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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1951/9

REPORT ON

SEISMIC REFRACTION TRAVERSE AT COMET, QUEENSLAND

(1951)

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ILLUSTRATIONS

1. INTRODUCTION

Towards the end of 1950, the deep bore which the Shell (Queensland) Development Company was drilling to test for oil on the Morella structure, 35 miles south of Rolleston (see inset map on accompanying plate), entered andesite at approximately 4000 ft. After boring about 200 ft into the andesite, the Company decided to abandon the hole. A new site for a test bore was selected on the Comet anticlinal structure, 60 miles north of Rolleston. Before proceeding with this new test, evidence was needed to ensure that neither a shallow basement nor volcanic rocks existed under this structure. The Bureau was therefore asked to shoot a refraction traverse over the anticline, in order to determine if basement rocks were likely to be present at a shallow depth. As a result the Bureau sent a seismic party to the area during January 1951.

The party consisted of three geophysicists - Mr E.R. Smith, party leader, Mr J.H. Quilty, and Mr J. Van der Linden, also a shooter, Mr E. Correll, and a student, Mr R. Pratten. Mr K.R. Vale, a senior geophysicist of the Bureau, supervised the commencement of the work. The Company attached a geophysicist, Mr Van der Keulen, to the party as its observer. The work commenced on February 6th and was completed on March 5th.

Fairly definite evidence was obtained of basement velocities occurring at a depth of less than 3000 ft, and after discussions between the Company's Chief Geologist, Dr Schurmann, Mr Van der Keulen, and officers of the Bureau, a decision was made not to proceed with the drilling of the Comet structure. The results have now been investigated in detail and are presented in this report.

2. GEOLOGY OF AREA

The problem was discussed at length with Dr W.F. Schneeberger, Supervising Geologist of the Bureau and formerly employed by Shell (Queensland) Development Company, who has a detailed knowledge of the geology of the area. The following description is based on this discussion and on notes prepared by Dr Schneeberger and also on a report by Dr Frank Reeves (1947).

The area to be described is generally referred to as the Springsure-Carnarvon area of Central Queensland. A locality map appears on the accompanying plate. The Permian system here is between 5000 and 7000 ft thick and overlies both pre-Palaeozoic and Palaeozoic formations. Permian rocks crop out about 45 miles south of Rolleston and consist chiefly of sandy shale and sandstone, including a coal-bearing series. Marine stages occur in the lower part of the section. The Permian has been subdivided into the Upper, Middle, and Lower Bowen series and these again into several stages. The Upper Bowen series probably corresponds to the Bandanna stage marked on the Company's geological map of the Comet anticline, and its thickness ranges from 1300 ft to 3200 ft. The Middle Bowen series corresponds to the Catherine stage and is approximately 1200 ft thick. The Lower Bowen is divided into three stages: The Ingelara stage (600 ft), the Serocold sandstone (1700 ft), and the Dilly stage (300 ft exposed).

To the east of the Springsure-Carnarvon area, near Cracow, a volcanic series is found interbedded with fossiliferous Permian limestones and is known as the "Lower Bowen Volcanics". However, these were not found anywhere in the Springsure-Carnarvon area and, according to Dr Schneeberger, are likely to be confined to regions east of this area. He considers that the andesite, entered in the Morella bore and also in the Arcadia bore 35 miles to the south-east, probably belongs to the Middle Devonian volcanic series which was found to the west of the Springsure-Carnarvon area (The Dunstable series in the Company's nomenclature).

To the west and north-west of the Springsure-Carnarvon area, great thicknesses of Upper Devonian and Carboniferous sediments occur (Telemon and Ducabrook series in the Company's nomenclature), but there thin out towards the east and may not be present at all in this area.

To the north-west of the area, there is a major basement uplift, near Anakie, 30 miles west of Emerald, where granite crops out over a large region.

The Comet anticlinal structure is situated about 100 miles north of the Springsure-Carnarvon area. It is 30 miles east of Emerald and 9 miles south-east of Comet. The Catherine stage of the Middle Bowen series is exposed on the flanks of the structure, and the Ingelara stage of the Lower Bowen series is probably exposed at the apex. If the thicknesses of the Permian stages given by Reeves for the Springsure-Carnarvon area apply at Comet, then the depth to the base of the Permian system here would be approximately 3000 ft.

The possible basement types at Comet are:

(1) Carboniferous and Upper or Devonian sediments (Ducabrook and Telemon series.

(2) Middle Devonian volcanics, similar to the andesite entered in the Morella bore.

