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SEISMIC SURVEY REPORT

on the

AREA "C", ALICE SPRINGS

Northern Territory

AUSTRALIA

Submitted to

EXOIL (N.T.) PROPRIETARY, LTD.

by

NAMCO INTERNATIONAL, INC.

DALLAS

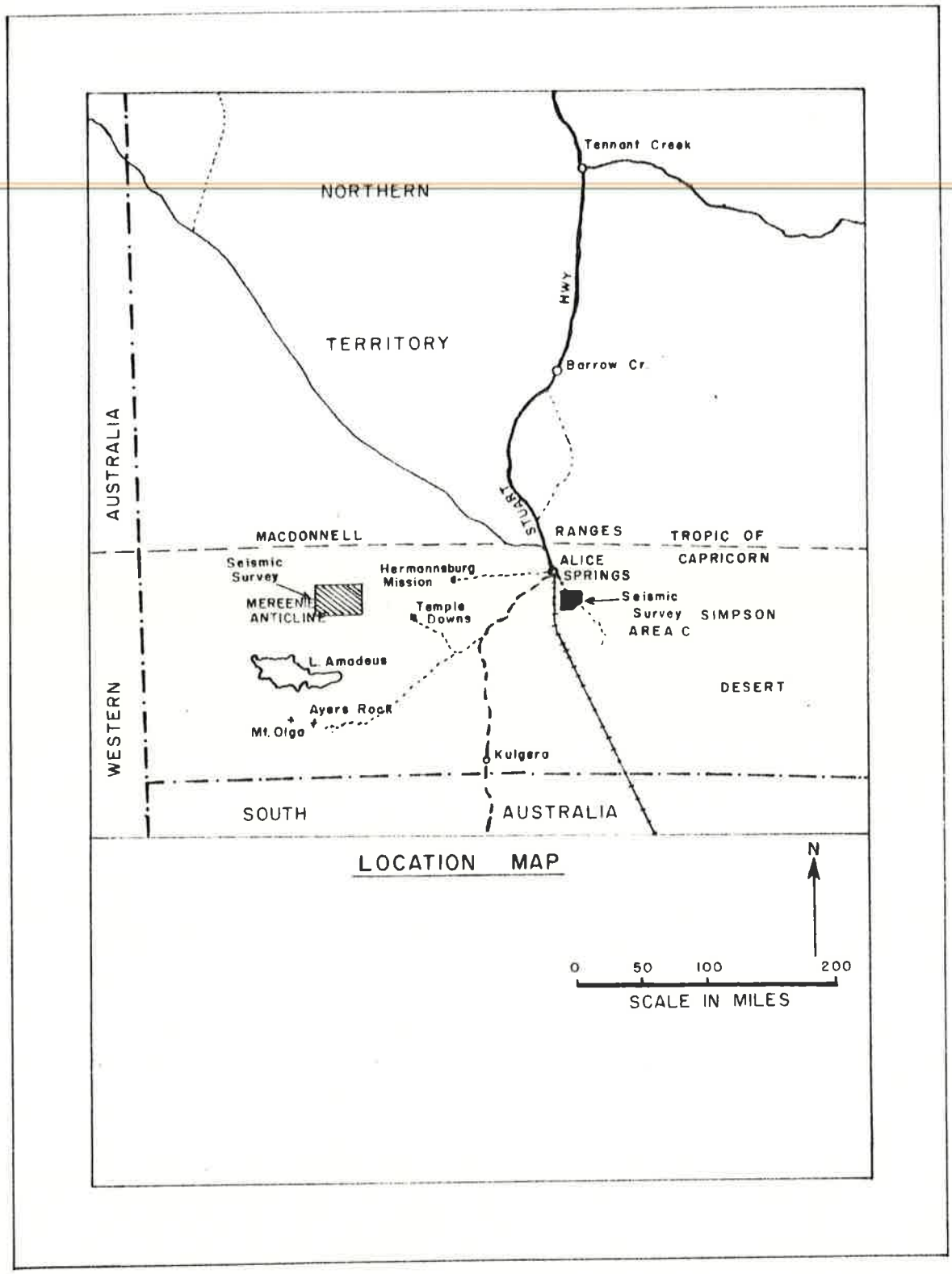
CONTENTS

ABSTRACT

A reflection seismic survey was conducted during October and November of 1962 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 subsurface structural control to evaluate a gravity anomaly outlined by a survey for Magellan Petroleum Corporation and to gain general knowledge of the geologic section in the prospect.

