Section

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GEOLOGICAL SURVEY

Seismic Investigations of the Wintinna Trough 1972

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South Australia

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
PETROLEUM EXPLORATION DIVISION

SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972

by

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ASSISTANT SENIOR GEOPHYSICIST
SEISMIC GEOPHYSICS SECTION

Rept.Bk.No. 73/181
G.S. No. 5186
D.M. No. 1155/71

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8th August, 1973

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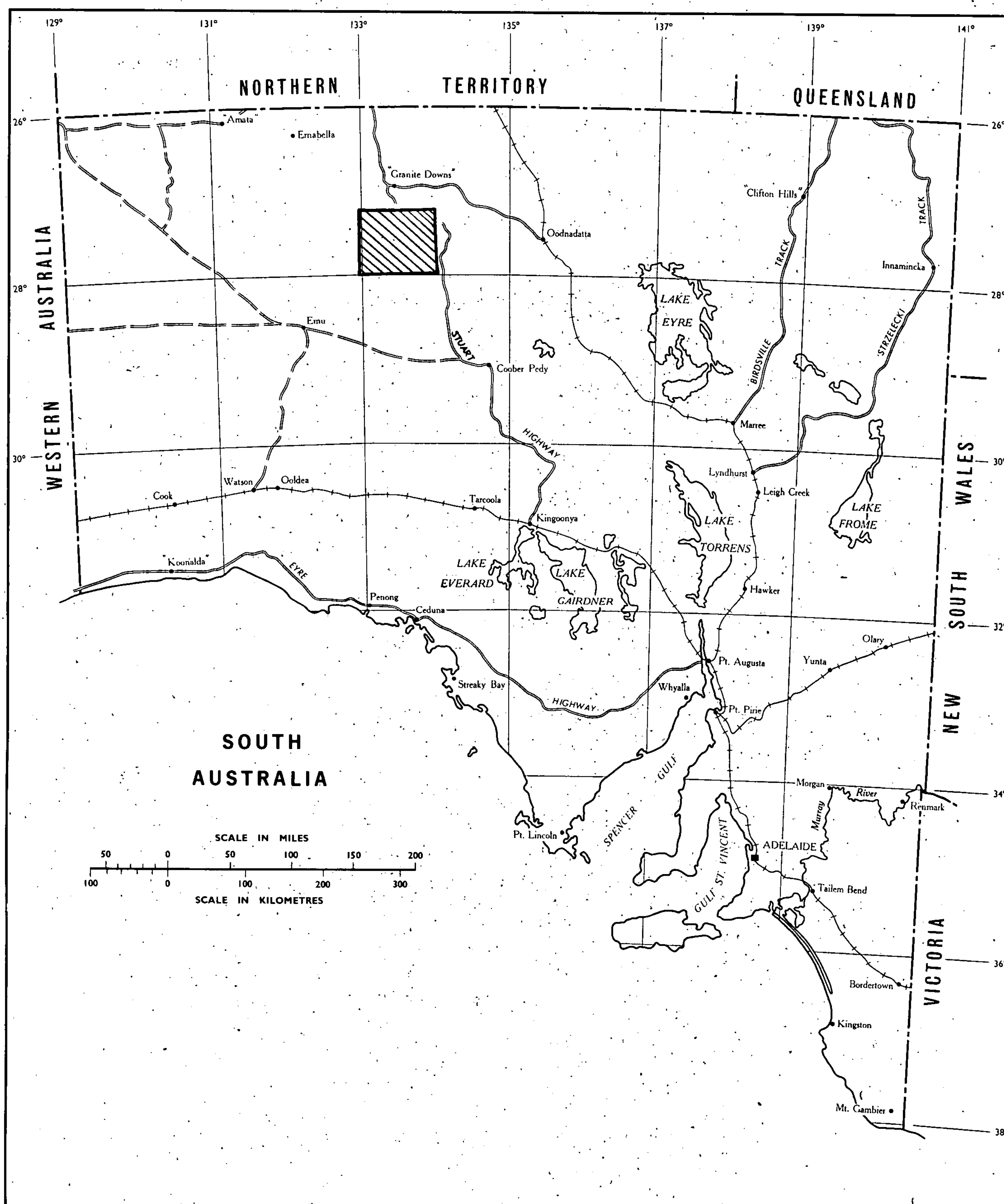

DEPARTMENT OF MINES —— SOUTH AUSTRALIA

Compiled. J. Hall		SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972 STATE LOCALITY PLAN	Date: 30 July 1973
Drn. TJE	Ckd.		Drg. No. Ba S10403

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

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SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972

ABSTRACT

Seismic refraction and reflection work in the Wallatinna area in 1972 has suggested a fault along the north-west edge of the Ammaroodinna inlier as the north-west limit of Permian sedimentation, and thus of the Arckaringa basin. This is probably not the limit of the lower Palaeozoic sediments of the Officer basin, which appear to extend south-east and perhaps east below the Arckaringa Basin.

