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SEISMIC SURVEY REPORT

on the

MEREENIE ANTICLINE AREA

Northern Territory

AUSTRALIA

Submitted to

EXOIL (N. T.) PROPRIETARY, LTD.

by

NAMCO INTERNATIONAL, INC.

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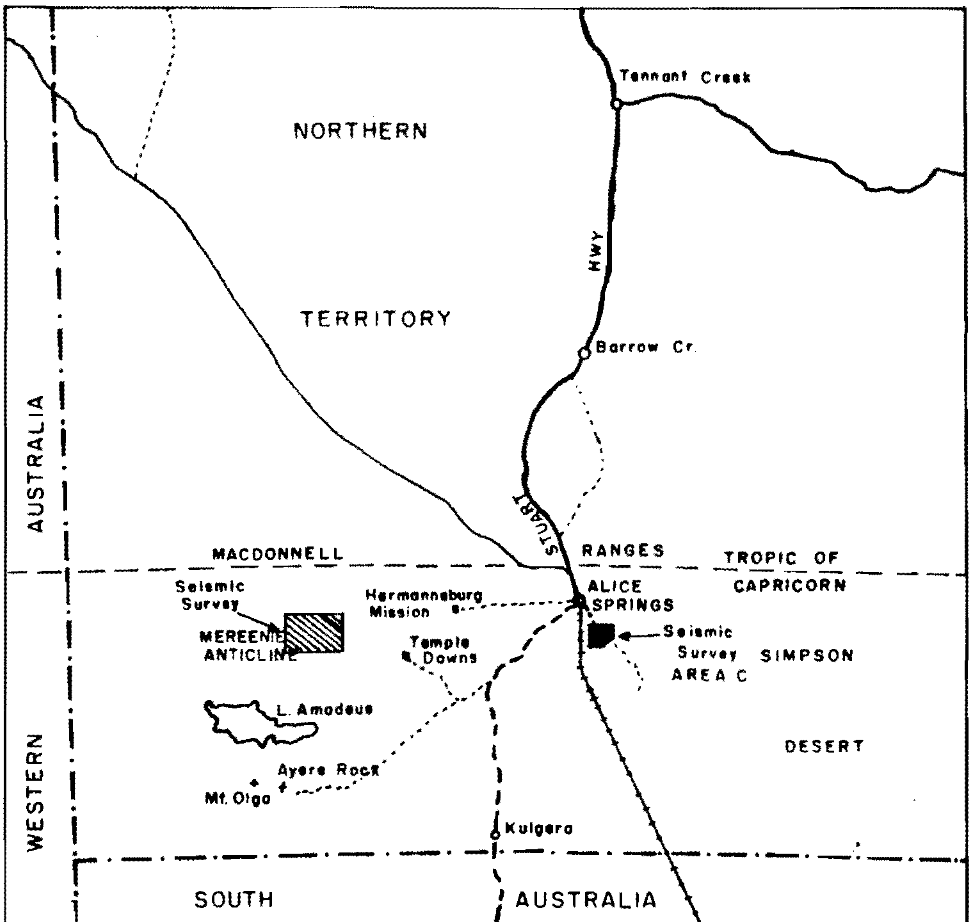


LOCATION MAP

1. INTRODUCTION

The Mereenie Anticline seismic survey was conducted for Exoil (N. T.) Proprietary, Limited, with registered office at Brisbane, Queensland, within Permit No. 43 and Permit No. 56 in the Northern Territory, Australia. Refer to Location Map, frontispiece.

The geophysical contractor was Namco International, Incorporated, of Dallas, Texas, with Australian headquarters in Adelaide, South Australia. Details of Equipment and Personnel employed are presented in Appendix I and Appendix II. Commencement and completion dates and other statistics for the survey are presented in Appendix III.

The Mereenie Anticline is located in the southwestern portion of the Northern Territory. Surface topography is characterized by gently rolling sand dunes, rocky outcrops, and indefinite drainage patterns. Due to the arid nature of the region the flora is restricted to hardy mulga, a few pines, gum trees, and low vegetation consisting of various shrubs, bushes, and spinifex.

The climate of the area is normally fine and clear. The daily temperature range was between a maximum of 70 to 100 degrees and a minimum of 50 to 70 degrees. Only sparse rainfall fell in the area during the time of the survey, and the surface water soon soaked into the dry subsurface.

