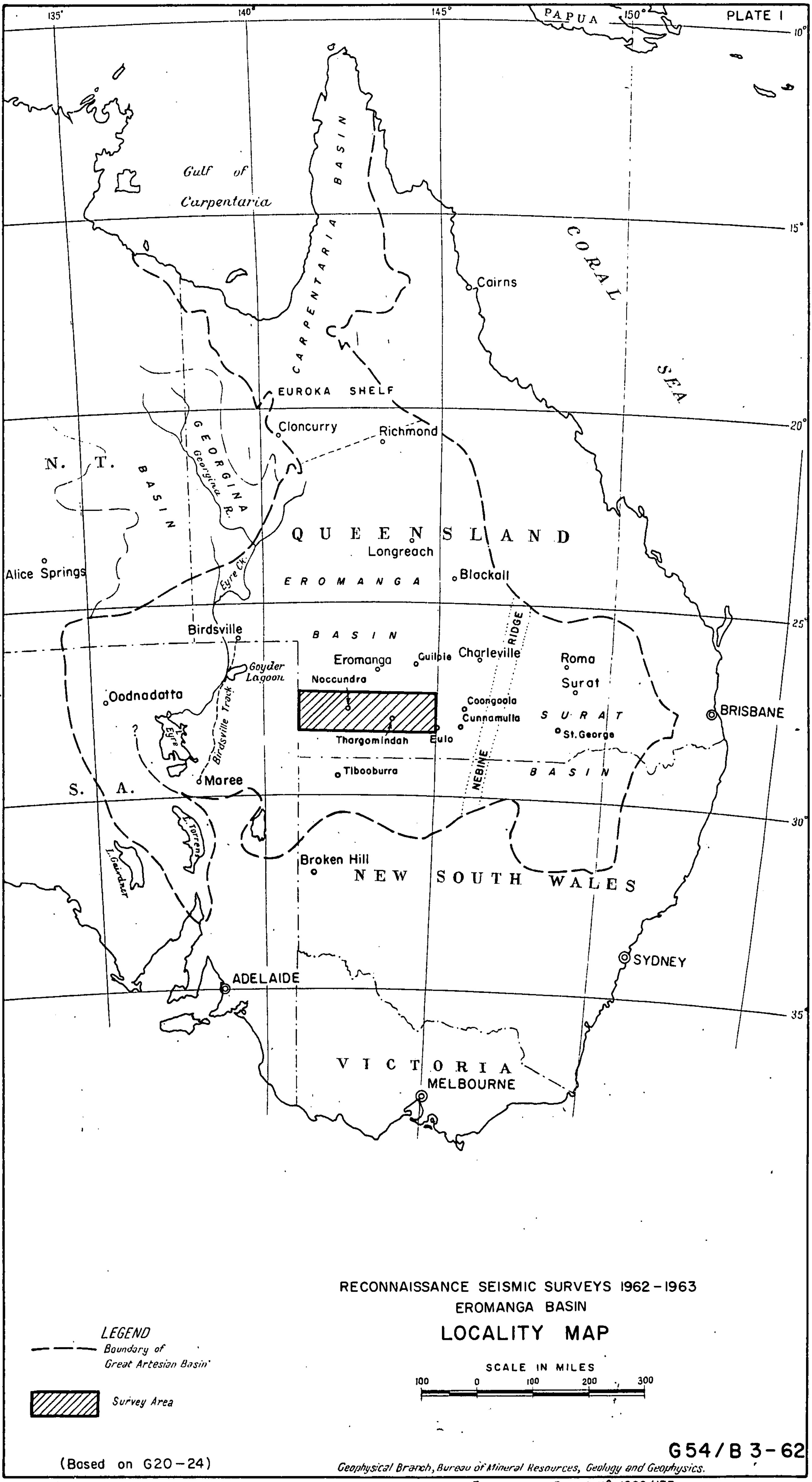
Age	Orientos No. 1 well: Formation	Lithology	Thickness (feet)	Orient No. 2 well: Formation	Lithology	Thickness (feet)
Recent & Tertiary		Unconsolidated red, yellow desert sand and grit, clay and dark grey carbonaceous shale. Congl. at base.	302			
Lower Cretaceous	Winton	Interbedded shale, light grey, silty, very carbonaceous and sst, quartz, chert. Occasional thin bands of lignite & limestone. Abundant shell fragments.	1898	Winton	Ferruginous Sst with 'billy' grading through calcareous sst and limestone to grey muddy ssts and mudstones with carbonaceous fragments or pyrite.	200
	Tambo	Shale, dark grey, few thin bands of grey brown limestone, shell fragments.	814	Tambo	Intercalated, greenish-grey to grey, muddy ssts & sandy mudstones. Occasional carbonaceous bands at top & bottom of interval.	1250
	Roma	Shale, dark grey, micaceous & slightly silty. Minor interbeds of sst. At base fine-coarse grained sst. with ironstone, pyrite, siderite.	1061	Roma	Grey, partly calcareous mudstone grading into intercalated, grey, partly calcareous, sandy mudstones & siltstones with carbonaceous bands.	320
	Transition Beds	Interbedded shale, dark grey, micaceous, sst, quartz, with kaolin cement, carbonaceous - predominantly sst. at base.	298	BLYTHESDALE GROUP: Transition Beds	White, clean, well sorted water-bea bearing sst. micaceous & calcareous in part, grey siltstone, shales & ssts. with carbonaceous fragments, sandy mudstone.	1030
Upper Jurassic	Mooga Sandstone	Sst, cream, fine-very coarse grained, conglomeritic, quartz, kaolin cement, good porosity. Very minor shale beds. Sst. contains chert, pink & clear quartz pebbles near base.	677	Mooga Sandstone		
Lower Jurassic	Walloon Coal Measures	Interbedded shale, dark grey to black, carbonaceous, coarse grained sst, conglomeritic, quartz & chert, some porous zones, coal bands, siltstone, & kaolin cement.	503	Un-named beds	Hard, pale green to brown, slightly calcareous sst grading to greenish-grey, partly recrystallised hornfelsic greywacke.	185
	GENTLE UNCONFORMITY					
Lower Triassic	Un-named beds	Siltstone-very fine grained sst, slightly dolomitic, slightly carbonaceous, very kaolinitic, interbeds of shale.	411			
Permian	Un-named beds	Shale, dark grey, brown-black, very carbonaceous, siltstone & sst, conglomeritic, thick coal beds, plant fragments. Sst. Interbedded with shale & siltstone, quartz with kaolin cement, rare chert pebbles toward base.	1324			
	ANGULAR UNCONFORMITY					
Ordovician	Un-named beds	Shale, dark grey, hard, dense, fissile, dolomitic. Fracture systems filled with calcite, dolomite, pyrite. Shaley with fine interbeds of sst, grey-green, very fine grained, translucent, dolomitic.	4239++			

G54/B3-86

APPENDIX D

Summary of results in the Orientos area

Formation	Depth below datum (300 ft. a.s.l.)	Theoretical reflection times from sonic log of Orientos No. 1 (ms)	Delhi Line 5, SP51, near Orientos No. 1					Refraction depth probe, Delhi Line 4 (15 miles SE of Orientos No. 1)					Refraction depth probe, Delhi Line 6. Centre of probe SP253 is near SP1025 on BMR Traverse F					East of Delhi SP253, Line 6.
			Refl.	Refr.	Vel. (ft/s)	Refl. time (ms)	Depth (ft)	Refl	Refr	Vel. (ft/s)	Refl. time (ms)	Depth (ft)	Refl.	Refr	Vel. (ft/s)	Refl. time (ms)	Depth (ft)	
Tambo	2026	[illegible]37																
Roma	2840	825																
Blythesdale Group: Transition Beds	3901	1051	'C'			1068	4000											The 'C' horizon is still associated with the Transition Beds.
Blythesdale Group: Mooga Sandstone	4199	1107	(The 'C' horizon is associated with Transition Beds at top of Blythesdale Group)					'C'	V_3	14,160	1234	5030 5050	'C'	V_3	14,080	1125	4625 4650	
Walloon Coal Measures	4876	1211																
Triassic	5379	1289				1289	5380									1270	5700	
Permian	5790	1346									1353	5850						
Top Coal Seams	5926	1365	'P'			1364	6025											
Bottom Coal Seams	6402	1439	(The 'P' horizon is associated with coal seams near top of Permian)					'P'			1492	6750	'P'	V_4	19,550	1395	6200 6600	The 'P' horizon is believed to be associated with the unconformity at the base of the Mesozoic.
Ordovician	7086	1538	(V_4 refractor is associated with unconformity at the top of the Ordovician)	V_4	18,380		7186		V_4	18,380		7500						



RECONNAISSANCE SEISMIC SURVEYS 1962-1963
EROMANGA BASIN
LOCALITY MAP

G54/B 3-62

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

To accompany Record Nº 1966/177

PLATE 2

HORIZONTAL 8 6 4 2 0 8 16 24 MILES
VERTICAL 2000 1000 0 2000 4000 6000 FEET

LEGEND

Refraction profiling — Good
Reflection (continuous profiling) — Inferred
Reflection (spot correlation) — Questionable
Magnetic horizon — Unconformity

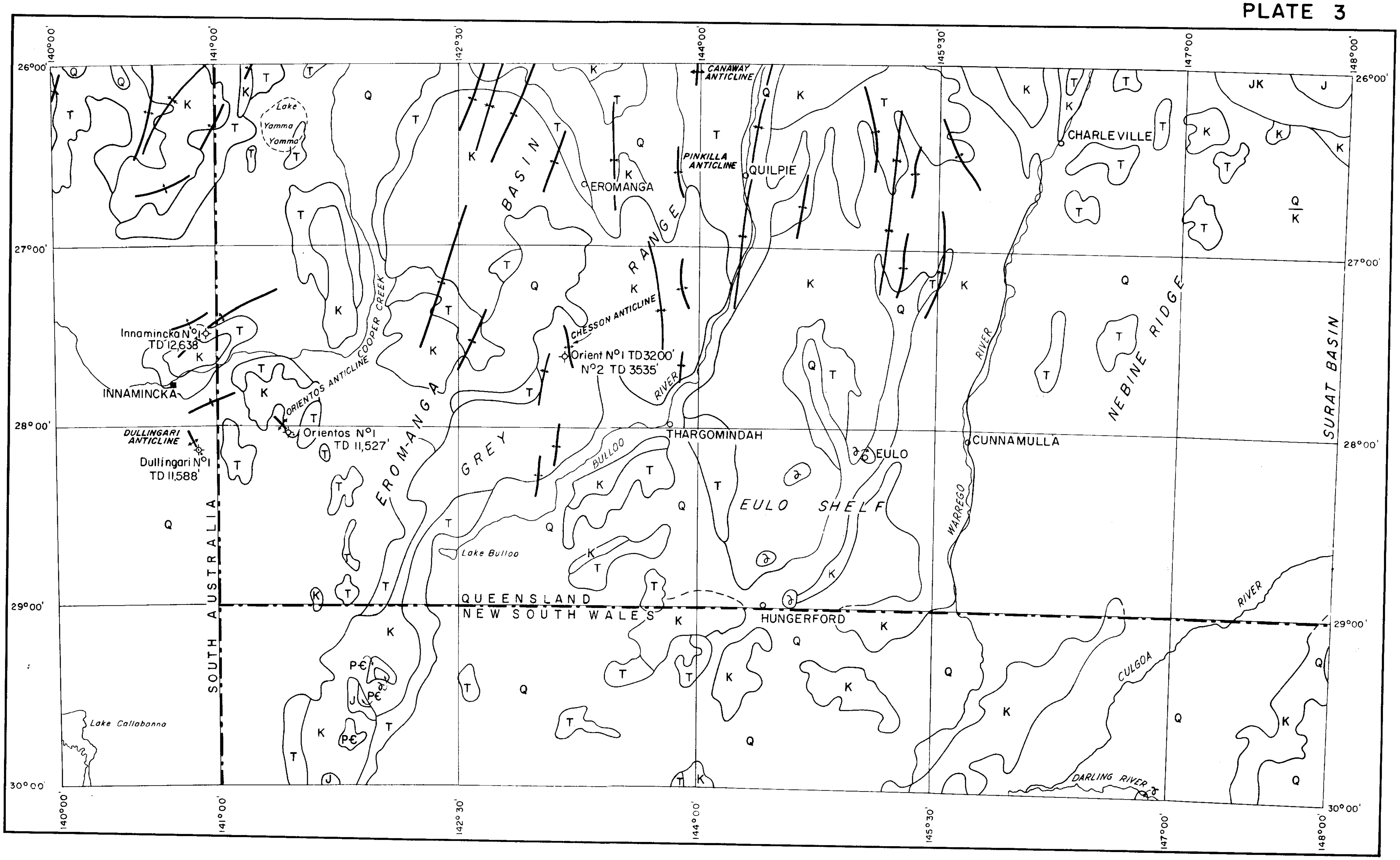
INTERPRETATION OF SEISMIC WORK CONDUCTED BETWEEN EULO AND THE QUEENSLAND/SOUTH AUSTRALIA BORDER

TO ACCOMPANY RECORD No. 1966/177

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

G54/B3-64

PLATE 3



GEOLOGY

LEGEND

Q	Quaternary	∂	Acid Plutonic or Hypabyssal rocks
K	Cretaceous		Anticline
T	Tertiary		Syncline
J	Jurassic		Drillhole
P€	Precambrian		

MILES
40 0 40

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS G54/B3-85
To accompany Record No 1966/177