(3) Granite as in the "Anakie Uplift".

3. DETAILS OF REFRACTION WORK

The traverse proposed by the Company was a straight line running nearly east-west along the main highway from Rockhampton to Emerald. It was at right angles to the axis of the anticline and crossed it 7 miles north of its apex. The Company's geologist, the late Dr Arthur Wade, estimated the dips on the flanks of the anticline to be between 5° and 10° and because dips as large as these affect the accuracy of calculations, the traverse was extended about 15,000 ft west and 20,000 ft east of the axis in order to get out on the flanks of the structure, where the dips were likely to be less. A bend of 5° 28' was made at the eastern end to avoid having to cross the railway line. The necessary surveying was carried out by an officer of the Queensland Mines Department. There were five shot-points, situated at the positions shown on the accompanying plan. Number 3 shot-point was at the centre of the traverse and was approximately 2000 ft east of the axis. The shot-holes were drilled by the Company, using a Southern Cross percussion rig. Number 1,3,4,5 were drilled to 80 ft, No. 2 only to 54 ft. The interval between the geophone stations was 200 ft.

Times to all geophone points were not measured, but recording was done at sufficient points to allow the construction of complete time-distance curves from all shot-points over the entire length of traverse.

Up-hole times were obtained at all shot-holes, and short weathering spreads, with geophones at 10-ft intervals, were shot at Shot-points 2,3, and 5. From an analysis of these, a general idea of the depth of the weathered layer and the correction to be made at each geophone was obtained. Corrections were also made for the depth of the shot and the elevations of the shot-points and geophone stations, using a datum level of 600 ft above sea level.

The times obtained after these corrections had been made were plotted against geophone distances and yielded the time-distance curves shown in the accompanying plate.

In addition to the tests on the Comet structure, some tests were carried out near Anakie on outcropping Permian and Devonian rocks and on granite.

4. RESULTS

(A) Comet Anticline

The time-distance curves indicate that, apart from the weathered layer which has a velocity of 2700 ft/sec, three different layers are present with average velocities of 11,400 ft/sec, 15,200 ft/sec and 18,000 ft/sec respectively. The intersecting curves from Shot-points 4 and 3 have been used to calculate the depths of the various layers under these two shot-points, using the intercept times. The intersecting curves from Shot-points 1 and 2 and also from 3 and 5 have been used similarly in calculating depths under these points. The depths obtained were plotted beneath the time-distance curves and profiles of the layers drawn.

The depths calculated for the lowest layer at Shot-point 3 are not accurate. The record obtained for a shot at this shot-point with geophones placed near Shot-point 4, did not have a shot-instant time-break on it. The velocity could still be measured and was 16,700 ft/sec. In drawing the time-distance curve to the west of Shot-point 3, it was assumed that the second velocity (15,000 ft/sec) extends out to where the highest velocity (16,700 ft/sec) was recorded. This makes the intercept time for the highest velocity as large as the data permit and thus the depth calculated is a maximum. Poor records were obtained at the extremity of the time-distance curve to the east of Shot-point 3, and although velocities were obtained from them, the vertical position for the curve was not certain. As in the previous example, a position which gave a maximum depth was chosen.

The profile of the upper interface is rather flat, except for a rise from R.L. -500 ft at Shot-point 4 to R.L. -200 ft at Shot-point 1. From this point to the other end of the traverse, there is a gradual fall to R.L. -350 ft. The lower interface shows much greater changes in depth and a good agreement with the geological structure. In the centre of the traverse near the axis of the structure the profile is relatively flat, being R.L. -1600 ft at Shot-point 1, somewhat less than R.L. -1800 ft at Shot-point 3, and R.L. -1900 ft at Shot-point 2; the drop to R.L. -2400 ft on the western side at Shot-point 4 sharpens to R.L. -3000 ft on the eastern side at Shot-point 5.