2. GEOLOGY

The Mereenie Anticline is located on the western part of Oil Permit No. 43 and the southeastern part of Oil Permit No. 56, in the Amadeus Basin, approximately 140 miles southwest of Alice Springs, N. T.

The southeastern portion of the Anticline is readily observed by the study of outcrops on the surface but the northwesterly extension of the structure is concealed by Recent deposits, including sand dunes, which prevent complete investigation of the feature by surface geology.

Sedimentary deposits in the region are thought to consist of Proterozoic, Cambrian, Ordovician, and undifferentiated Post-Ordovician beds overlain by a thin veneer of Recent deposits.

Potential source and potential reservoir beds are present in the Ordovician in the ranges located to the north and south of the Mereenie structure. A relatively shallow test suitably located on the Mereenie Anticline would probably penetrate the most prospective Ordovician zones.

Structurally, the feature is one of the anticlinal culminations along an uplift extending southeasterly for at least 70 miles. Assymetrical synclines and low-angle overthrusts indicate that the compression came from the north, starting after Ordovician time. The forces have given an east-west trend to the structures in the vicinity of the Mereenie Anticline, although an additional fault system, almost at right angles, sometimes causes an interruption of this pattern.

3. FIELD PROCEDURE

The results of the survey were obtained using the continuous reflection profile method of investigation. Shot points were spaced at 1320-foot intervals along the line of the traverses with 110-foot linear offset and seismometer group intervals. Refer to Figure 1, Typical Spread.

Recording was accomplished using National Geophysical Company, Inc., 26AA amplifiers and a National 4F oscillograph. A Techno tape recorder and field playback unit was used in conjunction with the National instruments for magnetic tape recording. A monitor seismogram and a magnetic tape were recorded simultaneously on each shot, using a wide-band filter setting, with each seismometer group independently activating its respective galvonometer and magnetic tape trace. The magnetic tapes were later played back through the field playback unit with a CH-CH filter setting, selected as optimum for the area, and with 50% mixing of adjacent traces. This filter combination features a low cutoff of 24 cycles per second and a high cutoff of 58 cycles per second at 50% response, with a peak frequency of 37 cycles per second.

Twelve seismometers per trace distributed in the line of profile were employed in the reflection program. An extra cable and a set of seismometers were used to keep a spread laid ahead of the recorders.

Shot holes were obtained by two combination air-water drills. The drilling conditions varied from good to poor, with the major limitations to production being associated with layers of hard sandstone, caving sand, and poor trail conditions. It was possible to drill all of the shot holes using a water injection method to control caving near-surface sand. The method proved very effective and was considered superior to the more tedious and time consuming mud drilling procedure.

All instrument spreads were chained. Horizontal and vertical control were obtained by alidade and plane table. The datum for the elevation and traverse control was a Magellan Petroleum Corporation datum station located 24° 2' South and 131° 37' East, approximately. All traverses were checked by loop closures, and it is felt that the control has been established within the normal limits of accuracy.

The normal working day was ten hours, including driving time to and from the field. Twenty-two days, including holidays, constituted a normal month.

4. QUALITY OF DATA

Record quality in the Mereenie Anticline Area varied considerably. The better records were obtained on the northeast flank of the structure and on the extreme southwest flank of the structure. Poor records were obtained on lines along the crest of the feature and on portions of the lines immediately southwest of the crest of the anticline.

It is felt that the poor records were probably associated with near-surface conditions in exceptional cases only, and that the main reason for poor records was a very disturbed subsurface. Strong reflection move-out patterns, which would indicate steeply dipping formations, were recorded on the southwest side of the crest. Several shot points were re-shot using short spreads, and, although the new procedure minimized the amount of dip per trace, only slight improvement was noticed in the clarity of the reflections. Subsequently, the apparent reflections on the short spreads were timed and plotted on the resolved time cross sections and indeterminate solutions were observed. This would imply that diffraction patterns were being observed and that multiple image points were being set up. The diffraction patterns manifest themselves as intense signals and probably obliterate any true reflected wave. The same situation is apparent on three of the four cross lines and at approximately the same level on the structure. A fault interpretation would seem to be appropriate and would satisfy the geological as well as the geophysical evidence.

The poor recordings along the crest of the feature might be explained in a similar manner. The structure has been sharply folded and diffractions may be set up at points where rapid changes in the dip occur. In addition, there is some indication of a minor thrust fault along the northwest flank of the trend which might suggest an imbricate structure and signify a complex culmination.