PLATE 3A

▲58 BMR gravity pendulum station

Eulo BMR 1:250,000 gravity map area

Bore

Feature boundary

SOUTH WEST QUEENSLAND & SOUTH AUSTRALIA

MAJOR GRAVITY FEATURES

SCALE IN MILES

40 0 40 80 120

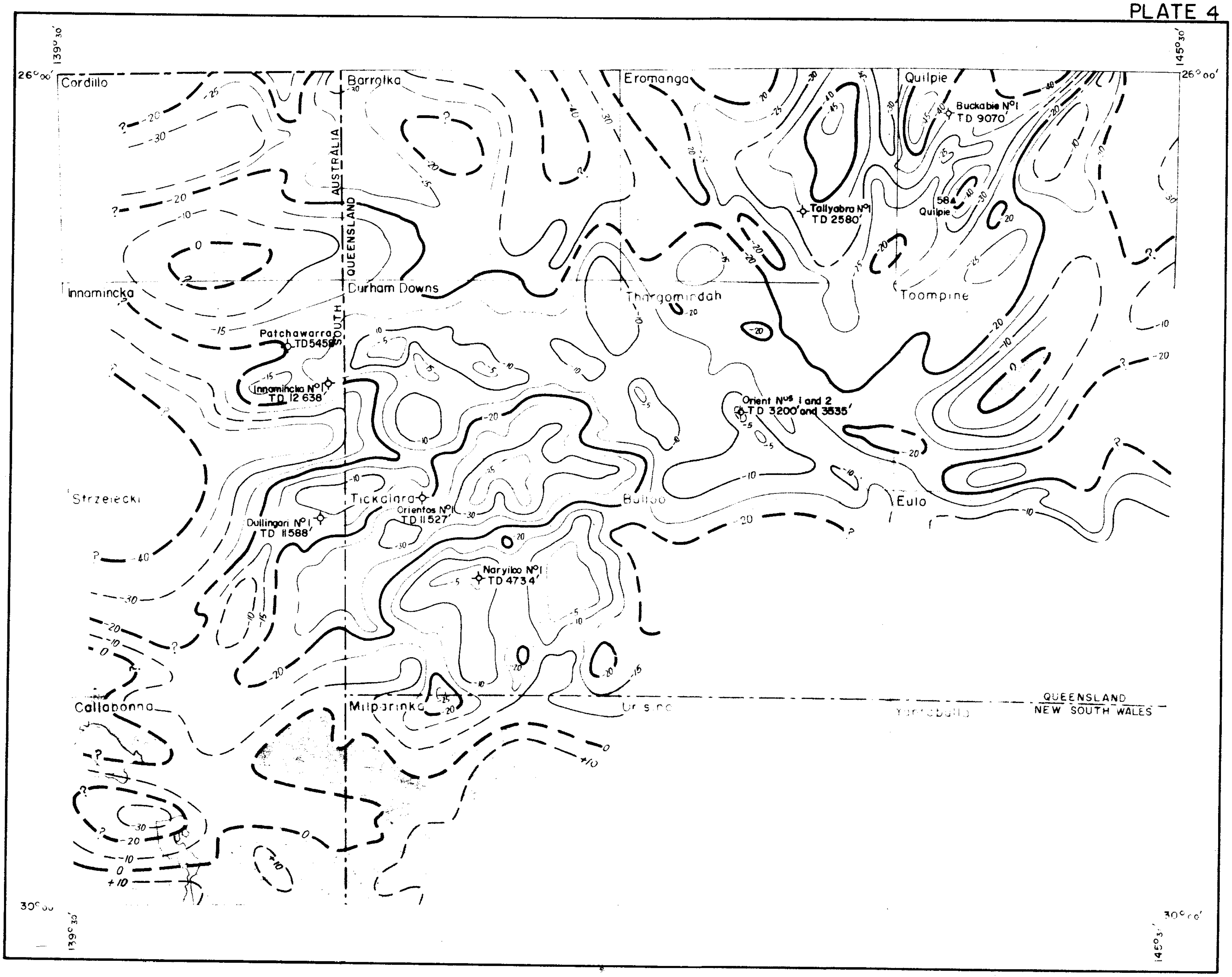
Reference - Division of National Mapping 40 miles to 1 inch topographic map

(BASED ON G54/B2-18-4)

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
TO ACCOMPANY RECORD No. 1966/177

G54/B2-18-7

PLATE 4



LEGEND

Isogals, values in milligals

Eulo BMR 1 250 000 gravity map area

▲ 58 BMR gravity pendulum station

Bore

Gravity "High"

Gravity "Low"

Bouguer anomalies are based on the observed gravity value at BMR pendulum station

No 58 Quilpie 979,006 5 milligals

For the calculation of Bouguer anomalies 1 9 g/cm³ has been adopted as an average rock density

Elevation datum Queensland State

SOUTH WEST QUEENSLAND & SOUTH AUSTRALIA

BOUGUER ANOMALIES

SCALE IN MILES

40 0 40 80 120

Reference Division of National Mapping 40 miles to 1 inch topographic map

CONTOUR INTERVAL 5 MILLIGALS

Compiled July 1962, Revised Jan 1963

(BASED ON G54/B2-18-3)

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
TO ACCOMPANY RECORD No. 1966/177

-6

PLATE 5

CORRECTED RECORD SECTION

RECORDING INFORMATION

Magnetic Recorder: DS7–7
Amplifiers: 8000 Explorer
Filters: K22–K92
A.G.C.: 1/1 125
Gain Initial: –60
Final: Max
Geophones: EVS2 – 20 c/s
Geophone pattern:
6/trace, 22' apart in line
Station interval 150'

Shot-hole pattern:

Single	SP59–74	SP90–105	SP120–135	SP152–167	SP184–199
Depth	77'	80'	98'	117'	116'
Charge	10 lb	15 lb	10 lb	10 lb	15 lb

PLAYBACK INFORMATION

Filters: 2/31–1/60
A.G.C.: S.S.
Gain Initial: –50 Except SP59–74
Final: –30 –40
Trip delay: 0 –30
Compositing: Nil

VELOCITY INFORMATION

t : Δt

HORIZONTAL SCALE

FEET
0 1000 2000 3000 4000 5000
0 1800 3600

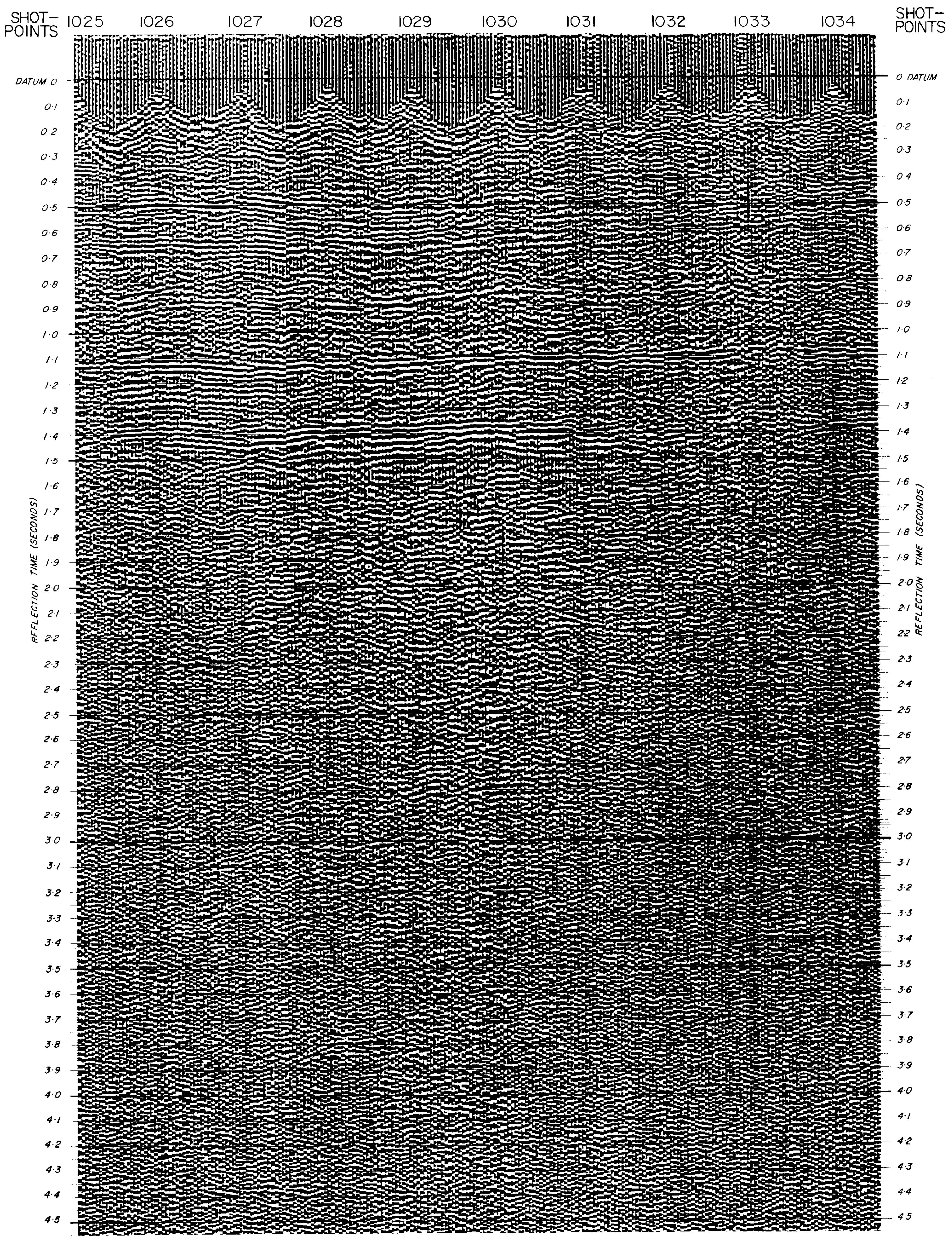
THARGOMINDAH – NOCCUNDRA RECONNAISSANCE SEISMIC SURVEY EROMANGA BASIN, QUEENSLAND 1963

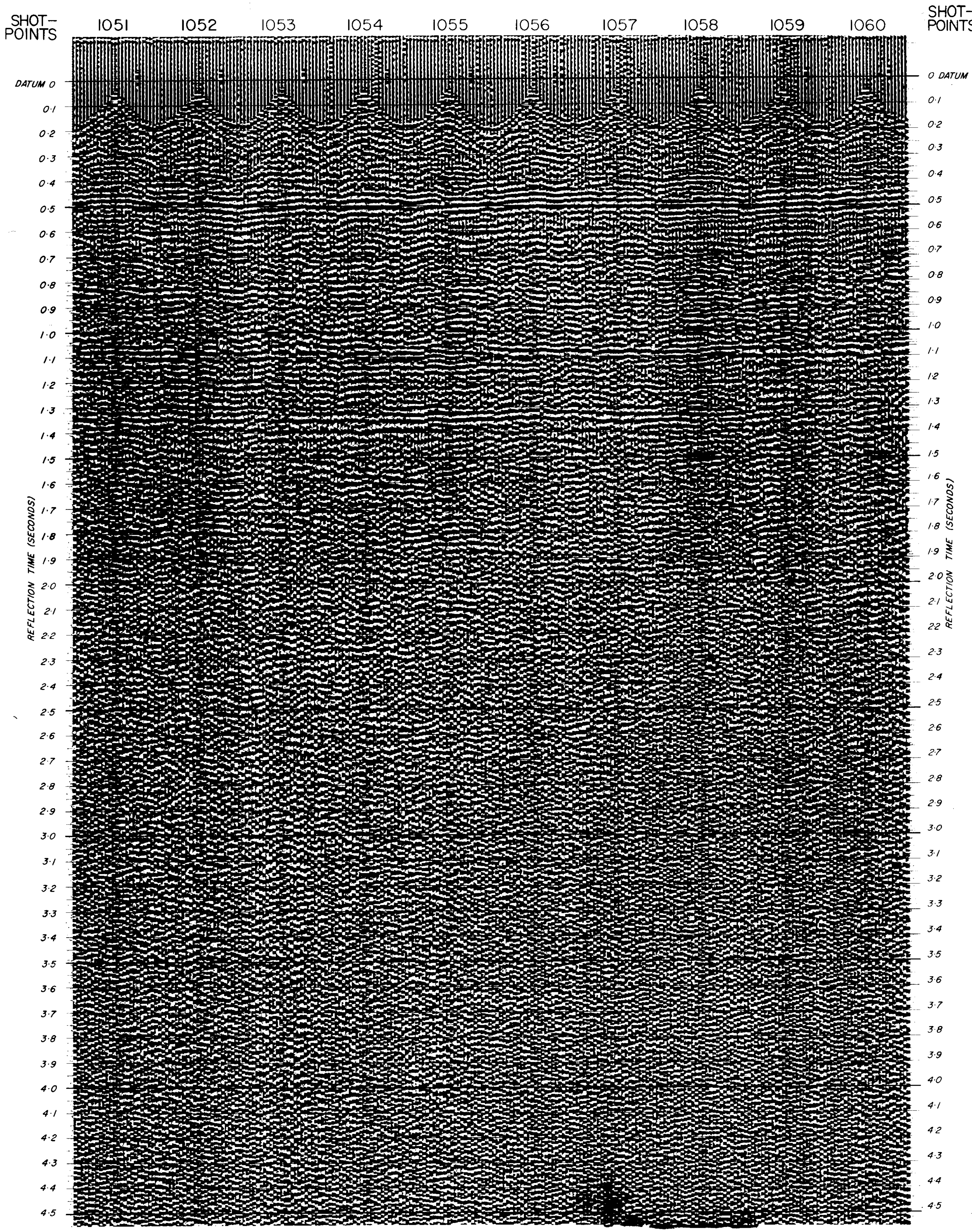
TRAVERSE N

RECORDED BY: *Seismic Party No. 1*
SECTION BY: *Bureau of Mineral Resources Playback Centre SIE MS 42*

G54/B3–75

TO ACCOMPANY RECORD No. 1966/177





CORRECTED RECORD SECTION

PLATE 6

RECORDING INFORMATION

Magnetic Recorder : DS7-7

Amplifiers : 8000 Explorer

Filters : K22-K92

A.G.C. : 1/1 125

Gain Initial : -60

Final : Max

Geophones : EVS 2-20 c/s

Geophone pattern :

6/trace, 22' apart in line

Station interval 150'

Shot-hole pattern :

Single

Depth 90-95'

Charge 10 lb

PLAYBACK INFORMATION

Filters : 2/31-1/60

A.G.C. : S.S.