Refraction velocities over the Wintinna gravity high suggest, but do not positively confirm, the presence of dolomites filling a basement trough. A stratigraphic well, Manya No.1, has been proposed to identify the refractor at its shallowest point. Target depth is 172 metres.

Another shallow well, Marla No.1, has been proposed to identify the high speed refractor near Wintinna Hill. Refraction velocities in this area are not definitely diagnostic of any known geological horizon, although lower Palaeozoic sandstones of the Officer basin are considered most likely. The predicted depth to the high speed refractor is 102 metres.

INTRODUCTION

Since the discovery in 1968 of the Wintinna gravity high coincident with a major magnetic basement trough, Departmental seismic operations have been carried out in the area to determine the cause of the anomalies and explain the discrepancy between the gravity and magnetic data (Milton, 1972, 1973 and 1971). Late in

1971 two lines were bulldozed over the central part of the anomaly for seismic operations in 1972, both starting at Wallatinna W.H. on the EVERARD 1:250 000 sheet. The longer line, ED, extended south-south-east for 58 kilometres over the Ammaroodinna inlier and the Wintinna gravity high. Line EE was bulldozed west-north-west for 34 kilometres into the Eastern Officer basin. A further line, EH, was established along 17½ kilometres of a Commonwealth Railways cleared line near Wintinna Hill. Plan 73-525 shows the position of the lines and their relationship to the gravity anomaly.

Continuous refraction work was carried out along the EH line, a combination of reflection and refraction along the ED line, and refraction along the eastern end of the EE line.

PREVIOUS GEOPHYSICS

Earlier investigations in the Arckaringa basin have been covered in Departmental reports on the 1969, 1970 and 1971 seismic field seasons (Milton, 1972, 1973 and 1971). Apart from a heli-copter gravity survey for Murumba Oil N.L. in 1970 (Nettleton, 1970) and an aeromagnetic survey for Exoil Pty. Ltd. in 1964-65 (Steenland, 1965), there has been no geophysical work by private companies within 100 kilometres of the present survey area.

GEOLOGY

A full account of the geology of the Arckaringa basin can be found in a paper presented by Dr. H. Wopfner at the I.U.G.S. Gondwana symposium in 1970 entitled "Permian Palaeogeography and Depositional Evironment of the Arckaringa Basin, South Australia".

Explanatory notes by G.W. Krieg covering the EVERARD 1:250 000 sheet are being prepared for publication.

In particular, the Wintinna gravity anomaly is interpreted as being caused by a dense pre-Permian dolomite filling a crystalline basement trough (Milton and Thornton, 1970). The dolomite is probably overlain by Permian sediments of the Arckaringa basin and Mesozoic sediments of the Great Artesian Basin.

EXPLORATION METHODS

Exploration methods were similar to those of 1971 (Milton, 1971) with Geoflex (I.C.I. Aust. Ltd. Trade Mark) the usual energy source. Much greater charges were used in an attempt to overcome the poor energy transmission of the loose surface sand covering much of the area. A further cause of poor energy transmission was the depth of burial of the Geoflex -- this was generally less than 45 centimetres rather than the optimum depth of 55 to 60 centimetres, with the result that a lot of energy was lost by blow-out at the surface. A larger tractor is being used for the 1973 season and optimum burial depths are being achieved.

Later work has suggested that the charge offset of 1200 feet (366 metres) used over most of the area was too short. With an offset of 2400 feet (732 metres), an improvement in signal to noise ratio of about three times could have been expected.

Some attempts were made to simulate a line source of variable detonation velocity using small Anzomex charges fired sequentially with varying time delays. It was hoped that this method could be used to improve the signal to noise ratios of the seismic signals reflected from different layers. Unfortunately, the nature of the ground surface (loose sand on the ED line, out-cropping sandstone on the EE line) made shot preparation such a slow process that the experiments were stopped before any conclusive results were obtained.

At the northern end of the ED line, attempts were made to obtain reflection data using conventional split-spread techniques with Anzomex charges at a depth of about 4½ metres. This was also unsuccessful because of dissipation of most of the explosive energy into the air and the loose sands surrounding the charge.

Gravity readings were taken at each shot point on the ED line and the Bouguer gravity values integrated with the data from the Eastern Officer Basin Helicopter Gravity Survey.