Deep holes, twelve-hole patterns, short spreads, variable seismometer spacing, different instrumental settings, and various charge sizes were used in an effort to improve the recordings with only small reward.

5. OPERATIONS

There were no unusual operating problems encountered while working the area. The use of a bulldozer could have improved driving conditions along the access route from the Areyonga road to the campsite as well as to the line worked, but local bulldozers are scarce and time did not permit acquisition of one.

Water for drilling and camp use is in short supply in the area. A hole was drilled near SP C-6 for camp supply after water had been found in the production hole. The amount of water produced was not sufficient to supply much more than one tanker load per day and would be unsatisfactory for any use but camp supply. As mentioned previously, the drilling was performed using a minimum of water and this well would not supply the needs of normal mud drilling.

6. INTERPRETATION PROCEDURE

Observed reflection times were corrected to a plane established at 2200-feet above sea level, using the standard uphole time procedure, with a correctional velocity of 10,000 feet per second within the zone from the shot reference position to the plane. Any additional weathering below the shot reference position was determined by a rectilinear intercept method, the additional delay time was applied, and the shot reference position was then referred to the base of the weathering. (See Figure 2.) Subsequent shots in the hole were corrected to the reference shot using a factor equal to the difference in uphole times.

Standard time cross sections were plotted as the primary interpretation. Later, a resolved time section was plotted for each traverse where strong dips were observed. The resolved sections migrate the reflections to their true horizontal position. Refer to Figure 3 for the procedure and computation used in preparing resolved time sections. An illustration of a sample profile has been prepared and is submitted as Enclosure III.

Both standard and resolved cross sections use a vertical scale of 1 centimeter equal to .020 second and a horizontal scale of 1 centimeter equal to 110 feet.

Structural control maps for the surface and for a strong deep reflected event tentatively identified as being associated with Lower Ordovician deposits are submitted as Enclosures I and II, respectively.

Enclosure I is a generalized topographic map contoured on a 25-foot contour interval. The data represent the surface elevation at each shot point.

Enclosure II is a structural control map of the Lower Ordovician event contoured on a .050-second contour interval. The data for this map have been obtained by interpolating continuity lines of the event on the resolved time section for the cross lines and from phantom and correlation times in the case of the crest lines. The data shown are felt to approximate true time depths beneath each shot point location.

7. DISCUSSION OF RESULTS

The seismic survey of the Mereenie Anticline in part corroborates the interpretation of the structure based on surface structural indications. The data outline a prominent anticlinal feature, arcuate in shape, extending between observed outcrops noted to the southeast and northwest. The anticline plunges gently to the southeast from its apex near SP E-45 and plunges to the northwest at the rate of about 100 feet per mile. Closure is suggested and exceeds 0.10 seconds, or approximately 750 feet assuming an average vertical velocity of 15,000 feet per second.

Seismic evidence suggests a structure formed by strong compressional forces, acting from the north, which folded and fractured beds along several planes. The feature could be classed as an imbricate structure if faulting could be used as an argument for the poor record area along the crest and if there is some association between the two faults depicted.

The main fault occurs at a point immediately southwest of the crest on the three most westerly cross lines. Some folding and dragging of the beds into the fault might be inferred which, if used, would still imply vertical displacement of more than .3 seconds, or 2,250 feet. Faulting has not been definitely established on the most easterly cross line ("D" line); the strength of the dips and the continuity of the more prominent reflections would indicate that the faulting is at least diminishing in that direction.

The arcuate shape of the feature might support this interpretation, since a line can be drawn connecting the major axis of the trends observed on the surface to the southeast and to the northwest. The bow in the structure may be caused or influenced by the faulting, and the departure of the curve from the major axis of the entire uplift might give some insight into the horizontal displacement of the faulting. The "D" line is located near the point where outcrops can be observed, and the culmination of the feature on this line comes close to the line joining the major axes. The fault might be hinged at some point farther southeast, and slippage on the northwest may have been along an old fault plane trending nearly normal to this one.

The second fault depicted is more minor in nature, with vertical throw in the order of 40 to 150 milliseconds, depending on the location observed. This fault, too, may diminish laterally as suggested by the difference of throw noted between the "B" and "C" lines. The faulting may be associated with the break to the southwest of the crest and if so, then the major fault might be termed a primary fault with secondary faulting emanating from its plane.

The seismic analysis of the Mereenie Anticline portrays a complex feature extending to depth. The structure probably had its origin during Pre-Cambrian time, suffered disturbances during Post-Ordovician time, subsided during early Mesozoic time, and became a positive feature once again during late Mesozoic time.