Gain Initial : -50

Final : -20

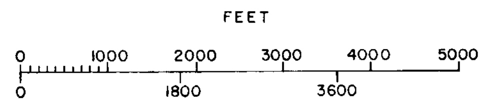
Trip delay : 0

Compositing : Nil

VELOCITY INFORMATION

t : Δt

HORIZONTAL SCALE



THARGOMINDAH - NOCCUNDRA
RECONNAISSANCE SEISMIC SURVEY
EROMANGA BASIN,
QUEENSLAND 1963

TRAVERSE P

RECORDED BY : *Seismic Party No. 1*

SECTION BY : *Bureau of Mineral Resources*

Playback Centre SIE MS 42

TO ACCOMPANY RECORD No. 1966/177

G54/B3-72

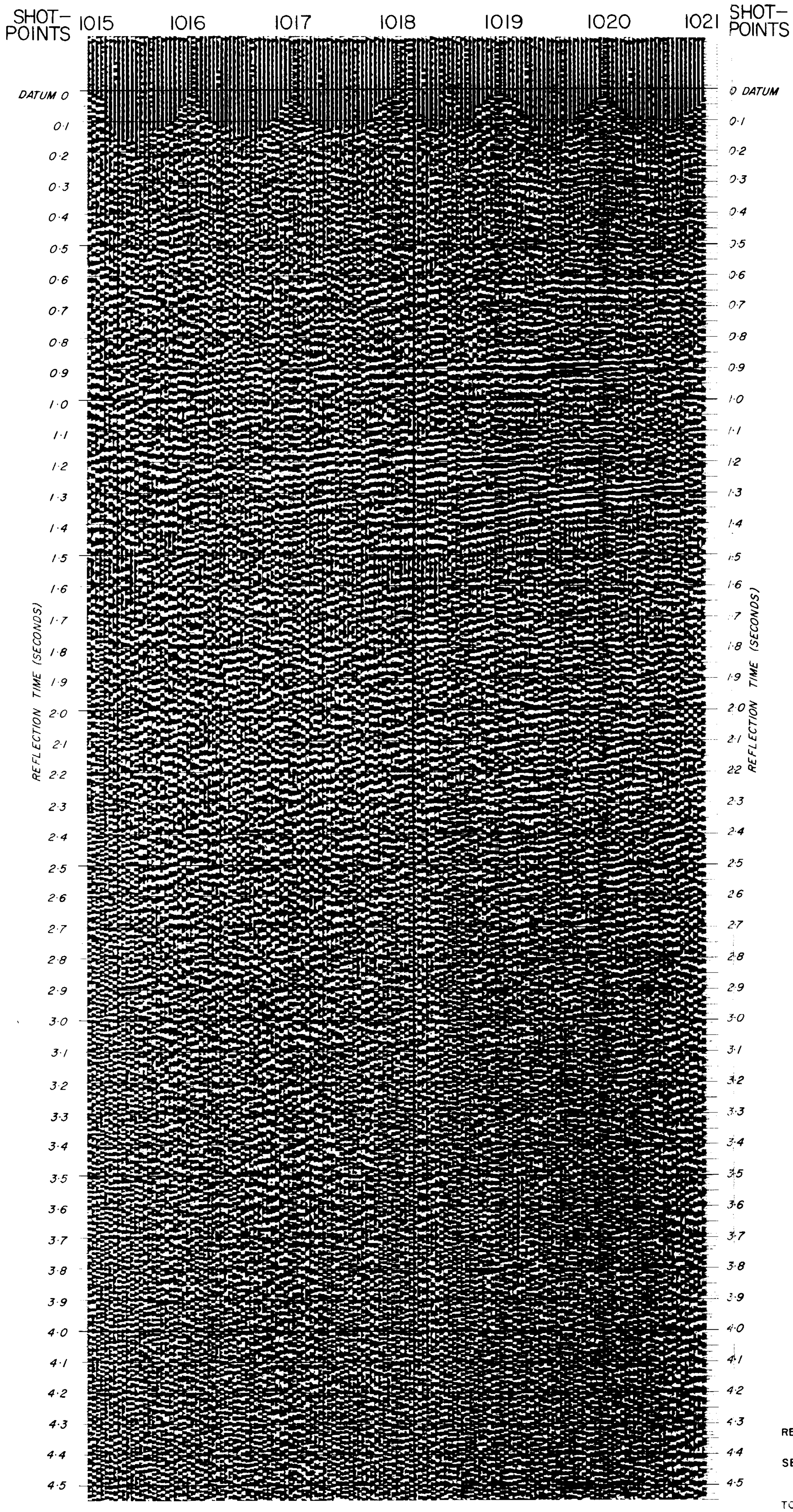


PLATE 7

CORRECTED RECORD SECTION

RECORDING INFORMATION

Magnetic Recorder: DS7-7
Amplifiers: 8000 Explorer
Filters: K22-K92
A.G.C.: 1/1 125
Gain Initial: -60
Final: Max
Geophones: EVS 2-20c/s
Geophone pattern:
6/trace, 22' apart in line
Station interval 150'

Shot-hole pattern:
Single
Depth 100'
Charge 20 lb

PLAYBACK INFORMATION

Filters: 2/31-1/60
A.G.C.: S.S.
Gain Initial: -50
Final: -20
Trip delay: 0
Compositing: Nil

VELOCITY INFORMATION

t : Δt

HORIZONTAL SCALE

FEET
0 1000 2000 3000 4000 5000
0 1800 3600

THARGOMINDAH - NOCCUNDRA RECONNAISSANCE SEISMIC SURVEY EROMANGA BASIN, QUEENSLAND 1963

TRAVERSE O

RECORDED BY: *Seismic Party No.1*

SECTION BY: *Bureau of Mineral Resources Playback Centre SIE MS 42*

G54/B3-71

TO ACCOMPANY RECORD No 1966/177

35

CORRECTED RECORD SECTION

PLATE 8

RECORDING INFORMATION

Magnetic Recorder: DS7-7

Amplifiers: 7000B

Filters: K18-K120

A.G.C.: W.B.

Gain Initial: -55

Final: -10

Geophones: HSJ-14 c/s

Geophone pattern:

8/trace, 19¼' apart in line

Station interval 110'

Shot-hole pattern:

	SP 209-213	SP 214-226	SP 237-250	SP 262-305	SP 306-351
	P	S	S	P	P
D	60'-105'	60'-105'	60'-105'	80'	75'
C	5x2½ lbs	15 lbs	15 lbs	10-20 lbs	5x5 lbs

P = • 30' • • • • (50') S = Single D = Depth C = Charge

PLAYBACK INFORMATION

Filters: 2/31-1/60

A.G.C.: S.S.

Gain Initial: -40 except SP 306-351 -50

Final: -30 except SP 306-351 -30

Trip delay: 0

Compositing: Nil

VELOCITY INFORMATION

t:Δt

HORIZONTAL SCALE

SP 209-305
0 1000 2000 3000 4000 FEET
0 1800 3600

SP 306-351
0 1000 2000 3000 4000 FEET
0 1320 2640 3960

THARGOMINDAH-NOCCUNDRA
RECONNAISSANCE SEISMIC SURVEY
EROMANGA BASIN,
QUEENSLAND 1963
SP 209 to SP 351

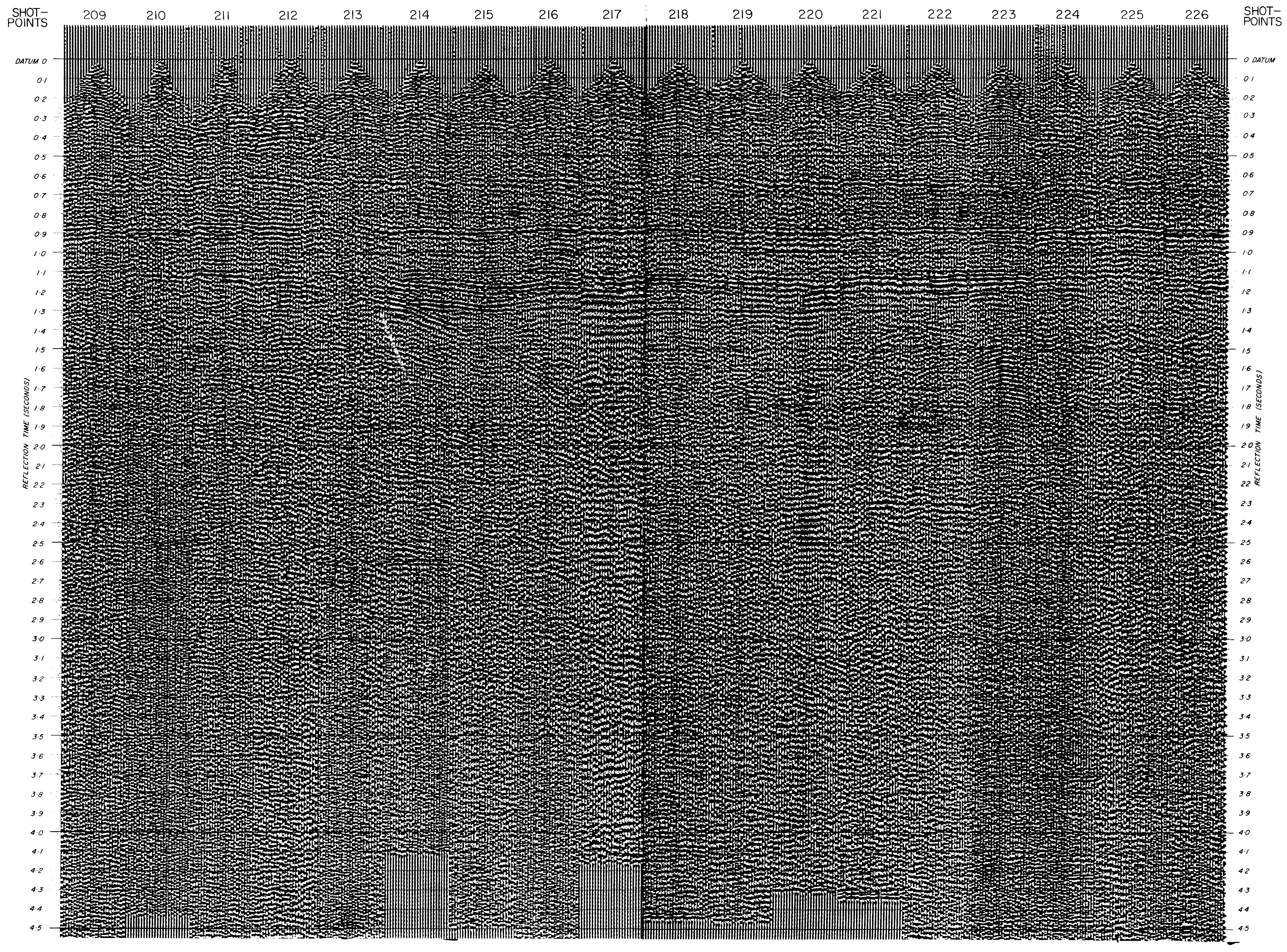
TRAVERSE L

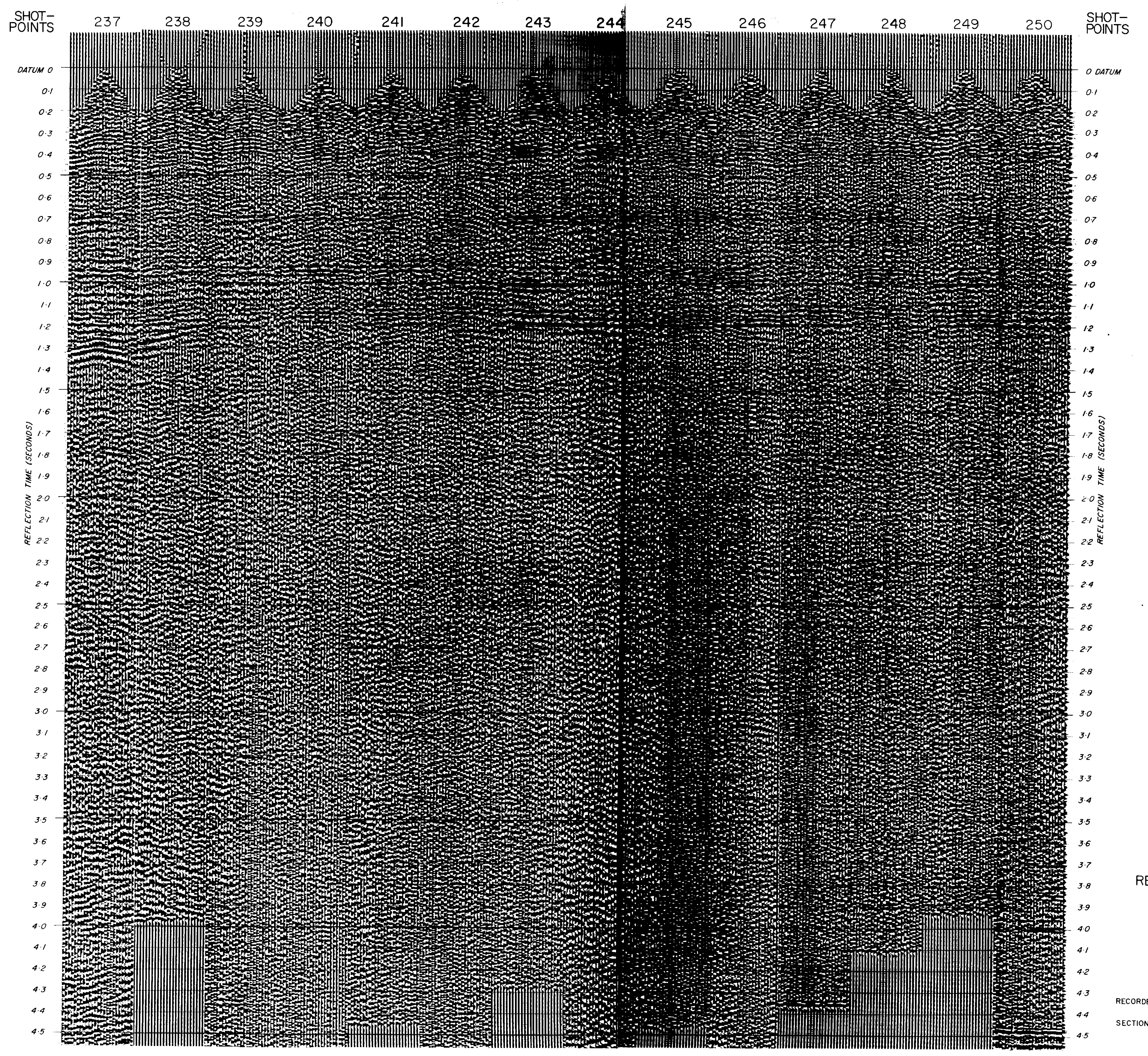
RECORDED BY: *Seismic Party No. 1*

SECTION BY: *Bureau of Mineral Resources Playback Centre SIE MS 42*

G54/B3-80

TO ACCOMPANY RECORD No. 1966/177





CORRECTED RECORD SECTION

RECORDING INFORMATION

Magnetic Recorder: DS7-7

Amplifiers: 7000B

Filters: K18 – K120

A.G.C.: W.B.