COMPUTATION METHODS

Two methods were used to compute the refraction data - those developed by Dooley (1952) and Hawkins (1961). The first assumes that the refracting layers are plane between shot point and the furthest geophone, and computes depths and dips of the refractors at the shot points. This method was normally used where the time-distance curves indicated the presence of several refractors, each of which could be considered plane. Where the sub-surface consisted basically of overburden above a high speed refractor, the computation method developed by Hawkins was used, particularly where the time-distance plots indicated a refractor whose surface could not readily be represented by a plane. This was most common in areas where the high speed refractor was less than about 300 metres deep.

The small amount of usable reflection data, from ED91 to ED122, was corrected to a datum 750 feet (229 metres) above sea level using near surface depths and velocities calculated from short weathering spreads. A major reflector was correlated from ED91 (.538 seconds two-way time) to ED122 (.810 seconds) and converted to depth using an average velocity obtained from a T^2-x^2 analysis of the reflection records. This reflection cross section was plotted with the ED refraction data on plans 73-526, 73-527 and 73-517.

INTERPRETATION OF RESULTS

EE LINE

Data on the high speed refractor were obtained only from the first 7¼ kilometres of the line from Wallatinna W.H. At this point (ED180) the refractor had deepened from about 30 metres below surface at EE196½ to about 150 metres, but was too deep to be recorded further west using the low energy Geoflex source. The velocities ranged from 4.08 km/s near Wallatinna to 4.97 km/s at EE180, the increase probably being due to a reduction in weathering of the refractor as it deepened and/or increased compaction. This refractor may correlate with lower Palaeozoic sediments of the eastern Officer basin, in particular with a refractor of velocity 4.57 km/s recorded north of the Munyarai structure at a depth of 640 metres (Moorcroft, 1969). A cross-section of the eastern end of line EE is presented as plan 73-529.

EH LINE

A high speed refractor was recorded over the whole length of this line, the shallowest depth being 90 metres at EH214, dropping away to 185 and 325 metres at EH182 and EH230 respectively. As with the EE line, velocities appear too low (4.67 to 5.40 km/s) to arise from either crystalline basement or pre-Permian dolomite such as that encountered in Mt. Willoughby No.1, 35 kilometres to the south-east. Three possible interpretations are suggested:

a. The refractor may be the lower Permian Boorthanna formation of the Arckaringa basin. This is doubtful as the velocity is appreciably higher than the 4 km/s usually recorded from this horizon.

b. A second possibility, also considered unlikely, but in this case because the velocity is too low, is that the refractor could be a pre-Cambrian sedimentary horizon.

c. The possibility considered most likely is that the refractor is a Devonian or Ordovician sandstone of the Officer basin, correlating with the high speed refractor recorded on the EE line.

A stratigraphic well, Marla No.1, has been proposed for EH222 to resolve the problem. The predicted depth to the highest speed refractor is 102 metres. An intermediate refractor of velocity 3.26 km/s was recorded at a depth of 75 metres at the northern end of the line, pinching out against the rising high speed refractor towards EH220. This velocity is indicative of the Permian Stuart Range formation in the Arckaringa basin. See plan 73-524 for a cross-section of line EH.

ED LINE

This line crosses the north-western boundary of the Arckaringa basin. Near the southern end of the line, over the peak of the Wintinna gravity high, the high speed refractor shallows to 165 metres at ED55, with a velocity of 5.33 km/s. Going north, the refractor deepens to 650 metres at ED86, with the velocity increasing to 6.40 km/s, typical of western Arckaringa basin dolomites. Weathering probably accounts for the decrease in velocity across the top of the structure. The ?dolomite refractor begins to deepen rapidly from about ED60 and is not recorded north of ED86. A shallow well (Manya No.1) will be drilled near ED55 to identify the high speed refractor.

A reflection section recorded from ED91 to ED120 is about 150 metres deeper than the extrapolated high speed refractor, but almost certainly correlates with it, the discrepancy being due to picking the second or third cycle of the reflection, or to using too great a velocity for converting reflection times to depths. No data were recorded from ED120 to ED140, but from 140 the high speed refractor is again recorded, shallowing from about 650 metres below surface to 150 metres at ED154, and then deepening again until too deep to be recorded at about ED161. The velocity of this refractor, 5.2 km/s, is rather low but it is tentatively correlated with crystalline basement. Intermediate refractors of velocity 3 to 4 km/s are correlated with Permian sediments, the wide range in velocity being due to variations in the presence and thickness of the Mt. Toondina beds (velocity 2.7 km/s), Stuart Range formation (3.3km/s) and Boorthanna formation (about 4km/s). The 4.6 km/s refractor may represent pre-Permian sediments. For clarity, these thin refracting layers have been shown as a single horizon on plan 73-517. A fault, down-thrown to the south-south-east, is postulated near ED166, mainly on gravity evidence (Nettleton, 1970), but also suggested by differences in dip and depth of the high speed refractor at ED161 and ED176. The section of uplifted high speed refractor, correlated with crystalline basement, between ED166 and ED191½ corresponds to the Ammaroodinna inlier (Krieg, 1972). To the north, the boundary of the inlier is marked by a further fault, down-thrown to the north-north-west, at ED191½. This fault is recorded on the refraction profiles and also has surface expression 15 kilometres south-west of ED191½. Overlying the high speed refractor are two refractors, one of velocity 2.7 km/s, interpreted as the Permian Mt. Toondina beds, and the other with velocity ranging from 3.6 to 4.6 km/s which could be lower Permian sediments of the Arckaringa basin or perhaps Officer basin sediments.