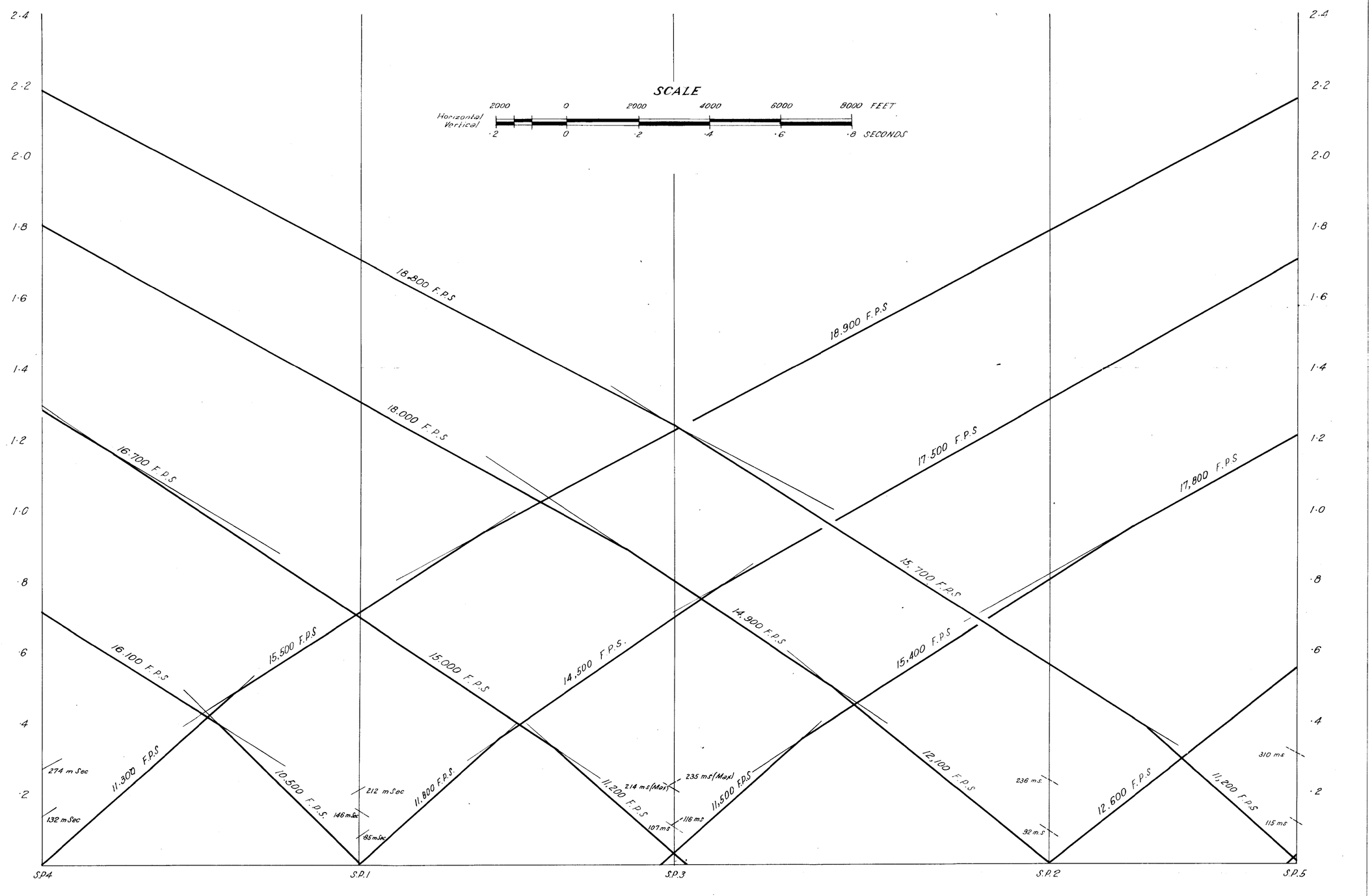
(B) Anakie

The nature of the layer of rock with a velocity of 15,200 ft/sec is not known. The velocity is at the upper extremity of the velocity range for dense sediments and at the bottom of the range for igneous rocks. Density tests made on cores of the Lower Permian sediments from the Arcadia bore gave densities as high as 2.7 g/cm^3, so it would not be surprising to find that Permian sediments in this area have very high seismic velocities.