Gain Initial: –55

Final: –10

Geophones: HSJ – 14 c/s

Geophone pattern:

8/trace, 19¼' apart in line

Station interval 110'

Shot-hole pattern:

Single

Depth 60 – 105'

Charge 15 lb

PLAYBACK INFORMATION

Filters: 2/31 – 1/60

A.G.C.: S.S.

Gain Initial: –40

Final: –30

Trip delay: 0

Compositing: Nil

VELOCITY INFORMATION

t, Δt

HORIZONTAL SCALE

FEET

0 1000 2000 3000 4000 5000

0 1800 3600

THARGOMINDAH – NOCCUNDRA
RECONNAISSANCE SEISMIC SURVEY
EROMANGA BASIN,
QUEENSLAND 1963

TRAVERSE L

RECORDED BY: *Seismic Party No. 1*

SECTION BY: *Bureau of Mineral Resources Playback Centre SIE MS 42*

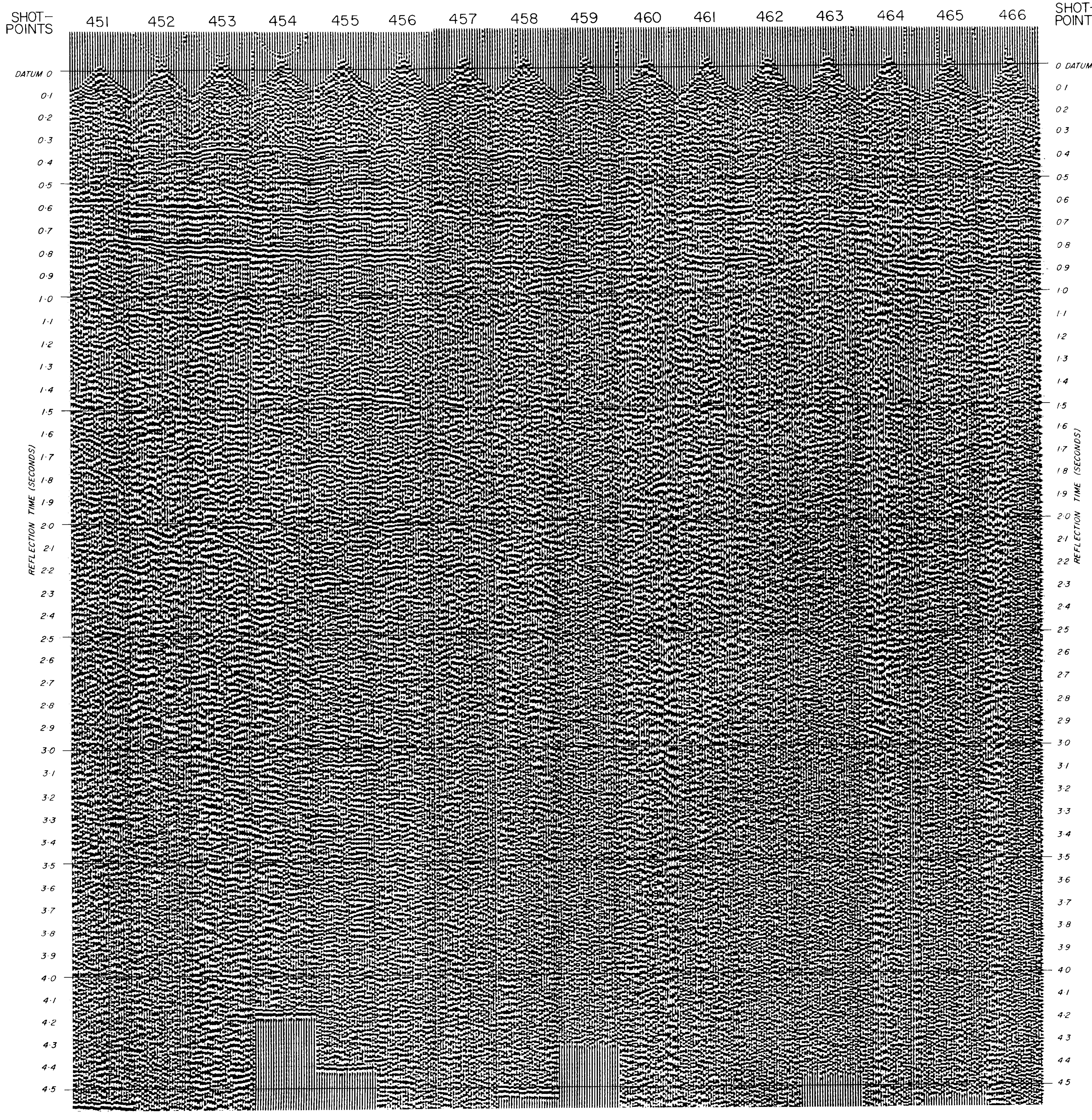


PLATE 9

CORRECTED RECORD SECTION

RECORDING INFORMATION

Magnetic Recorder : DS7-7

Amplifiers : 7000B

Filters : K18 - K120

A.G.C. : W.B.

Gain Initial : -55

Final : -10

Geophones : HSJ - 14 c/s

Geophone pattern :

8/trace, 19¼' apart in line

Station interval 110'

Shot-hole pattern :

30'

50'

x

Depth 75'

Charge 5 x 5 lb

PLAYBACK INFORMATION

Filters : 2/31-1/60

A.G.C. : S.S.

Gain Initial : -50

Final : -30

Trip delay : 0

Compositing : Nil

VELOCITY INFORMATION

t : Δt

HORIZONTAL SCALE

FEET

0 1000 2000 3000 4000

0 1320 2640

THARGOMINDAH - NOCCUNDRA RECONNAISSANCE SEISMIC SURVEY EROMANGA BASIN, QUEENSLAND 1963

SP 451 to SP 466

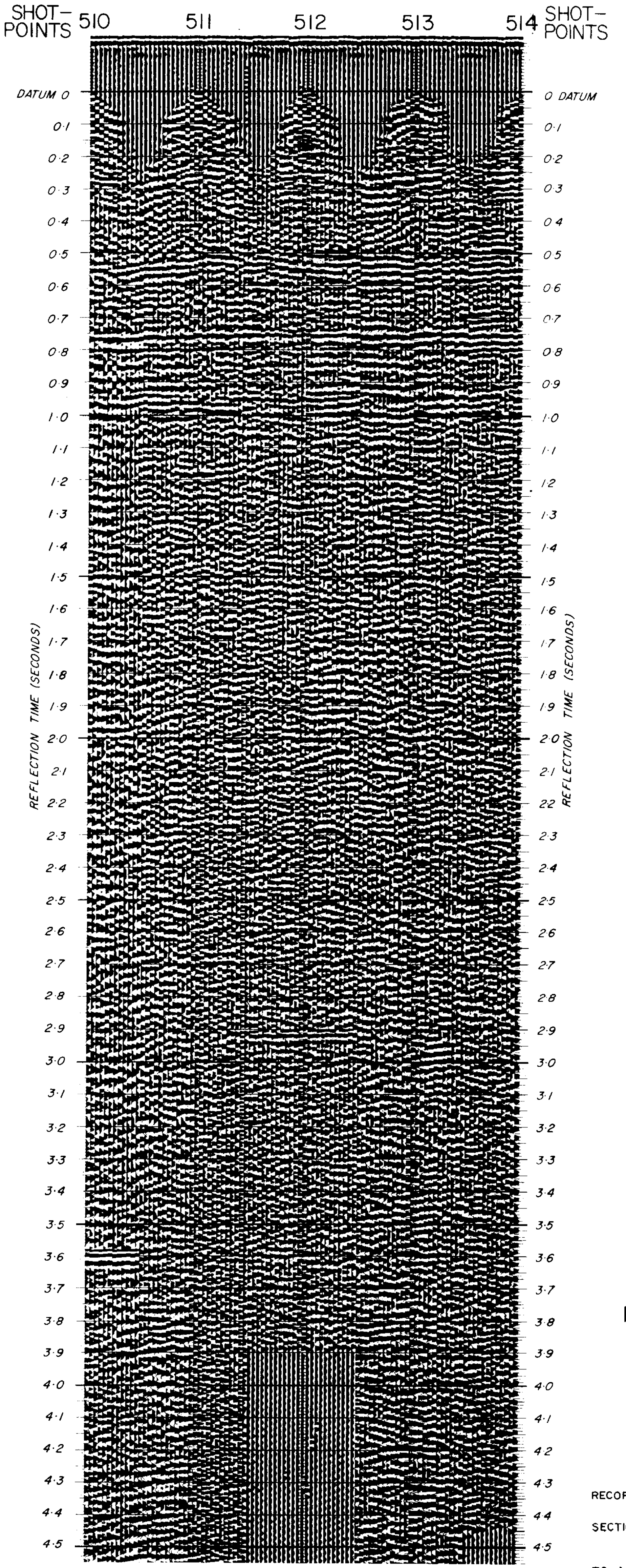
TRAVERSE L

RECORDED BY : *Seismic Party No. 1*

SECTION BY : *Bureau of Mineral Resources Playback Centre SIE MS 42*

TO ACCOMPANY RECORD No. 1966/177

G54/B3-84



CORRECTED RECORD SECTION

RECORDING INFORMATION

Magnetic Recorder : DS7-7

Amplifiers : 7000B

Filters : K18 - K120

A.G.C. : W.B.

Gain Initial : -55

Final : -10

Geophones : HSJ - 14 c/s

Geophone pattern :

8/trace, 19¼' apart in line

Station interval 150'

Shot-hole pattern :

Single

Depth 90'

Charge 15 lb

PLAYBACK INFORMATION

Filters : 2/31 - 1/60

A.G.C. : S.S.

Gain Initial : -50

Final : -20

Trip delay : 0

Compositing: Nil

VELOCITY INFORMATION

t : Δt

HORIZONTAL SCALE

FEET

0 1000 2000 3000 4000 5000

0 1800 3600

THARGOMINDAH - NOCCUNDRA
RECONNAISSANCE SEISMIC SURVEY
EROMANGA BASIN,
QUEENSLAND 1963

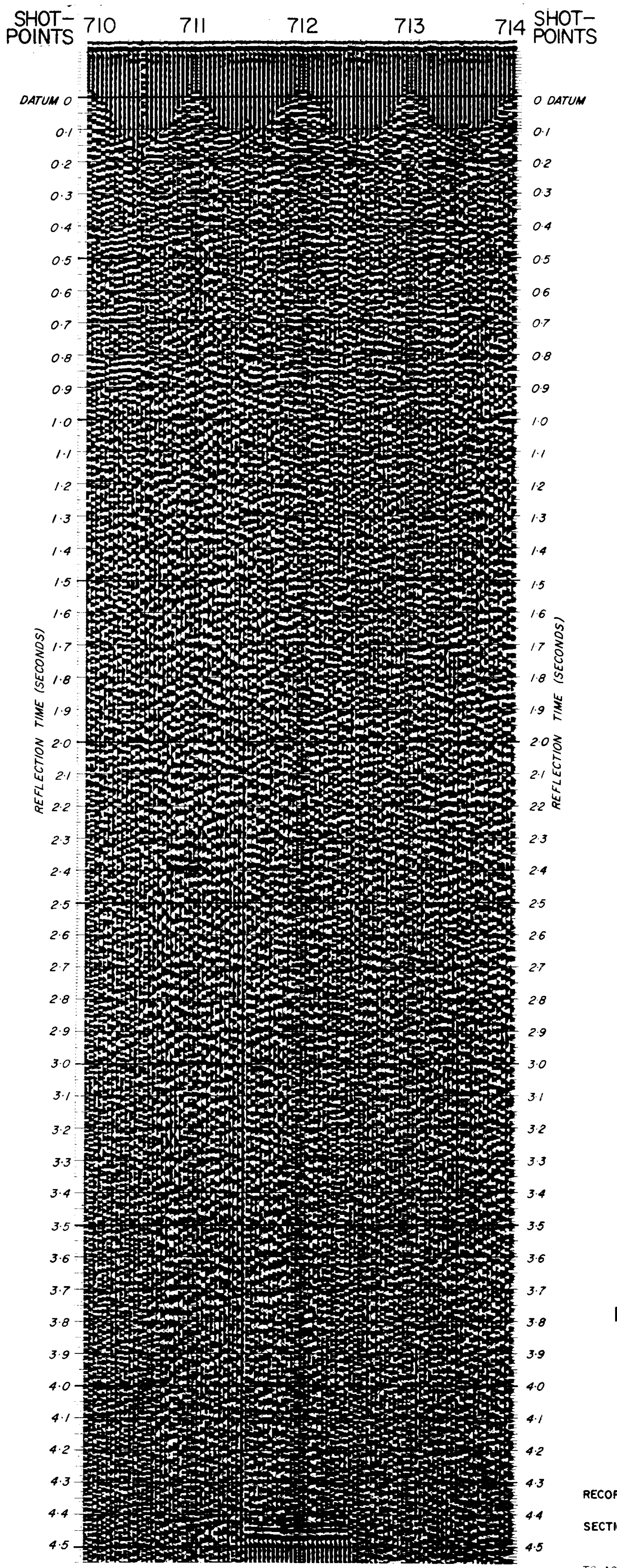
TRAVERSE R

RECORDED BY : *Seismic Party No. 1*

SECTION BY : *Bureau of Mineral Resources*
Playback Centre SIE MS 42

TO ACCOMPANY RECORD No. 1966/177

G54/B3-74



CORRECTED RECORD SECTION

PLATE 10

RECORDING INFORMATION

Magnetic Recorder : DS7-7

Amplifiers : 7000B

Filters : K18 - K120

A.G.C. : W.B.