North of the fault, the high speed refractor is not recorded, the deepest data coming from a 4.6 km/s refractor about 30 metres below surface. This velocity seems too high to suggest correlation with Permian sedimentation (except perhaps the Boorthanna formation) and it probably arises from Officer basin sediments.

CONCLUSIONS

As a result of the 1972 seismic operations the northwestern boundary of the Arckaringa basin is interpreted as being the north-western edge of the Ammaroodinna inlier at ED191½. The boundary of the Officer basin probably lies further to the south-east of the Ammaroodinna Hill area.

Positive identification of the cause of the Wintinna gravity anomaly is still lacking, although the seismic results support the interpretation of a dense dolomite filling a crystalline basement trough. The proposed well, Manya No.1, should finally resolve the problem.

Another shallow stratigraphic well, Marla No.1, has been proposed to determine the nature of the high speed refractor in the Wintinna Hill Area.

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8th August, 1973

J.McGH:TG

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REFERENCES

Dooley, J.C., 1952 Calculation of Depth and Dip of Several Layers by Refraction Seismic Methods. In: Bull. Bur. Min. Resour. Geophys. Aust., 19: Appendix.

Hawkins, L.V., 1961 The Reciprocal Method of Routine Shallow Seismic Refraction Investigations. Geophysics, 26: 806-819.

Krieg, G.W., 1972 The Ammaroodinna Inlier. Quart. geol. Notes, Geol. Surv. S. Aust., 41: 3-7.

Milton, B.E., 1973 Geophysical Exploration of the Arckaringa Basin 1970. Mineral Resour. Rev. S.Aust., 134: 62-76.

--- 1971 Experiments in the Use of Directed Line Sources in Refraction Profiling, Arckaringa Basin, 1971. Bull. Aust. Soc. Explor. Geophys., 2, No.4: 1-10.

--- 1972 Seismic Survey, Western and Central Arckaringa Basin. Mineral Resour. Rev. S.Aust., 132: 65-74.

--- and Thornton, R.C.N., 1970 Discovery of a Dense Lower to Middle Palaeozoic Dolomite in the North-west Arckaringa Basin. Quart. geol. Notes., Geol. Surv. S. Aust., 36: 10-15.

Moorcroft, E., 1969 Seismic Reflection, Refraction and Gravity Survey, Eastern Officer Basin, 1966. Min. Rev. Adelaide, 126:58-70.

Nettleton, L.L., 1970 Eastern Officer Basin Helicopter Gravity Survey. S.Aust. Dept. of Mines open file Env. 1196 -- unpublished.

Steenland, N.C., 1965 Eastern Officer Basin Aeromagnetic Survey for Exoil Pty. Ltd. S.Aust. Dept. Mines open file Env. 527 -- unpublished.

Wopfner, H., 1970 Permian Palaeogeography and Depositional Environment of the Arckaringa Basin, South Australia. In: I.U.G.S. Second Gondwana Symposium, South Africa, 1970, pp. 273-291.

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Section

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S.A. DEPARTMENT OF MINES

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Seismic Investigations of the Wintinna Trough 1972