The results of the survey indicate a minor anticlinal feature southwest of the minimum gravity anomaly flanked by strong synclinal tendencies to the west and northwest. The thickness of the section varies from approximately 10,000 feet on structure to more than 15,000 feet basinward.


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

1. INTRODUCTION

The Alice Prospect 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 survey was between 70 to 100 degrees maximum, with nocturnal minimums of between 50 and 70 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 Mac Donnel Ranges and the Ooraminna Range, approximately 20 miles south of Alice Springs.

Although there is no surface indication of a structure at depth, the results of a gravity survey performed for Magellan Petroleum Corporation suggested a strong minimum gravity anomaly which was interpreted as being an expression of the near-surface proximity of the low-density Bitter Springs formation. If this were the case, then a major anticlinal feature might be anticipated in the area.

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.

Structural conditions in the vicinity of the Alice Prospect suggest that major tectonic forces acted on the deposits causing assymetrical synclines and low-angle overthrusts after Ordovician time and gave a general east-west trend to the structural fabric. Some faulting is also apparent trending in a direction normal to this main system.

Potential source beds in the area are located in Ordovician, Cambrian, and Proterozoic deposits. The fact that petroliferous rocks have been found in beds of Proterozoic age makes the area unique and academically very interesting.

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^{o} 50' South and 133^{o} 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 record quality in the Alice Prospect varied considerably. The better recordings were obtained on the west and southwest portions of the area, where shale and clay drilling was encountered. On the east and northeast side of the area the quality of data deteriorated to the point where the information obtained was almost unusable.

The poor records were associated with near-surface conditions consisting of sand and gravel layers and a relatively thick layer of additional low-velocity material.

Near-surface refracting velocities on the east and northeast side of the project suggested a thick layer of 4,000-foot-per-second material underlain by an undetermined thickness of 8,000-foot-per-second material. On the west side of the prospect the velocities approached 11,500 feet per second consistently. The transition between the two near-surface conditions was abrupt and suggests truncation of a major sandstone member to the east.

The poor records obtained were partly improved by a multiple hole pattern arrangement consisting of 15 or 25 holes spaced 30 feet apart to form a square rotated 45^{o} to the line. This arrangement was predominantly successful in clarifying a prominent shallow reflection tentatively identified as the Jay Creek formation of the Cambrian, and it is believed that further success could be achieved by additional experimentation.

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 on the "A" line were generally poor and were actually the major operational problem encountered. The substitution of multiple hole patterns in effect relieved the problems and drilling never again became a problem.

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 110 feet was used in preparing the cross sections.

Four structural control maps have been constructed (Enclosures I-IV, 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. This map is contoured on a 25-millisecond interval.

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

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

Enclosure IV is a generalized topographic map of the surface contoured on a 10-foot contour interval. The data represent the surface elevation at each shot point.

7. DISCUSSION OF RESULTS

The three seismic maps presented are generally conformable and indicate the presence of a rather high area located in the east and southeast portion of the area surveyed. From the highest point detected by the survey the section plunges moderately northwesterly into the deeper reaches of the basin. Some departure from this regional tendency is observed when anomalous conditions are apparent, such as near the intersection of the "B" and "D" lines and at the northwest end of the "A" line.

The anomalous conditions suggests the possibility of biohermal development near the base of the Jay Creek formation. The evidence used to support this theory is:

1. The presence of a high area on Horizon "D" which is thought to provide the necessary environment to promote reef development.
2. The increase in the amount of closure of structure at shallower positions in the section.
3. Excellent indications of divergence between shallow reflections and the deeper platform events - typical of the situation where a buildup due to biohermal development has occurred. Refer to Enclosure V, Typical Section - Line "D".
4. Numerous outcrops of biohermal growths of Cambrian age in the vicinity.