Gain Initial : -55

Final : -10

Geophones : HSJ - 14 c/s

Geophone pattern :

8/trace, 19¼' apart in line

Station interval 150'

Shot-hole pattern :

Single

Depth 90'

Charge 15 lb

PLAYBACK INFORMATION

Filters : 2/31 - 1/60

A.G.C. : S.S.

Gain Initial : -50

Final : -20

Trip delay : 0

Compositing: Nil

VELOCITY INFORMATION

t : Δt

HORIZONTAL SCALE

FEET

0 1000 2000 3000 4000 5000

0 1800 3600

THARGOMINDAH - NOCCUNDRA
RECONNAISSANCE SEISMIC SURVEY
EROMANGA BASIN,
QUEENSLAND 1963

TRAVERSE S

RECORDED BY : *Seismic Party No. 1*

SECTION BY : *Bureau of Mineral Resources*
Playback Centre SIE MS 42

TO ACCOMPANY RECORD No. 1966/177

G54/B3-73

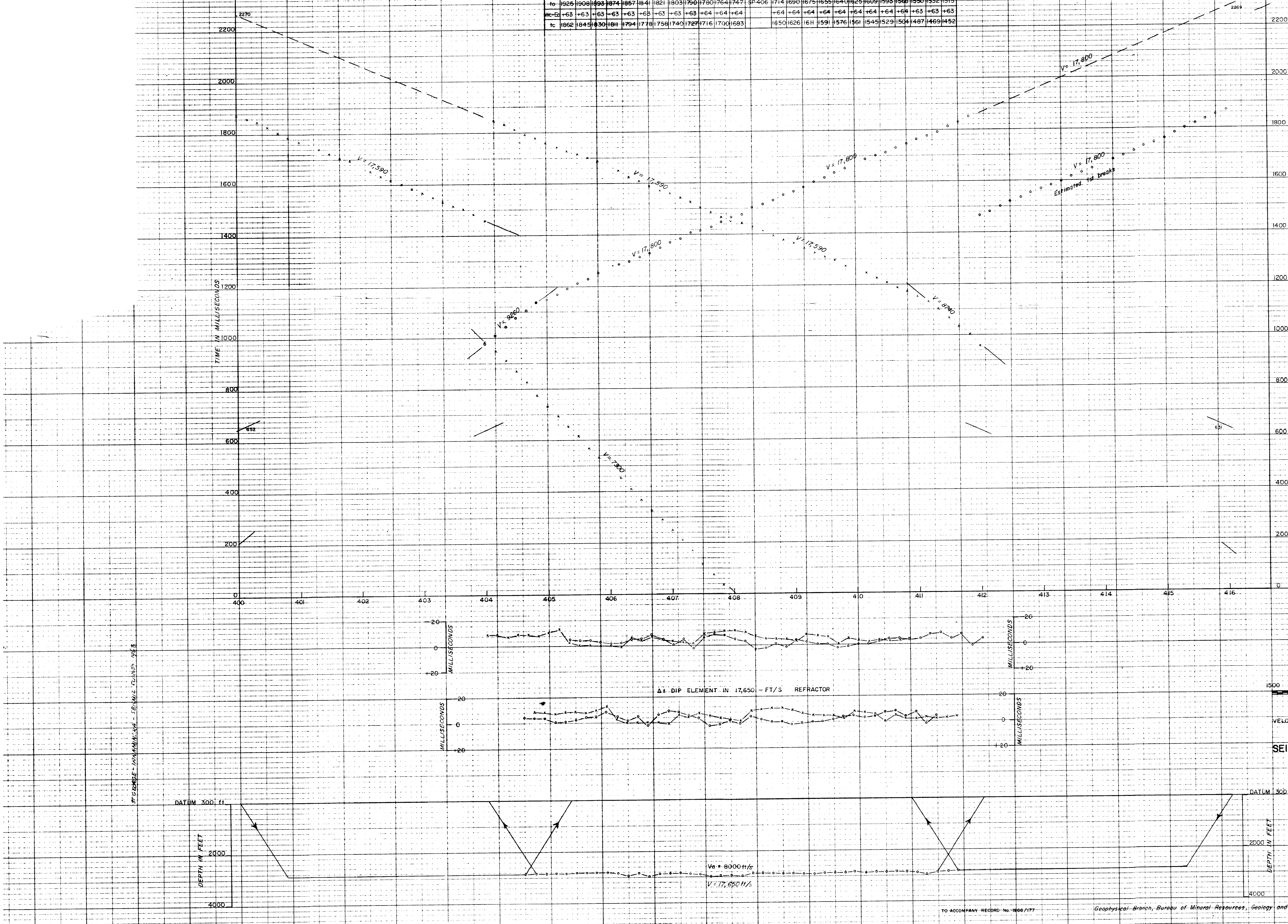
PLATE II

	24	23	22	21	20	19	18	17	16	15	14	13	SP400	12	11	10	9	8	7	6	5	4	3	2	1
to								1234	1258	1276	1293	1313	SP406	1346	1360	1377	1391	1411	1432	1445	1469	1478	1492	1510	1530
Wc+Ec								+63	+63	+63	+63	+63		+63	+63	+63	+63	+63	+63	+63	+63	+62	+62	+62	+62
tc								1171	1195	1213	1230	1250		1283	1297	1314	1328	1348	1369	1382	1406	1416	1430	1448	1468

													SP 400												
to	1518	1537	1560	1576	1590	1609	1621	1640	1659	1676	1695	1711	SP410	1744	1759	1774	1790	1809	1825	1839	1855	1876	1890	1916	1927
Wc+Ec	+58	+58	+58	+59	+59	+59	+59	+59	+59	+59	+59	+59		+59	+59	+60	+60	+60	+60	+60	+60	+60	+60	+60	+60
tc	1460	1479	1502	1517	1531	1550	1562	1581	1600	1617	1636	1652		1685	1700	1714	1730	1749	1765	1779	1795	1816	1830	1856	1867

													SP 416												
to	1521	1505	1491	1476	1459	1442	1427	1405	1389	1373	1362	1340	SP410	1309	1291	1274	1257	1239							
Wc+Ec	+63	+63	+63	+63	+64	+64	+64	+64	+64	+64	+64	+64		+64	+64	+65	+65	+65							
tc	1458	1442	1428	1413	1395	1378	1363	1341	1325	1309	1298	1276		1245	1227	1209	1192	1174							

	24	23	22	21	20	19	18	17	16	15	14	13	SP 416	12	11	10	9	8	7	6	5	4	3	2	1
to	1925	1908	1893	1874	1857	1841	1821	1803	1790	1780	1764	1747	SP406	1714	1690	1675	1655	1640	1625	1609	1593	1568	1550	1532	1515
Wc+Ec	+63	+63	+63	+63	+63	+63	+63	+63	+63	+64	+64	+64		+64	+64	+64	+64	+64	+64	+64	+64	+64	+63	+63	+63
tc	1862	1845	1830	1811	1794	1778	1758	1740	1727	1716	1700	1683		1650	1626	1611	1591	1576	1561	1545	1529	1504	1487	1469	1452



FEET
1500 0 1500 3000
HORIZONTAL SCALE
VELOCITIES SHOWN IN FT/S

SEISMIC REFRACTION RESULTS
TRAVERSE Q -

TO ACCOMPANY RECORD No. 1966/177

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

G54/B3-50

PLATE 12

SP 518

	24	23	22	21	20	19	18	17	16	15	14	13		12	11	10	9	8	7	6	5	4	3	2	1
to	1784	1760	1746	1729	1715	1706	1692		1664	1651	1635	1618		1584	1568	1550	1527	1518	1501	1490	1473	1458	1447	1427	1412
Wc+Ec	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	SP 510	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26
tc	1758	1734	1720	1703	1689	1680	1666		1638	1625	1609	1592		1558	1542	1524	1501	1492	1475	1464	1447	1432	1421	1401	1386

SP 506

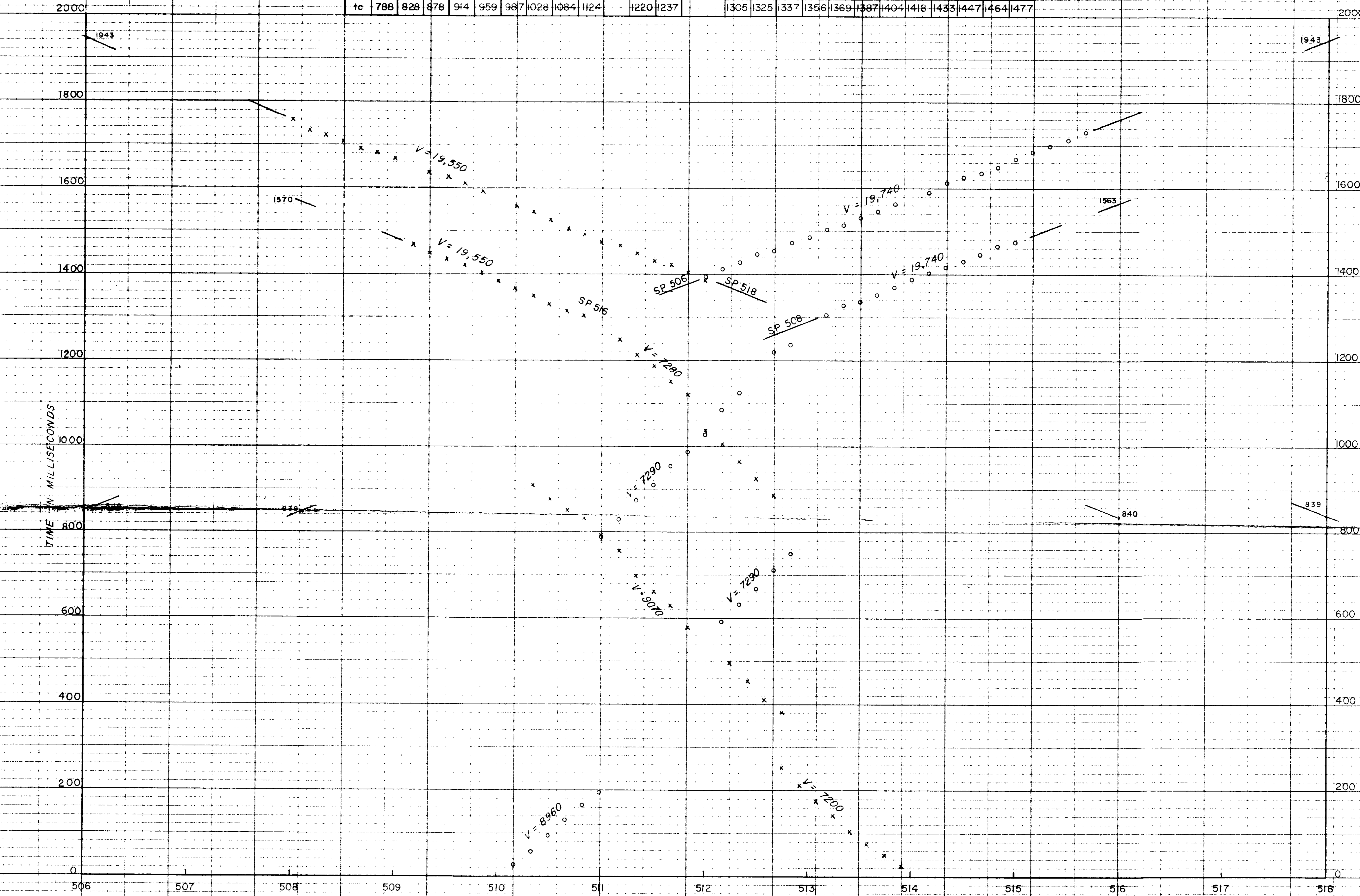
to	1426	1443	1456	1473	1485	1502	1513	1530	1544	1560	1577	1594		1623	1641	1653	1666	1677	1696	1710	1727	1742	1759		
Wc+Ec	+29	+29	+29	+29	+29	+29	+29	+29	+29	+30	+30	+30	SP 514	+30	+30	+29	+29	+28	+28	+28	+28	+28	+28		
tc	1397	1414	1427	1444	1456	1473	1484	1502	1515	1530	1547	1564		1593	1611	1624	1637	1649	1668	1682	1699	1714	1731		

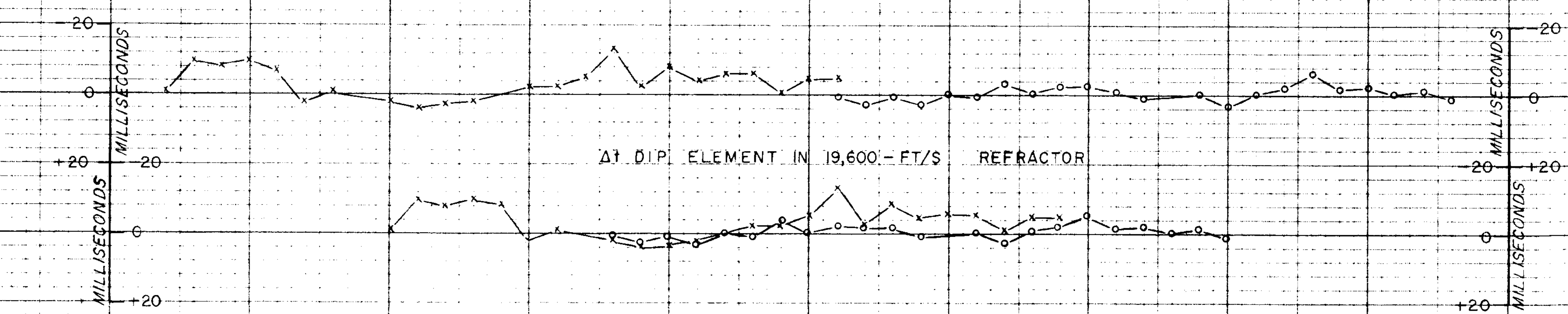
SP 516

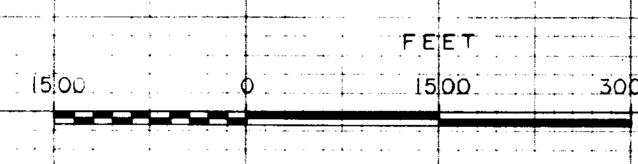
to		1496	1479	1464	1446	1429	1412	1395	1377	1360	1344	1329		1264	1229	1202	1169	1134	1049	1019	979	939	899		
Wc+Ec		+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	+26	SP 511	+14	+14	+14	+14	+14	+14	+14	+14	+14	+14		
tc		1470	1453	1438	1420	1403	1386	1369	1351	1334	1318	1303		1250	1215	1188	1155	1120	1035	1005	965	925	885		