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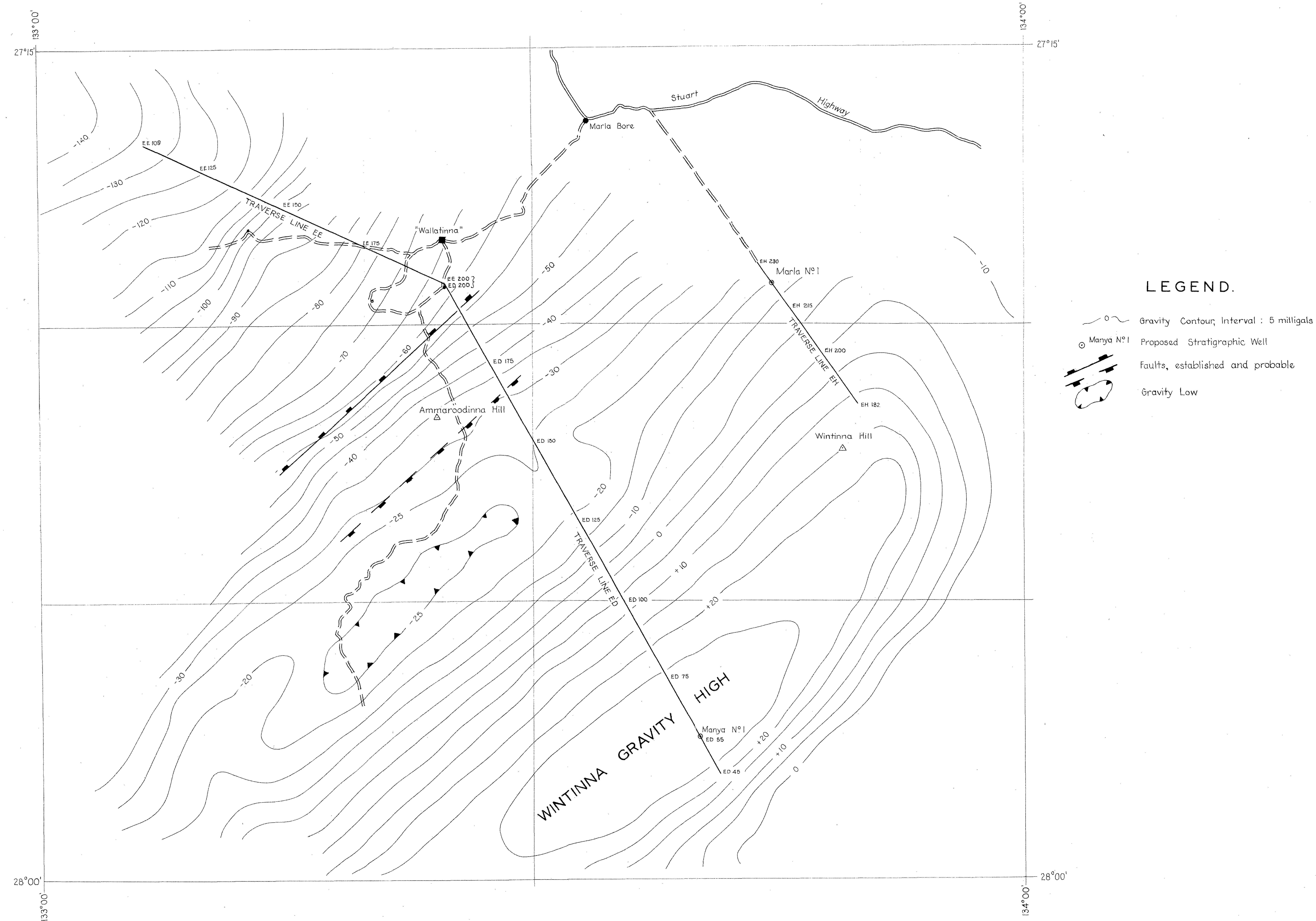
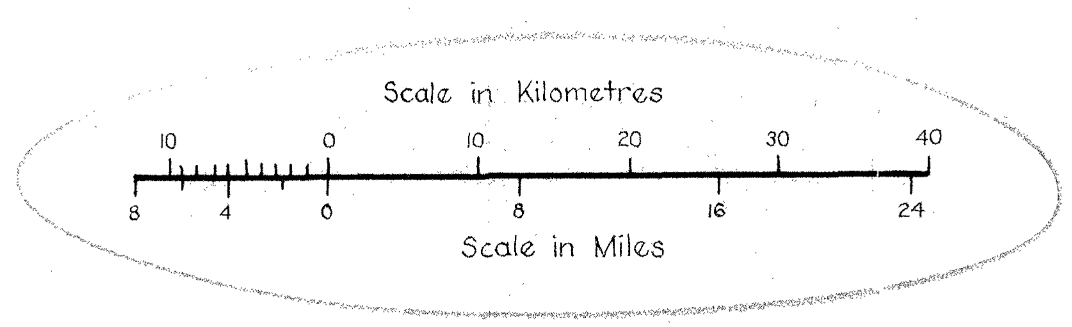
South Australia —





