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PR 1962-0022

SUPPLEMENTAL

SEISMIC SURVEY REPORT

on the

AREA "C", ALICE SPRINGS

Northern Territory

AUSTRALIA

Restricted

Submitted to

EXOIL (N. T.) PROPRIETARY, LTD.

by

NAMCO INTERNATIONAL, INC.

DALLAS

C O N T E N T S

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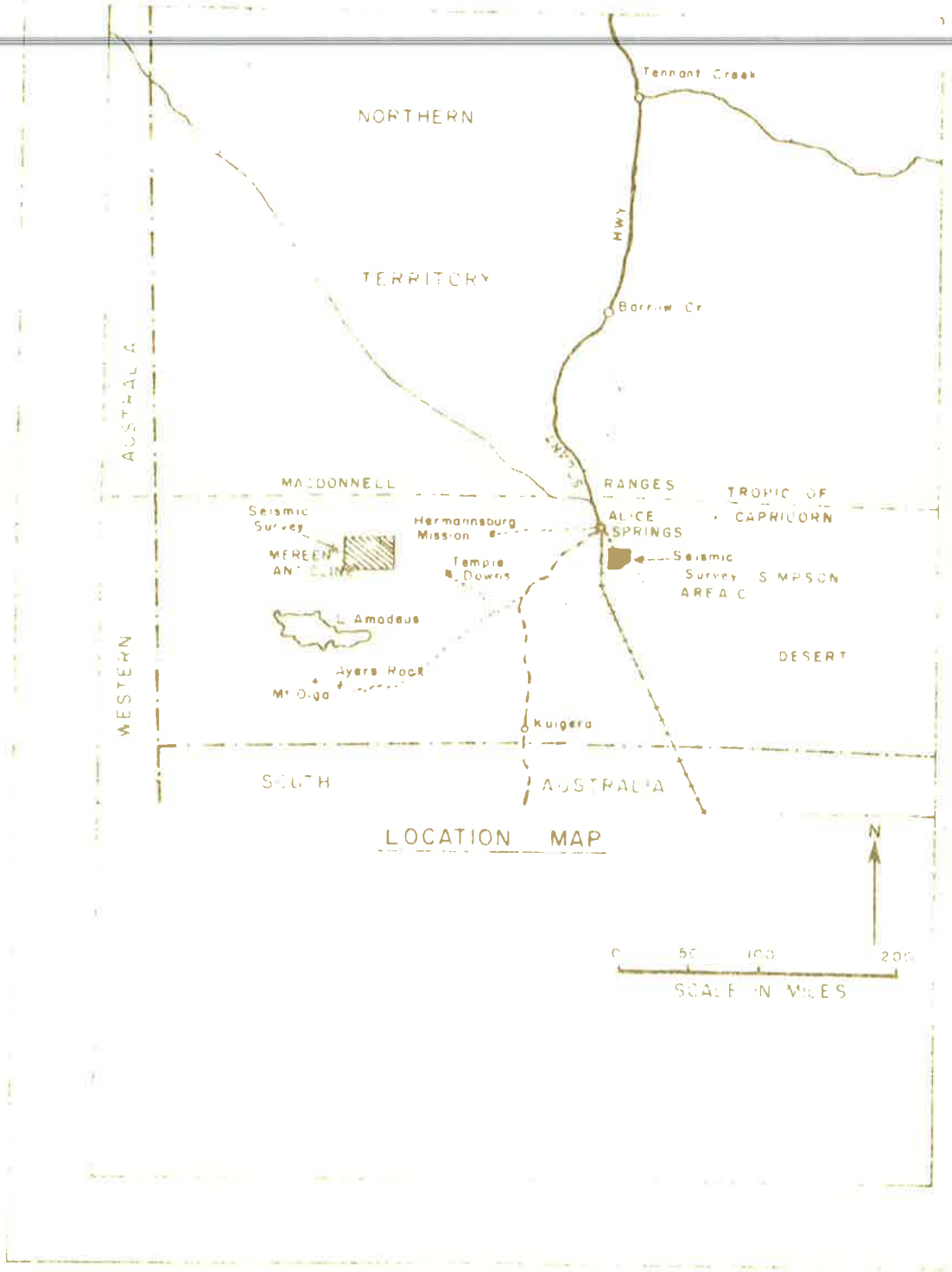
ABSTRACT

A reflection seismic survey was conducted during April of 1963 for Exoil (N.T.) Proprietary, Limited, by Party No. 84 of Namco International, Incorporated, within Permit No. 43 of the Northern Territory. The seismic traverses were located in the north-central section of the Permit Block in an area designated Area "C".