SP 508

	24	23	22	21	20	19	18	17	16	15	14	13		12	11	10	9	8	7	6	5	4	3	2	1
to	802	842	892	928	973	1001	1042	1098	1138		1234	1251		1332	1352	1364	1383	1396	1414	1431	1445	1459	1473	1490	1503
Wc+Ec	+14	+14	+14	+14	+14	+14	+14	+14	+14	+14	+14	+14	SP 513	+27	+27	+27	+27	+27	+27	+27	+27	+26	+26	+26	+26
tc	788	828	878	914	959	987	1028	1084	1124		1220	1237		1305	1325	1337	1356	1369	1387	1404	1418	1433	1447	1464	1477







VELOCITIES SHOWN IN FT/S

SEISMIC REFRACTION RESULTS

TRAVERSE R

ST GEORGE - INNAMINCKA SEISMIC SURVEY, 1963

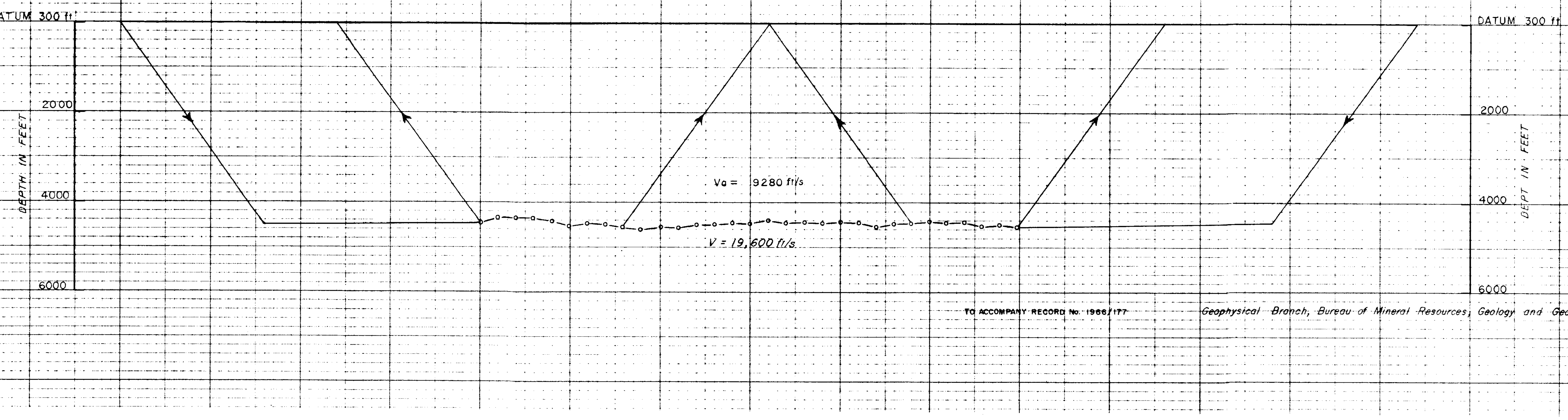


PLATE 13

SP 706

	24	23	22	21	20	19	18	17	16	15	14	13		12	11	10	9	8	7	6	5	4	3	2	1
to	1348	1368	1388	1404	1428	1442	1459	1476	1498	1509	1529	1514	SP 714	1571	1588	1601	1618	1638	1655	1670	1683	1702	1718	1733	1748
Wc+Ec	+37	+37	+37	+37	+37	+37	+37	+37	+36	+36	+36	+36		+36	+36	+36	+35	+35	+35	+35	+35	+35	+35	+35	+35
tc	1311	1331	1351	1367	1391	1405	1442	1439	1462	1473	1493	1508		1535	1552	1565	1583	1603	1620	1635	1648	1667	1683	1698	1713

SP 718

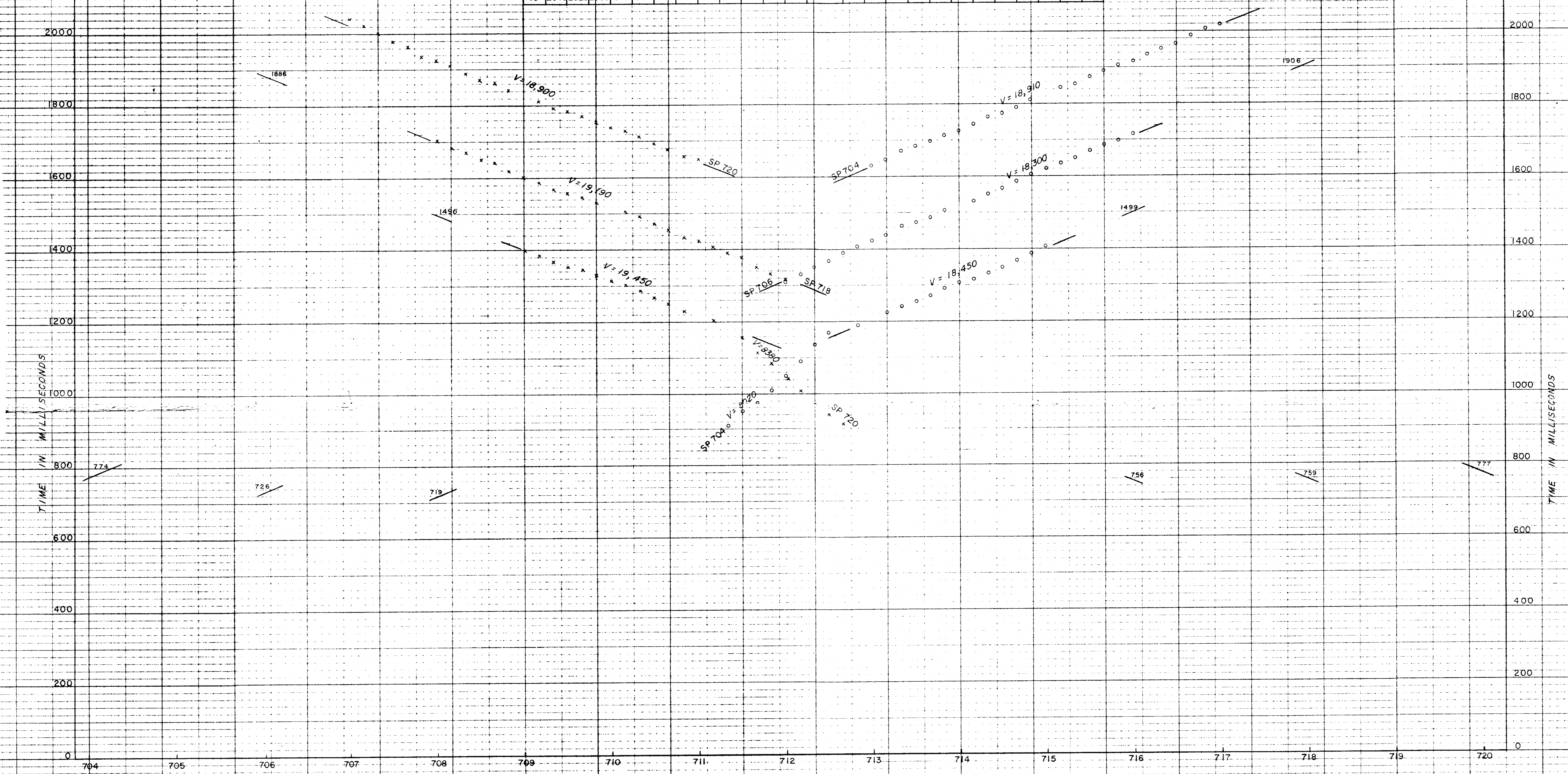
to	1740	1720	1708	1690	1680	1657	1640	1624	1605	1596	1580	1569	SP 710	1540	1527	1505	1490	1470	1461	1443	1430	1415	1388	1370	1350
Wc+Ec	+35	+35	+36	+36	+37	+37	+37	+37	+37	+37	+36	+36		+36	+36	+36	+36	+36	+36	+36	+36	+36	+36	+36	+36
tc	1705	1685	1672	1654	1643	1620	1603	1587	1568	1559	1544	1533		1504	1491	1469	1454	1434	1425	1407	1394	1379	1352	1334	1314

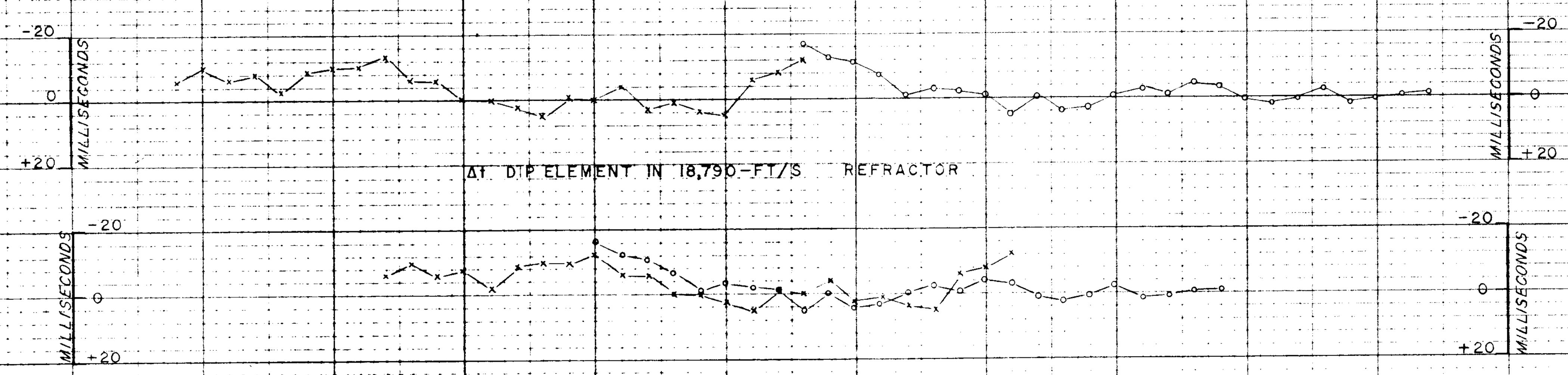
SP 704

to	1663	1681	1705	1715	1733	1748	1760	1777	1795	1807	1821	1840	SP 715	1875	1889	1906	1921	1936	1950	1968	1984	1996	2018	2033	2050
Wc+Ec	+35	+35	+35	+34	+34	+34	+34	+34	+34	+34	+33	+33		+33	+33	+33	+32	+32	+32	+32	+32	+32	+31	+31	+31
tc	1628	1646	1670	1681	1699	1714	1726	1743	1761	1773	1788	1807		1842	1856	1873	1889	1904	1918	1936	1952	1964	1987	2002	2019

SP 720

	24	23	22	21	20	19	18	17	16	15	14	13		12	11	10	9	8	7	6	5	4	3	2	1
to	2072	2052	2033	2013	1998	1974	1960	1945	1928	1913	1900	1878	SP 709	1848	1828	1818	1803	1790	1774	1762	1748	1728	1712	1694	1685
Wc+Ec	+32	+32	+33	+34	+34	+35	+35	+35	+36	+36	+37	+37		+37	+37	+36	+36	+36	+36	+36	+36	+36	+36	+36	+36
tc	2040	2020	2000	1979	1964	1939	1925	1910	1892	1877	1863	1841		1811	1791	1782	1767	1754	1738	1726	1712	1692	1676	1658	1649





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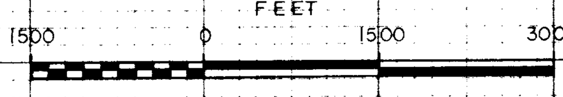
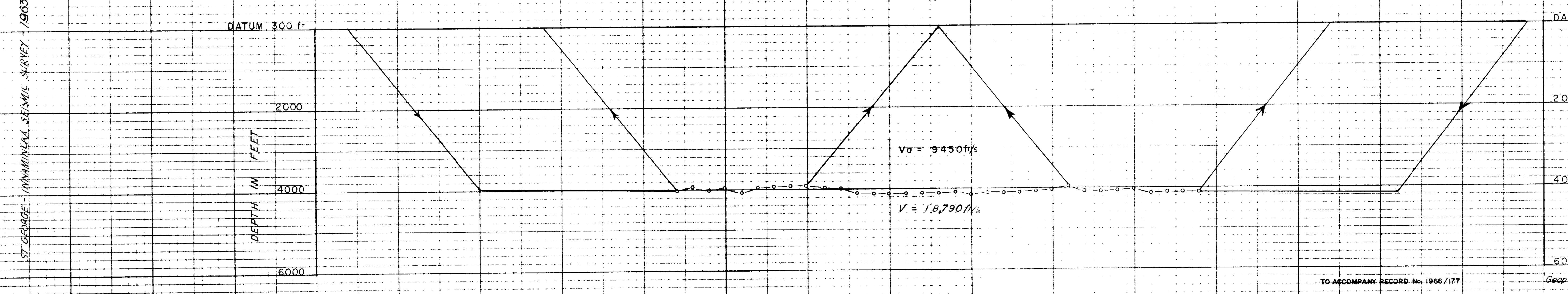