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SEISMIC INVESTIGATIONS OF THE
WINTINNA TROUGH, 1972

SEISMIC TRAVERSES AND BOUGUER ANOMALY CONTOURS

SEISMIC SECTION	J. Hall GEOLOGIST	Drn. JH	SCALE: As Shown
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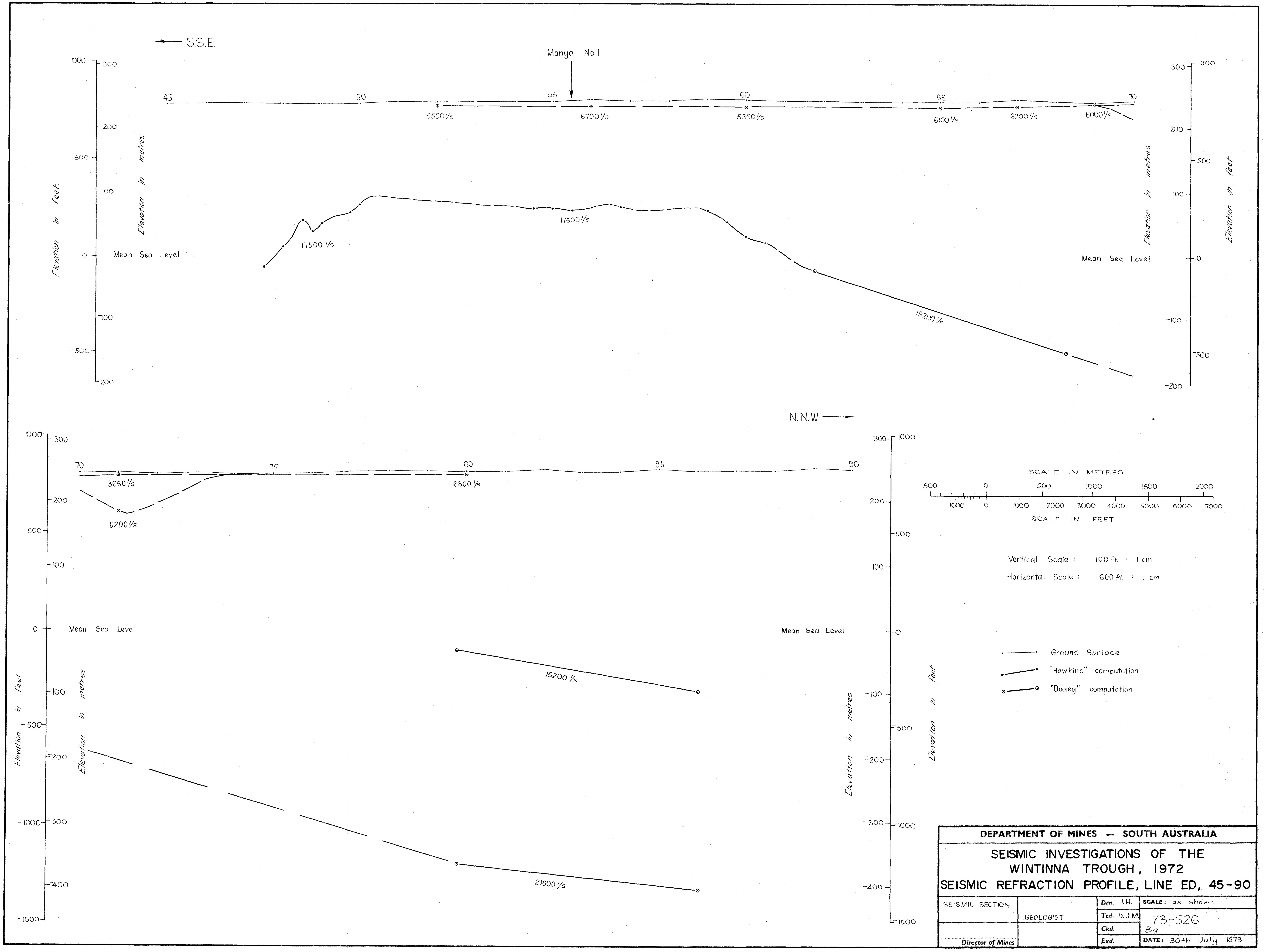
		Ckd.	Ba
Director of Mines		Exd.	DATE: 27th July 1973



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SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972
SEISMIC REFRACTION PROFILE, LINE ED, 45-90

SEISMIC SECTION	GEOLOGIST	Drn. J.H.	SCALE: as shown
		Tcd. D.J.M.	73-526
		Ckd.	Ba
Director of Mines		Exd.	DATE: 30th. July 1973

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SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972
SEISMIC REFLECTION PROFILE, LINE ED, 90-140