The purpose of the survey was to provide detailed subsurface structural control to define the areal extent of structural closure revealed by a reconnaissance seismic program conducted in 1962. In addition, the new control was expected to confirm or alter the previous interpretation of a reefoid type buildup in the area.

The results of the survey indicate that the areal extent of the closure was restricted to a small area central in the prospect, but no information has been obtained which restricts a northwestern extension of this anomaly. Several of the new profiles display indications of reflection divergence similar to that observed on the initial work and strengthen the original interpretation.


NORTHERN
TERRITORY
Tennant Creek
HWY
Barrow Cr
AUSTRALIA
MACDONNELL
RANGES
Seismic
Survey
Hermannsburg
Mission
MEREENIE
AN
Temple
Downs
ALICE
SPRINGS
TROPIC OF
CAPRICORN
Seismic
Survey
AREA C
SIMPSON
DESERT
Amadeus
Ayers Rock
Mt Olga
WESTERN
Kulgera
SOUTH
AUSTRALIA
LOCATION MAP
N
0
50
100
200
SCALE IN MILES

1. INTRODUCTION

The Alice Prospect supplemental seismic survey was conducted for Exoil (N.T.) Proprietary, Limited, with registered office at Brisbane, Queensland, within Permit No. 43 in the Northern Territory, Australia. Refer to the 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 Alice Prospect is located in the south-central section of the Northern Territory, 20 miles south-southeast of Alice Springs. Surface topography is characterized by flat countryside on the east. This gives way to gentle sand dunes on the west and the area is bounded on the south by the Ooraminna anticline. Flora in the project is restricted to mulga trees on the flats and sand dunes with numerous gum trees growing along watercourses. The drainage pattern in the area is predominantly to the north into the Todd River.

The climate of the area is normally fine and clear. The daily temperature range during this supplemental survey was between 70 and 80 degrees maximum, with noctural minimums of between 50 and 60 degrees. Some rainfall fell in the area, but soon soaked into the subsurface.

2. GEOLOGY

The Alice Prospect is situated in the Amadeus Basin between the Macdonnel Ranges and the Ooraminna Range, approximately 20 miles south of Alice Springs.

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.

Numerous inclusions of algal reef have been noted in outcrops of the Lower Cambrian Jay Creek formation (Madden 1960) in the eastern part of the Amadeus Basin near Phillipson Pound. If algae occurred in sufficient quantities it could provide both source and reservoir material for oil generation and accumulation. It is quite unknown whether the supply of organic material was adequate to provide for any significant accumulations of oil so low in the geological column, yet a common feature of Cambrian limestones in the Georgina Basin is that they have a strong petroliferous odour when freshly broken. Reef criteria in the Area "C" Seismic Survey indicates a thick section of reef (1,000 feet or more), although of not much lateral extent. This large an indication, in addition to the frequent occurrences as reported by Madden 1960, McNaughton 1961 and Bowman 1963, makes the Jay Creek Formation freely prospective for commercial oil accumulation. A thick reef with structural closure would be the logical place for a test of Lower Cambrian potentialities.

The Bitter Springs, Areyonga, and Pertatataka of Upper Proterozoic age outcrop in the Macdonnel Ranges east of Ellery Creek and all exhibit a limited amount of algal limestones (Stelck and Hopkins, 1961). Shallow water conditions are

believed to have existed throughout deposition of the Bitter Springs, as indicated by inclusions of algal gypsum, pelletoids and glauconitic beds. The soft clastic glacial Areyonga is thought to be the product of eustatic lowering of the sea and has good reservoir characteristics. The Pertatataka formation, conformably overlying the Areyonga formation, is predominantly silty shale with some algal limestone appearing near the top in the eastern part of the Amadeus Basin.

The Cambrian sequence consists of Arumbera, Jay Creek and Goyder formations, all outcropping at the Ooraminna anticline a few miles south of Area "C". The Arumbera exhibits a sand facies with varying degrees of granularity at outcrops throughout the Amadeus Basin. In the east it is quite porous and well-sorted while in the west it grades rather indefinitely into the underlying Pertatataka. The Jay Creek formation is considered to be over 3,000 feet thick southeast of Alice Springs and probably represents the deepest significant off-structure target in this area. It is predominantly carbonate in the east and grades into clastic sediments including the Hugh River and Mission shale and the Gardiner and Goyder sands in the west. Source material is the Hugh River shale and algal limestones and reservoir is algal biostrome.