VELOCITIES SHOWN IN FT/S

SEISMIC REFRACTION RESULTS

TRAVERSE S



TO ACCOMPANY RECORD No. 1966/177

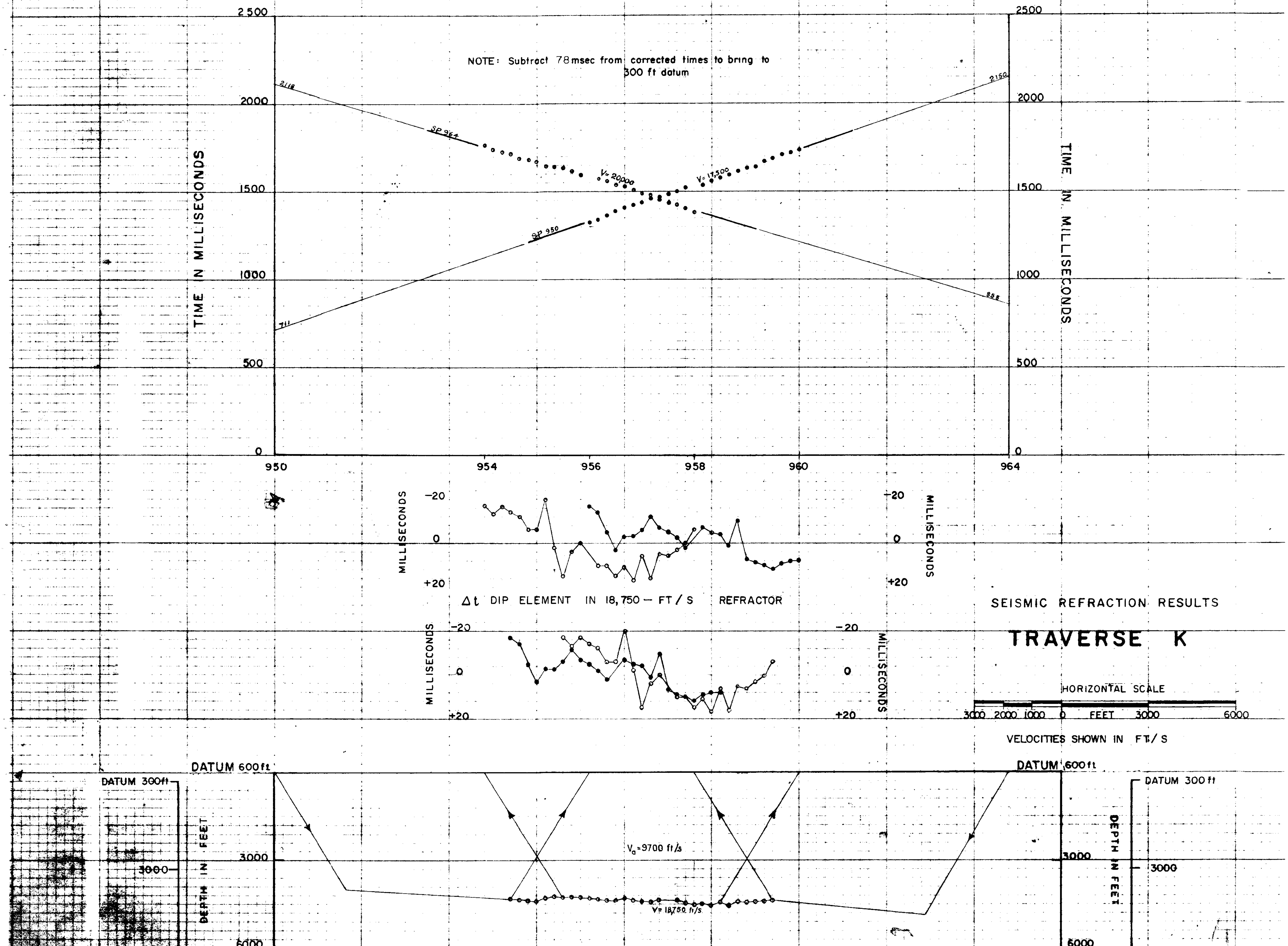
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

G54/B3-51

PLATE 14

	24	23	22	21	20	19	18	17	16	15	14	13	SP964	12	11	10	9	8	7	6	5	4	3	2	1
t_o	1715	1703	1686	1670	1656	1646	1630	1610	1606	1604	1576	1556	SP956	1532	1516	1506	1486	1467	1450	1444	1418	1403	1384	1365	1344
W_c+E_c	-38	-38	-38	-38	-38	-38	-38	-38	-38	-37	-38	-38		-40	-40	-39	-39	-38	-38	-38	-37	-37	-37	-37	-36
t_c	1753	1741	1724	1708	1694	1684	1668	1648	1644	1641	1614	1594		1572	1556	1545	1525	1505	1488	1482	1455	1440	1421	1402	1380

	24	23	22	21	20	19	18	17	16	15	14	13	SP950	12	11	10	9	8	7	6	5	4	3	2	1
t_o	1282	1300	1325	1350	1361	1377	1390	1414	1422	1440	1460	1480	SP958	1503	1521	1539	1560	1575	1598	1616	1633	1651	1664	1679	1695
W_c+E_c	-43	-44	-44	-43	-43	-42	-42	-42	-41	-41	-40	-40		-40	-40	-39	-39	-39	-39	-39	-39	-39	-39	-39	-39
t_c	1325	1344	1369	1393	1403	1419	1432	1456	1463	1481	1500	1520		1543	1561	1578	1599	1614	1637	1655	1672	1690	1703	1718	1734



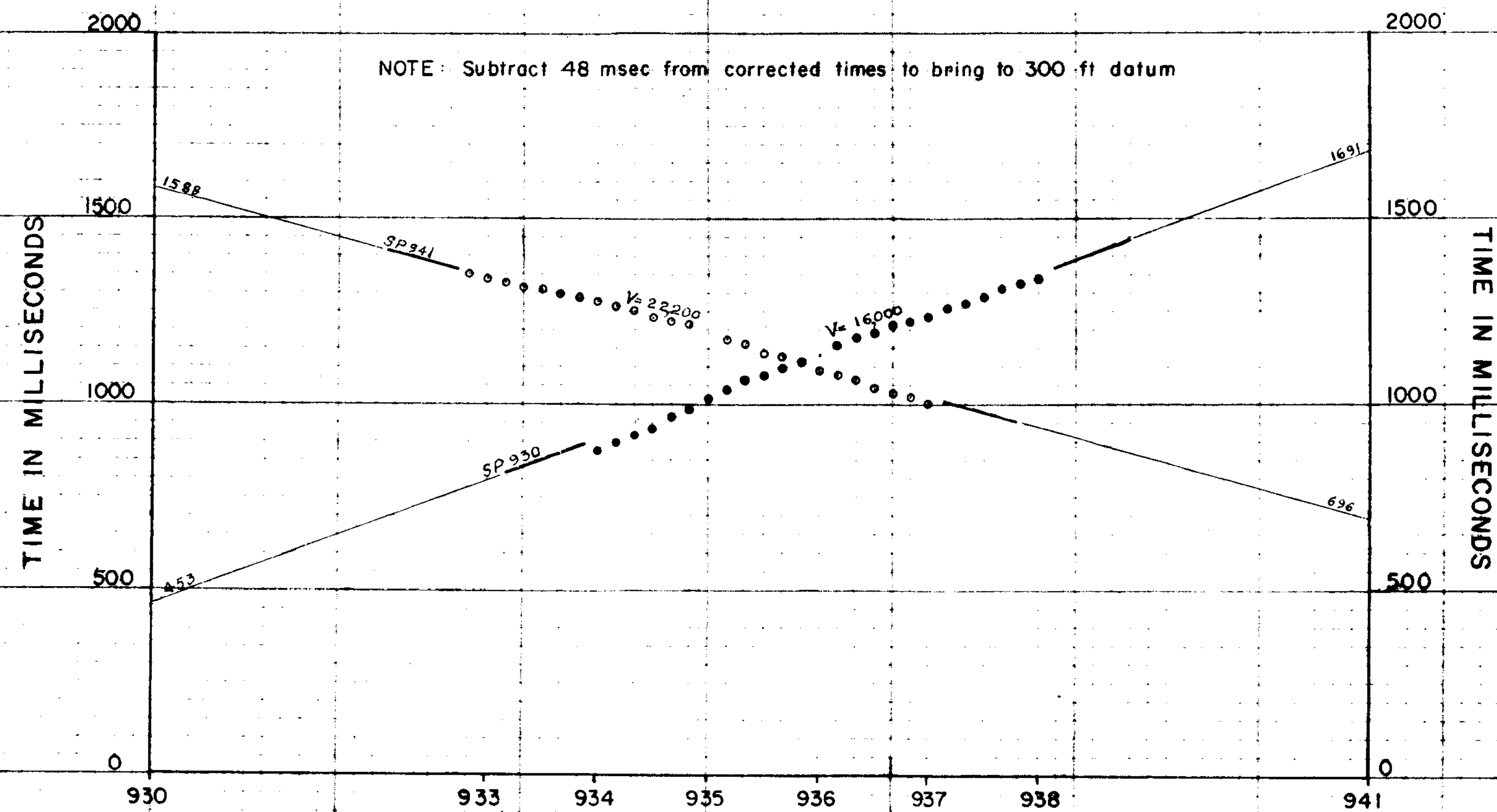
SEISMIC REFRACTION RESULTS

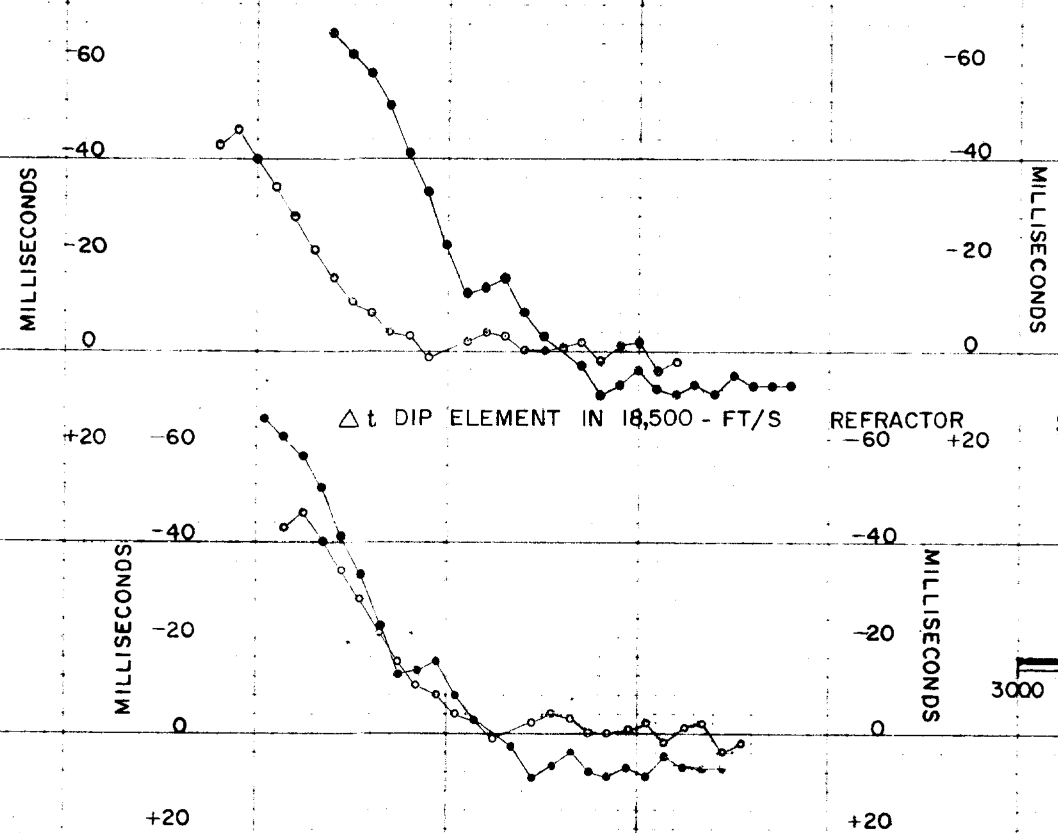
TRAVERSE K

PLATE 15

	24	23	22	21	20	19	18	17	16	15	14	13	SP 941	12	11	10	9	8	7	6	5	4	3	2	1
t_o	1322	1303	1292	1282	1272	1262	1252	1241	1227	1215	1199	1187	SP 935	1152	1134	1118	1105	1089	1072	1055	1042	1023	1006	995	977
W_c+E_c	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23		-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23
t_c	1345	1326	1315	1305	1295	1285	1275	1264	1250	1238	1222	1210		1175	1157	1141	1128	1112	1095	1078	1065	1046	1029	1018	1000

	24	23	22	21	20	19	18	17	16	15	14	13	SP 930	12	11	10	9	8	7	6	5	4	3	2	1
t_o	856	876	897	920	946	971	998	1024	1039		1077	1098	SP 936	1136	1158	1173	1186	1206	1223	1237	1256	1268	1286	1303	1319
W_c+E_c	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23		-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23	-23
t_c	879	899	920	943	969	994	1021	1047	1062		1100	1121		1159	1181	1196	1209	1229	1246	1260	1279	1291	1309	1326	1342