The petroleum and natural gas possibilities are not necessarily reduced by all the action the structure has received, for these potentialities would be related to the time of migration of the hydrocarbons and whether or not the structure had been disturbed since accumulation began. The disturbances which affected this structure probably likewise affected structures deeper in the basin and, if so, any overflow might migrate up dip into structures such as this one. If the structure has been dormant since accumulation, then tremendous possibilities for production exist in all areas delineated as traps. These include areas defined by faults as well as the apex or minor closures on the crest.

The most suitable selection of a location for an exploratory test would be one located on the highest point outlined by the survey. Any other location would, at this time, be secondary and could not be used effectively in an evaluation of the reliability of this survey and the potentialities of the area.

APPENDIX I

EQUIPMENT

RECORDING:

1 International Model 160 4-wheel drive recording truck, complete with cable reels and recording cab

1 International Model 160 4-wheel-drive cable truck, complete with seismometer racks and cable reels

1 Complete set of 24-channel National Geophysical Type 26-AA seismic instruments capable of recording both reflections and refractions

1 Complete Model 401-A Techno magnetic recording system with Model TI-480B moveout corrector and reduced drum speed (approximately 11 seconds of recordable time per standard Techno tape optionally available for refractions)

3 Cables designed to accomodate one-third mile reflection spreads

480 Electro-Tech type EVS 20-cycle geophones in groups of six per string with 15-foot spacing between phones

SHOOTING:

1 International Model 190 6-wheel-drive explosive truck complete with 1200-gallon flat-type water tank

1 Complete set of shooting equipment, including both conventional and multi-hole blasters and firing harnesses

SURVEYING:

1 J-6 Jeep 4-wheel-drive truck

1 Complete set of surveying equipment and instruments, including both theodolite and alidade

DRILLING:

2 Heavy-duty Mayhew 1000 combination air-water rigs, mounted on International 190 6-wheel-drive trucks. These rigs are equipped with 667 CFM air compressors, 5 x 6 Gardner-Denver mud pumps, and 300 feet of heavy-duty Mayhew drill stem per unit

2 International Model 190 6-wheel-drive heavy-duty water trucks with 1200-gallon flat type tanks and stake bodies

1 J-5 Jeep 4-wheel-drive truck for drill supervisor

SUPPLY:

1 International Model A-160 4-wheel-drive supply truck with stake body

OFFICE:

1 Elder trailer office completely equipped with office machines, drafting equipment, radio, and air conditioner

1 Land Rover 4-wheel-drive truck for camp use

SHOP:

1 Elder trailer machine shop complete with drill press, benches, vises, air compressor, and all necessary hand tools and equipment for all repairs.

1 Welding trailer, complete with both arc and acetylene welding equipment and supplies

CAMP:

1 Elder trailer all-electric kitchen, air-conditioned, complete with all appliances and utensils

1 Elder trailer diner, with necessary furniture, fixtures, tableware, and air-conditioner

1 Elder trailer shower and utility unit

1 Elder Power Trailer, complete with two 25-KW diesel generators for camp power

1 1200-gallon camp water trailer, complete with pressure system

1 Complete complement of portable kitchen and diner equipment for fly camp, including generator and refrigerator

All trucks and trailers equipped with sand tires. All trucks equipped with front end winches. All International trucks equipped with power steering.

APPENDIX II

PERSONNEL

Party Chief - H. E. Bowman

Seismologist - J. F. Homola

Observer - R. R. Kocian

Surveyor - G. W. Cozby

Drill Supervisor - L. L. Reeve

Drillers - W. G. Pfau
J. Mackie

Thé basic crew comprised a total of twenty men. Two additional men were provided for field duty.

Technical and administrative supervision was provided by Mr. W. Jarrott Harkey.