SEISMIC SECTION		Drn. J.H.	SCALE: as shown
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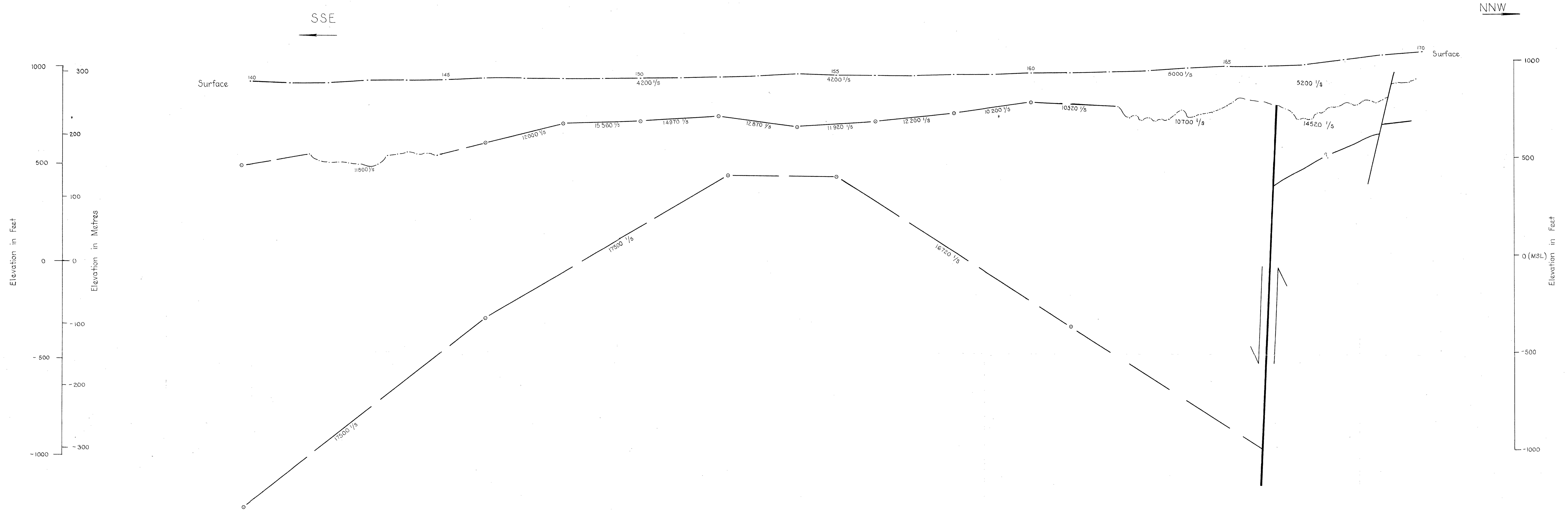
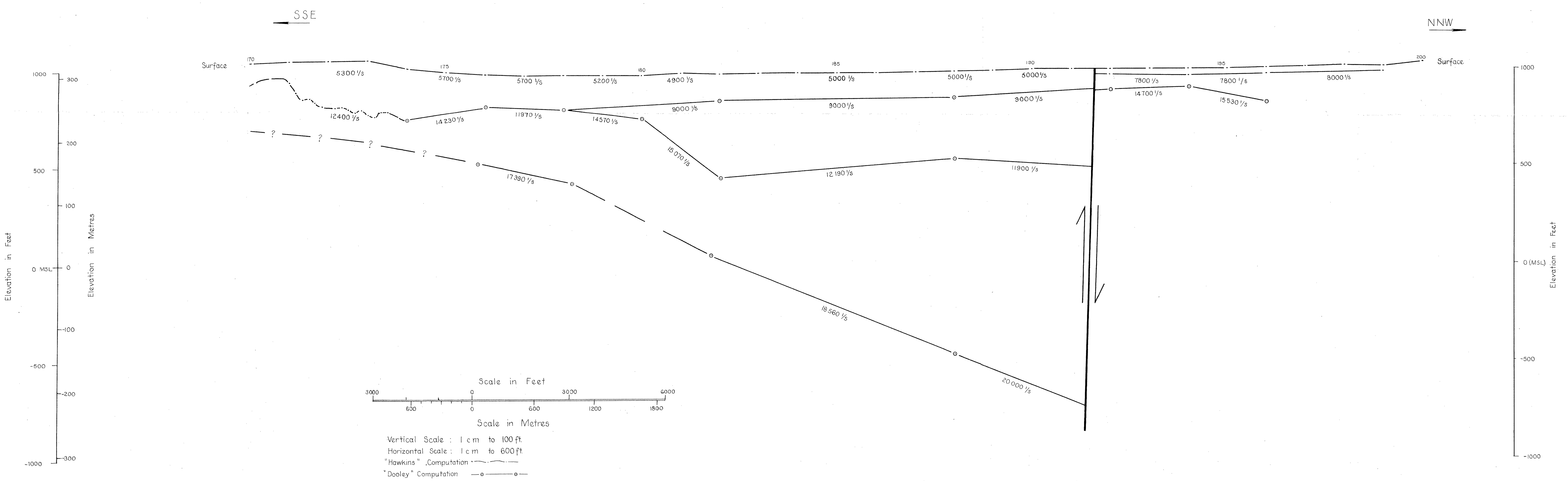
		Ckd.	Ba
Director of Mines		Exd.	DATE: 27th. July 1973