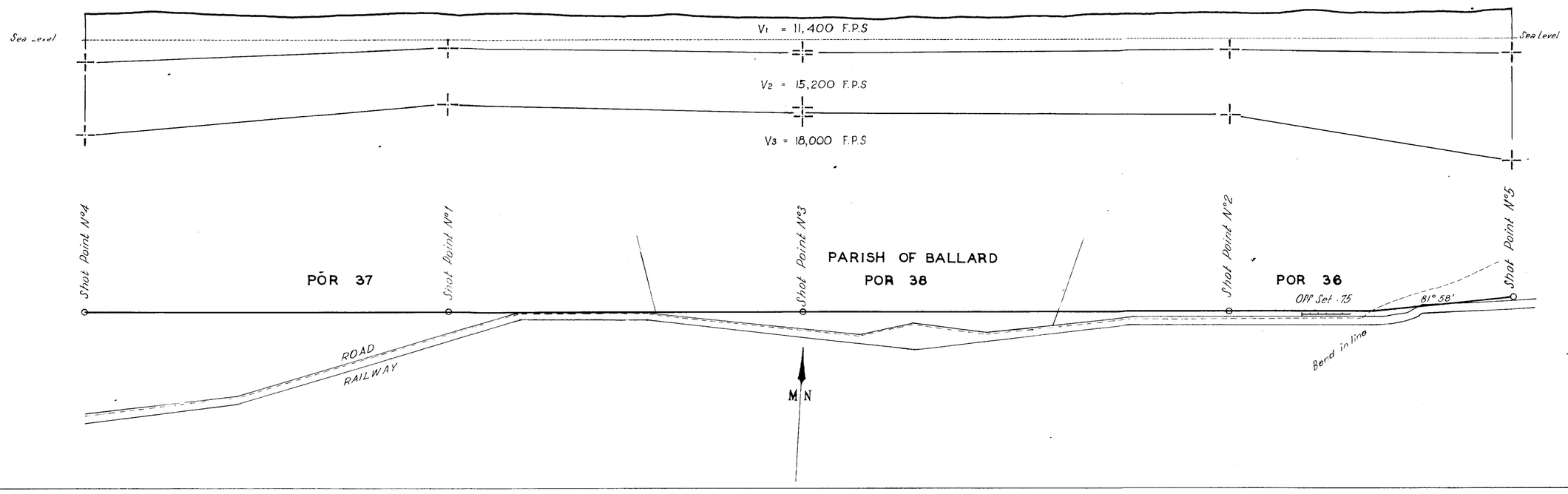
40 miles west of Emerald and 10 miles west of Anakie, there are outcrops of Permian and Devonian sediments and granite. A one-day trip was made there to measure velocities on these outcrops in order to see if any evidence could be obtained which would help to determine the nature of the 15,200 ft/sec layer. The velocities obtained were 15,200 ft/sec on the granite, 10,900 ft/sec on the Devonian, and two separate values of 6200 ft/sec and 10,000 ft/sec on the Permian.

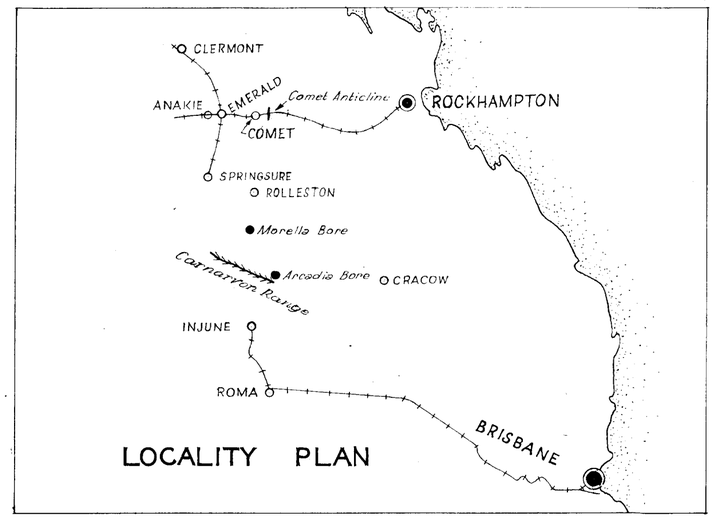
5. CONCLUSIONS

The highest velocity recorded, 18,000 ft/sec, is almost certainly too high to be assigned to sediments, except perhaps massive limestone. There is no evidence that such a limestone exists and it is concluded therefore that igneous rock is present at a depth of approximately 2200 ft, near the axis of the anticline. The identity of the second layer of velocity 15,200 ft/sec must remain unknown. Although no high velocities were proved in the sediments at Anakie, the possibility still remains that under a large thickness of Permian sediments, as in the Springsure-Carnarvon area, the lower stages might have high velocities. Actually if it is allowed that this layer is sedimentary, then the thickness of the sediments on the Comet anticline, 2200 ft, would be comparable with that expected from the thicknesses of the Permian stages as given by Reeves.



PROFILE OF VELOCITY LAYERS





GEOPHYSICAL SURVEY AT COMET. QLD.

SEISMIC REFRACTION
TIME DISTANCE CURVES & PROFILES

HORIZONTAL SCALE
2000 0 2000 4000 6000 8000 FEET

E. R. Smith.
Geophysicist

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Geophysical Section, Bureau of Mineral Resources Geology & Geophysics

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