APPENDIX III

STATISTICAL DATA

Starting date, first shot	September 25, 1962
Completion date, last shot	October 18, 1962
Total number of holes shot	168
Total number of shots	246
Average number of holes shot per day	7.1
Total miles of subsurface coverage	36.9
Total number of moving days, recording	4.9
Days lost due to weather	0
Days lost due to equipment failure	0
Days lost due to holidays	1
Total number of field days, recording	23.62
Total number of hours, recording	195.4
Total hours driving time, recording	40.8
Total pounds dynamite used	5443
Average pounds dynamite per shot	22
Total number detonators used	355

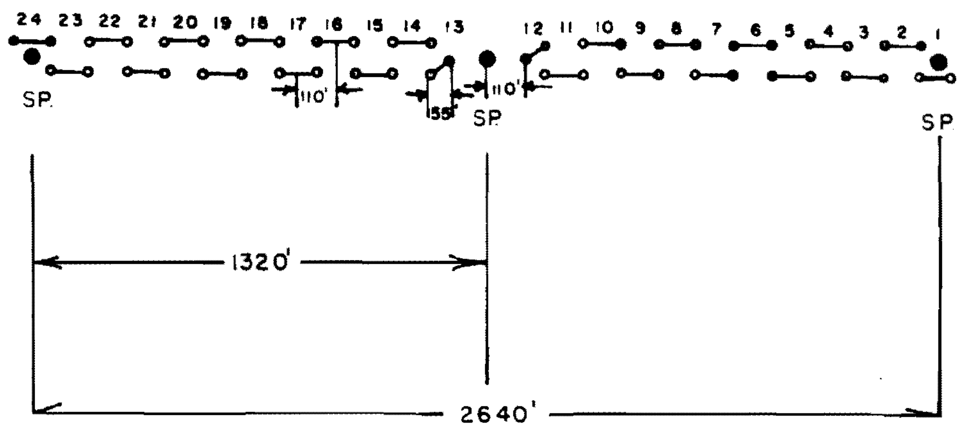
Total number drill shifts in field	40.65
Total number drill shifts, water well and stand-by	5.6
Total hours field time, drills	334.2
Total hours driving time, drills	78.3
Rock bits used	14
Insert bits used	20
Total footage drilled	24,375 - 71'/hr.
Total number holes drilled	171
Average number of holes drilled per field shift	4.2
Average depth of holes, including patterns	143
Average depth of shots, including patterns	118'
Mud, chemicals, and casing used	0

NAMCO INTERNATIONAL, INC.

H. E. Bowman
Party Chief Party No. 84

W. Jarrott Harkey
Supervisor

October 18, 1962



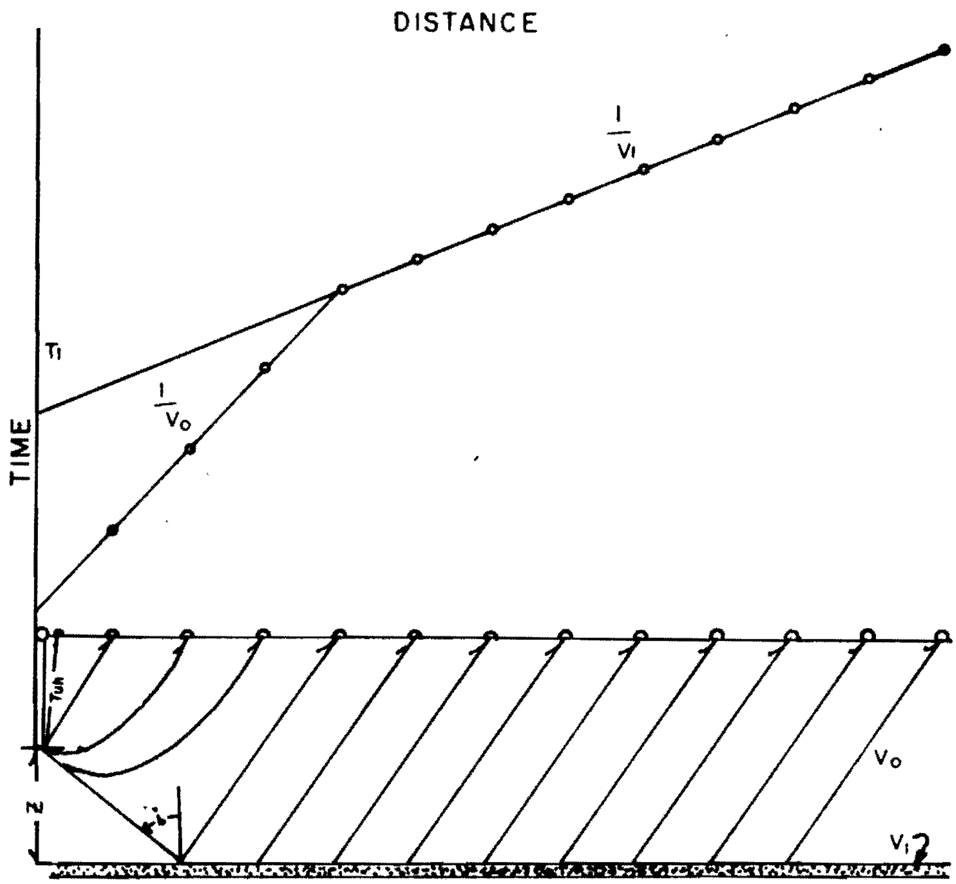
TYPICAL SPREAD

24 TRACES

12 SEIS. PER. TRACE

10' SEIS. SPACING

FIGURE 1.