The unsorted Goyder sands are overlain without break by well sorted sands of the basal Ordovician Pacoota formation.

The Pacoota blankets the Amadeus Basin and consists of very clean and porous sandstone with a heavy concentration of Scolithus. Its thickness in the eastern part of the basin is about 1,000 feet.

The richly fossiliferous Horn Valley and the clean well-sorted sands of the Stairway, if existing at all southeast of Alice Springs, are expected to be very thin. Their presence would add to the prospect, the Horn Valley being good source material and the Stairway having fair reservoir properties.

The Mereenie sandstone is stated by Quinlan to extend as far east at Area "C". It may represent a thin reservoir bed beneath the surface Alluvium sands.

Geology contributed by Geological Department of Exoil (N.T.) Pty. Ltd.

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 Seismometer Spread.

Recording was accomplished using National Geophysical Company 26-AA amplifiers and a National 4 F 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 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 were distributed uniformly within the line of the profile in the reflection program. An extra cable and a set of seismometers were employed 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 hard layers of sandstone, clean gravel and, at times, caving sand. It was possible to drill all of the shot holes using a water injection method to control caving near-surface sand. The method proved effective and was considered superior to the more tedious and time-consuming mud drilling procedure.

All instrument spreads were chained, and horizontal and vertical control were obtained by alidade and plane table. The datum for the elevation and traverse control was a Magellan Petroleum Corporation gravity survey station, number 933, located 23° 50' South and 133° 56' East approximately. All traverses were checked by loop closure, 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

The quality of the recordings in this supplemental program varied from poor to very good. The better data were obtained at points located south of the "E" line and west of the "K" line. North and east from this locality the quality of data deteriorated to the degree of being questionable.

The poor records were associated with near-surface conditions consisting of layers of sand and shattered sandstone with a relatively thick layer of additional low velocity material. While this overburden probably constitutes the principal reason for the poor data, there are several indications of erratic reflection moveouts and rapid character changes which might be attributed to a disturbed section in this area.

Near-surface refraction velocities on the east and northeast side of the project suggested a thick layer of 4000-foot-per-second material underlain by an undetermined thickness of 8000-foot-per-second bedding. On the west side of the area the velocities consistently approached 11,500 feet per second. The transition between the two near-surface conditions was abrupt and suggests truncation of a major sandstone member (Pertnjara formation?) to the east.

Some improvement of poor recordings from single holes was obtained with a pattern of 16 20-foot holes spaced 60 feet apart in a square pattern rotated 45 degrees to the line of profile. This arrangement was predominantly successful in clarifying prominent shallow reflection tentatively associated with the Jay Creek formation of the Cambrian. Additional improvements might be achieved with further experimentation of recording techniques.

5. OPERATIONS

There were no unusual operating problems encountered while working the area. The fact that the campsite was located close to Alice Springs relieved the crew of arduous supply hauls and contributed to the excellent morale of the crew.

The surface conditions in the area are such that little difficulty was experienced in moving about the area and equipment failure was unusual.

The drilling conditions in the Alice Area were generally good. Hard sandstone layers impeded drill production and increased bit costs but never severely affected the progress of the crew.

6. INTERPRETATION PROCEDURE

Observed reflection times were corrected to a plane established at 1,500 feet above sea level, using the standard uphole time procedure with a correctional velocity of 8,000 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 rectilineer intercept method, the additional delay was applied, and the shot reference position was 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 and have been submitted. Since dips in the area rarely exceed 10^{o}, migrated sections were not deemed necessary. A vertical scale of 1 centimeter equal to .020 reflected time and a horizontal scale of 1 centimeter equal to 220 feet was used in preparing the cross sections.

Five structural control maps have been constructed (Enclosures I-V, inclusive) and are submitted with this report.

Enclosure I is a structural control map of a reflected event tentatively identified as being associated with the Jay Creek formation of the Cambrian.

Enclosure II is a structural control map for an unidentified reflected event, Horizon "D", believed to originate in Lower Cambrian or Upper Proterozoic deposits.

Enclosure III is an Isochron map of the interval between the Jay Creek and Horizon "D" events.

Horizon "X", Enclosure IV is based on a reflection which displays anomalous dips and which is thought to be associated with the top of a reefoid type buildup in the section.

Enclosure V is a generalized topographic map of the surface contoured on a ten foot interval. The data represent the surface elevation at each shot point.

7. DISCUSSION OF RESULTS

The results of the supplementary survey have been integrated with data from the original survey and are displayed on three structural, one isochronal, and one topographic map.