SEISMIC REFRACTION PROFILE – ED LINE

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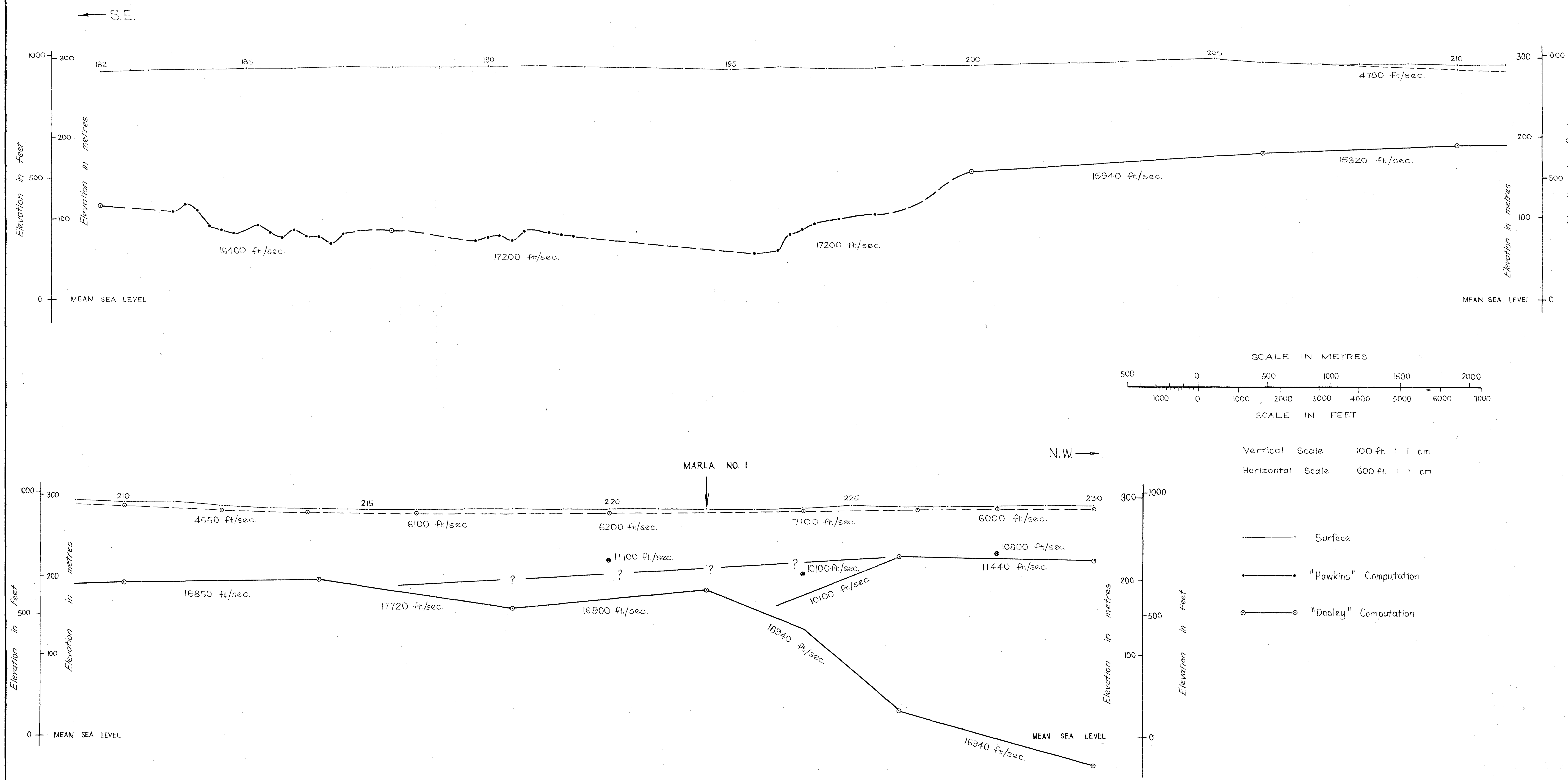
SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972 REFRACTION PROFILE, LINE ED, 140 – 200			
SEISMIC SECTION	J. HALL GEOLOGIST	Drn. J.H.	SCALE: AS SHOWN
		Tcd. TJE	73 – 517
		Ckd.	AB
Director of Mines		Exd.	DATE: 28 JULY 1973



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SEISMIC INVESTIGATIONS OF THE WINTINNA TROUGH, 1972 SEISMIC REFRACTION PROFILE, LINE EH, 182-230			
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		Ckd.	Ba
Director of Mines		Exd.	DATE: 27th. July 1973