CALCULATION - WEATHERING THICKNESS

$$Z = \frac{(T_1 - T_{uh})\,V_o}{2 \operatorname{Cos} i}$$

WHERE

Z = DEPTH OF BASE OF WEATHERING BELOW SHOT

T_1 = INTERCEPT TIME OF SLOPE $\frac{1}{V_1}$

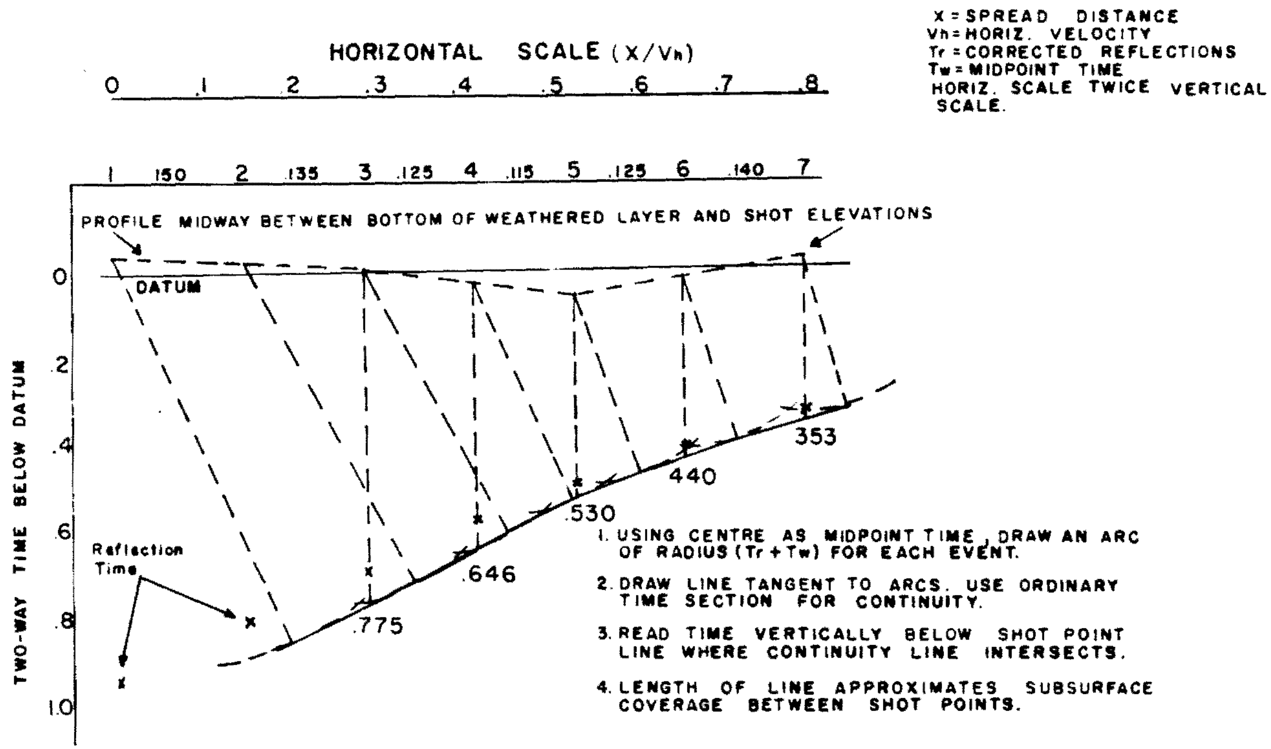
V_o = WEATHERING VELOCITY

V_1 = SUBWEATHERING VELOCITY

$\operatorname{Sin} i = \frac{V_o}{V_1} \therefore \operatorname{Cos} i = \frac{\sqrt{V_1^2 - V_o^2}}{V_1}$

T_{uh} = UPHOLE TIME OF SHOT

FIGURE 2.



GRAPHICAL TIME RESOLUTION

FIGURE 3.