The three seismic structural maps (Enclosures I, II and IV) are generally conformable and indicate the presence of a strong anticlinal trend flanked by parallel synclinal features. The high area trends to the northwest and plunges dently in that direction. A small area of structural closure is revealed near the intersection of Lines "B" and "D".

The degree of closure is greatest on the Horizon "X" map, least on Horizon "D", and intermediate at Jay Creek level.

The Isochron map (Enclosure III) displays time-interval relationships which are not considered conformable with the attitude of the structural features displayed on the other maps, based on normal conditions of compaction and compression relative to structure. In the northwestern portion of the area surveyed the thickest interval shown on the isochron map is coincident with the position of the anticlinal trend.

The definition of the trend of structural closure described above fulfills one of the objectives of the survey. The other purpose was to obtain information which would support or modify the theory of a reef-type buildup in the Jay Creek formation. In the previous survey divergence had been noted between reflections in a zone below the Jay Creek event. It was postulated, on the basis of the character of the divergence and the structural relationship of subsequent deposits in the section, that this condition might indicate a reef-type growth in the Cambrian.

Of the new profiles recorded, two lines give excellent examples of reflection divergence, while others show more subtle changes in character and interval values. The "J" line has two separate illustrations of section increase, with the best being located between shot points J-2 and J-4 and the other between J-10 and J-12. On the "H" line the degree of divergence is less apparent, probably because of the obliquity of the line to the major structural axis, but it should be noted that the gross interval increase is of the same order.

A reflection occurring at the top of the band including the divergence has been mapped as Horizon "X" (Enclosure IV) to describe the anomaly. The event has been interpreted continuously within the limits of the area of good records. Confidence in the illustration of a definite boundary is gained from the persistence of the reflection, the fact that anomalous dips and subsequent divergence occur at the same level throughout this area, and the fact that loop closure was made without undue interpretational difficulty.

Two dashed lines are superimposed on Enclosure IV. The outside line delineates the limits of the anomalous zone in the section, while the other outlines the configuration of the area where .040 second of reflection divergence (or buildup) has been measured. Within this second line even greater amounts of thickening have been determined.

The supplemental shooting in the area has provided further examples of the abnormal structural conditions which led to the reef theory in the original report. Nothing has been found which discredits the theory, and it is felt that sufficient evidence has been obtained to justify a drill test at the highest point on the trend.

An exploratory test on the trend would serve three useful purposes. Primarily it would determine the geological and economic significance of the seismic anomaly. Secondly, it might test the full Cambrian section at a location where strata of that age are relatively near to the surface. Finally, the stratigraphic information obtained would assist greatly in the evaluation of the northeastern portion of the Amadeus Basin as a whole.

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

3 Cables designed to accommodate 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 Land Rover 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 Land Rover 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

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	W.G. Pfau
Drillers	R. Belsham
	T.J. Adam

The basic crew comprised a total of twenty men. One additional man was provided for field duty.

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

APPENDIX III

STATISTICAL DATA

Starting date, first shot	April 24, 1963
Completion date, last shot	April 30, 1963
Total number of holes shot	57
Total number of shots	88
Total miles of subsurface coverage	13.7
Total number of moving days	1.63
Days lost due to equipment failure	0
Days lost due to holidays	1
Total number of field days, recording	6.7
Total number of field hours, recording	60.8
Total number of driving hours, recording	6.2
Total pounds dynamite used	3288
Average pounds dynamite per shot	37.4
Total number detonators used	634
Total number drill shifts in field	13
Total number field hours, drilling	115.8
Total number driving hours, drilling	14.2
Rock bits used	5
Insert bits used	32
Total footage drilled	19,360

Total number holes and patterns drilled	58
Average number of holes or patterns drilled per field shift	4.5
Average footage of holes including patterns	334
Average number of holes shot per day	8.5
Days lost due to weather	0
Average depth of shot, excluding patterns	63
Depth of pattern holes (usually 16 holes)	20
Mud, Chemicals and casing	0