$\triangle$t DIP ELEMENT IN 18,500 - FT/S REFRACTOR

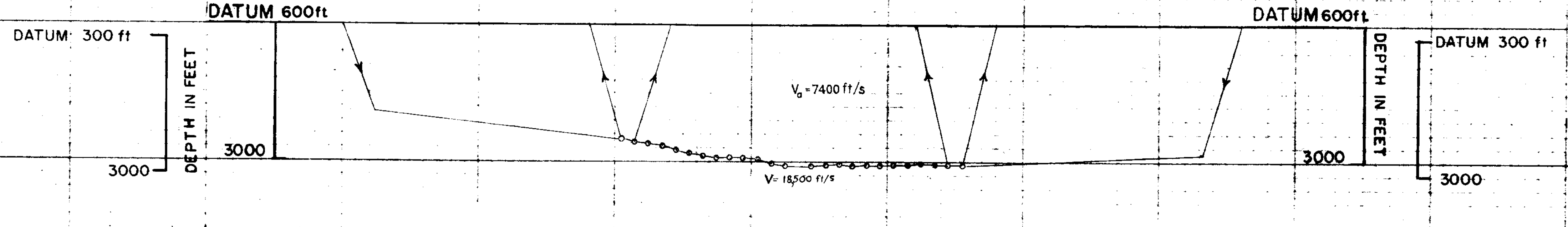
SEISMIC REFRACTION RESULTS

TRAVERSE J

HORIZONTAL SCALE

3000 2000 1000 0 FEET 3000 6000

VELOCITIES SHOWN IN FT/S



ST George - Innamincka, 1962

TO ACCOMPANY RECORD No 1966/177

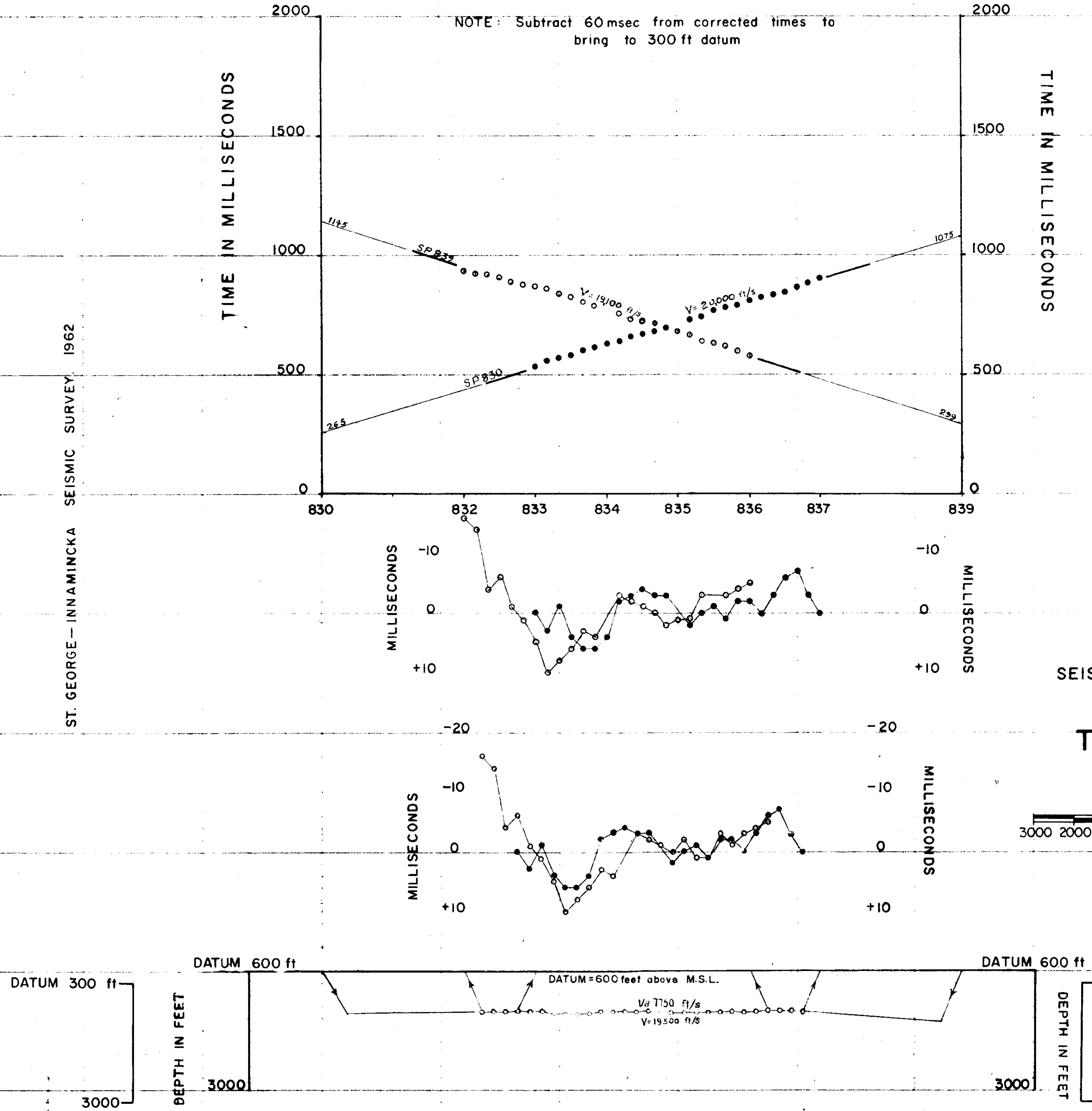
Geophysical Branch, Bureau of Mineral Resources Geology and Geophysics G54/B3-2-1

PLATE 16

	24	23	22	21	20	19	18	17	16	15	14	13	SP839	12	11	10	9	8	7	6	5	4	3	2	1
t_o	907	893	888	872	861	848	837	827	809	791	773	758	SP 834	721	706	692	678	665	648	633	614	600	583	567	549
W_c+E_c	-30	-30	-30	-29	-29	-29	-29	-29	-29	-30	-30	-30		-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30
t_c	939	923	918	901	890	877	866	856	838	821	803	788		751	736	722	708	695	678	663	644	630	613	599	579

	24	23	22	21	20	19	18	17	16	15	14	13	SP 830	12	11	10	9	8	7	6	5	4	3	2	1
t_o	504	523	534	553	571	586	599	609	623	637	653	669	SP 835	704	718	732	749	762	777	794	806	819	833	852	871
W_c+E_c	-28	-28	-28	-29	-29	-29	-29	-29	-29	-29	-29	-29		-29	-29	-29	-29	-29	-29	-29	-29	-29	-29	-29	-29
t_c	532	551	562	582	600	615	628	638	652	666	682	698		733	747	761	778	791	806	823	835	848	862	881	900

ST. GEORGE – INNAMINCKA SEISMIC SURVEY 1962



SEISMIC REFRACTION RESULTS.

TRAVERSE I

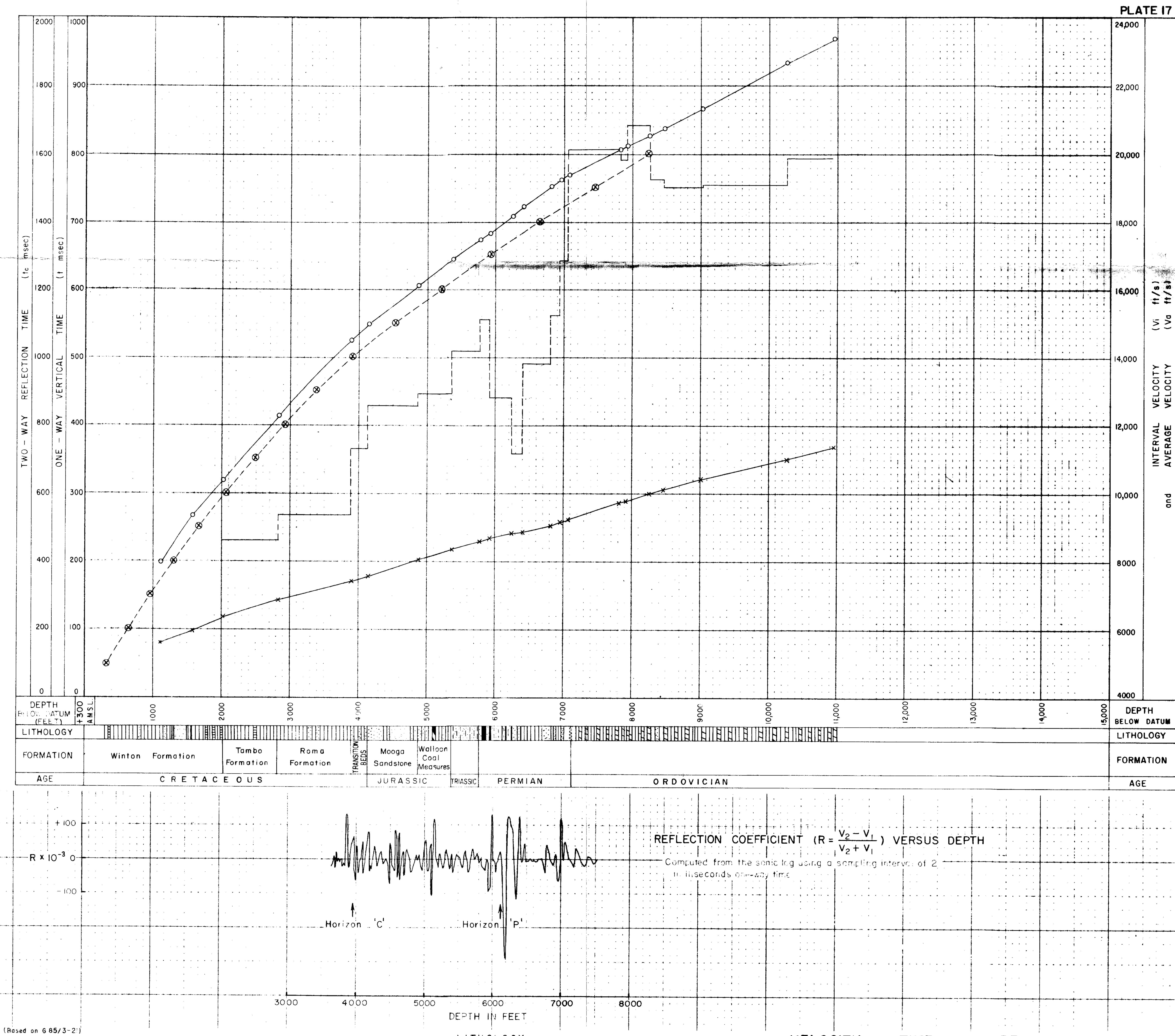
HORIZONTAL SCALE

3000 2000 1000 0 FEET. 3000 6000

TO ACCOMPANY RECORD No. 1966/177

Geophysical Branch, Bureau of Mineral Resources Geology and Geophysics. G55/B3-34-1

PLATE 17



(Based on G 85/3-2)

LITHOLOGY

Sandstone	Siltstone
Shale	Coal
Limestone	Dolomite

Time / depth curve (t-d), Orientos No. 1

Interval velocity (Vi)

Average velocity (Va)

Time / depth curve from t:Δt analysis (Curve 3 of Plate 1...)

VELOCITY AND TIME VERSUS DEPTH

EROMANGA BASIN

AREA DELHI-SANTOS ORIENTOS No 1

Basis SONIC LOG and WELL VELOCITY SURVEY

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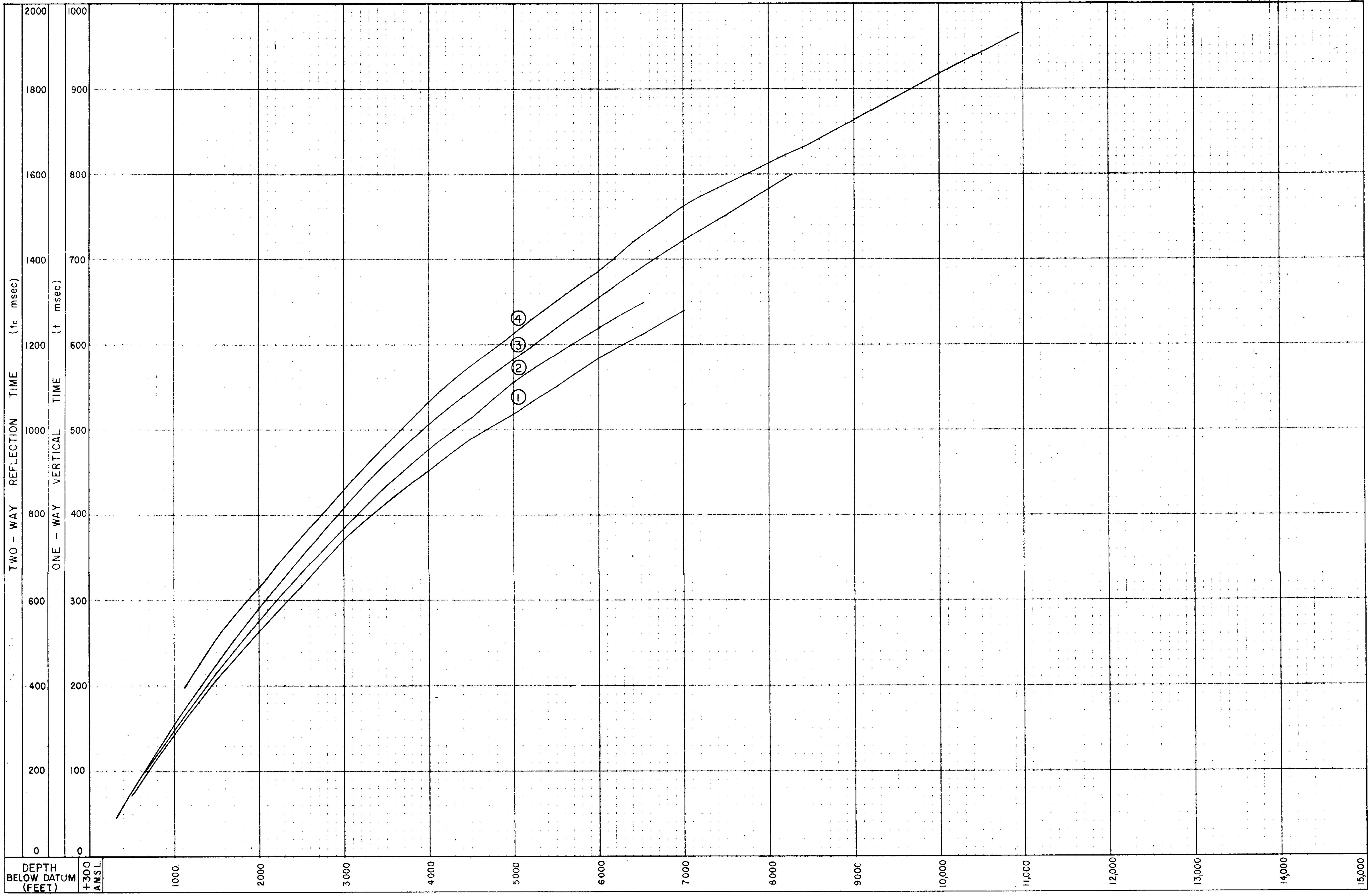
G54/B3-61-2



① Time / Depth Curve (Derived from $t : \Delta t$ analysis of reflections)
② " " " " " " "
③ " " " " " " "
④ " " (Derived from the Sonic Log and Well Velocity Survey of Orientos No I Well)

TIME VERSUS DEPTH

AREA __EROMANGA_ BASIN

Comparison of Velocity distributions used between Eulo and the Queensland / South Australia border

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 54 / B 3-63