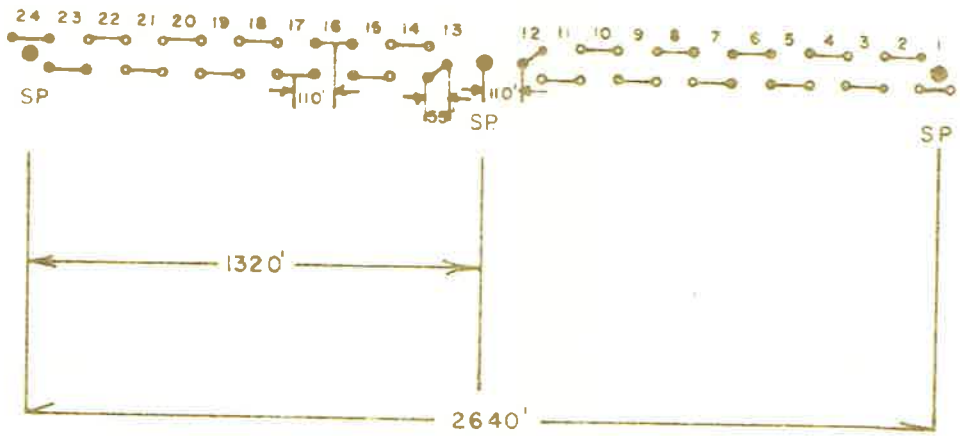
Note: Production limited by short lines and day-by-day assignment of program.

NAMCO INTERNATIONAL, INC.

H.E. Bowman
Party Chief Party No.84

W.J. Harkey
Supervisor

April, 1963.



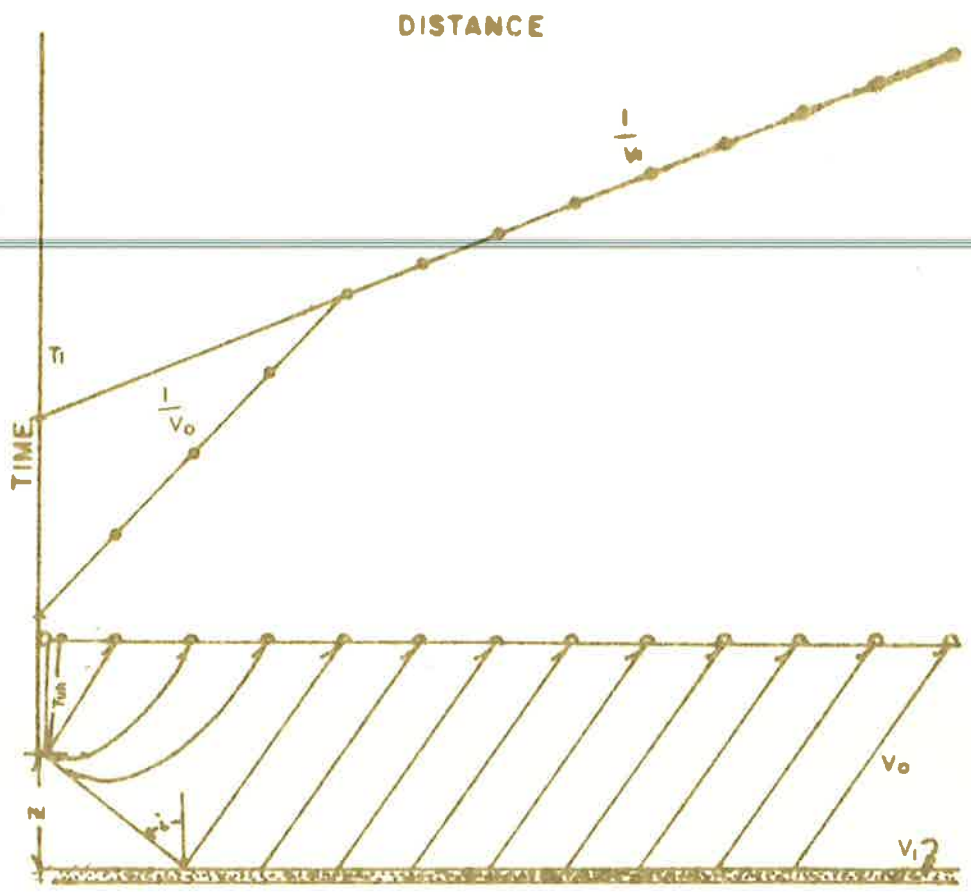
TYPICAL SPREAD

24 TRACES

12 SEIS. PER. TRACE

:0' SEIS. SPACING

FIGURE 1.



CALCULATION - WEATHERING THICKNESS

$$Z = \frac{(T_i - T_{uh})\, V_o}{2 \cos i}$$

WHERE

Z = DEPTH OF BASE OF WEATHERING BELOW SHOT

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

V_o = WEATHERING VELOCITY

V_1 = SUBWEATHERING VELOCITY

$\sin i = \frac{V_o}{V_1} \therefore \cos i = \frac{\sqrt{V_1^2 - V_o^2}}{V_1}$

T_{uh} = UPHOLE TIME OF SHOT

FIGURE 2.