Although the structure depicted at the intersection of the "B" and "D" lines on the Jay Creek map may appear minor in nature, it is thought to express a general geologic condition in the prospect and probably may be indicative of similar features in the vicinity.

Structures such as this are considered very attractive since they probably have not been subjected to the disturbances that caused the many complex features in the Amadeus basin. No doubt the structure was contorted by the forces causing the various regional uplifts, but in the

main the structure has probably retained most of its original characteristics, and if capable of reservoir possibilities, probably retains much of the primary accumulation.

A possibility of similar structural conditions is suggested by seismic evidence near SP A-5, in the northwestern portion of the area surveyed. Although record quality is poor in this vicinity, it is recommended that additional profiles utilizing multiple holes be obtained to evaluate the possible anolmaly in the event that work is resumed in the area.

The results of the seismic survey do not entirely support the gravity interpretation of a structurally high area located near SP's A-7 and A-8. It is suggested that the sharp change in residual gravity may be related to near-surface conditions, such as a buried drainage pattern filled with recent alluvium.

While the seismic survey of Area "C" has not revealed a major closed anticline within the area covered, anomalous conditions exist which merit further attention.

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 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-6 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

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

T. J. Adam

The 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	October 25, 1962
Completion date, last shot	November 4, 1962
Total number of holes shot	115
Total number of shots	132
Total miles of subsurface coverage	30
Total number of moving days	2.785
Days lost due to equipment failure	0
Days lost due to holidays	0
Total number of field days, recording	11.695
Total number of field hours, recording	102.55
Total number of driving hours, recording	14.4
Total pounds dynamite used	4630
Average pounds dynamite per shot	35.1
Total number detonators used	461
Total number drill shifts in field	21.0
Total number drill shifts, water well and stand-by	3.0
Total number field hours, drilling	182.6
Total number driving hours, drilling	17.4
Rock bits used	11
Insert bits used	40

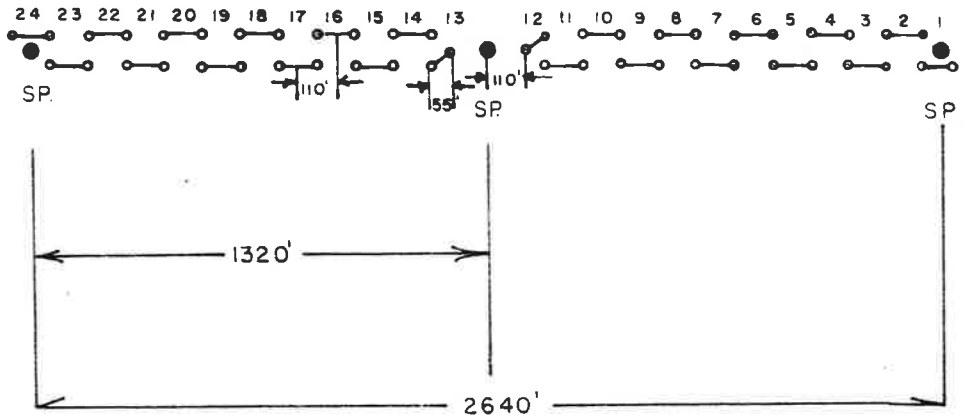
Total footage drilled	18,228
Total number holes and patterns drilled	116
Average number of holes or patterns drilled per field shift	5.5
Average depth of holes including patterns	157.1
Average number of holes shot per day	10
Days lost due to weather	0
Average depth of shot, excluding patterns	104
Depth of pattern holes (usually 15 holes)	20
Mud, Chemicals and casing	0

NAMCO INTERNATIONAL, INC.

H. E. Bowman
Party Chief Party No. 84

W. J. Harkey
Supervisor

November 1962



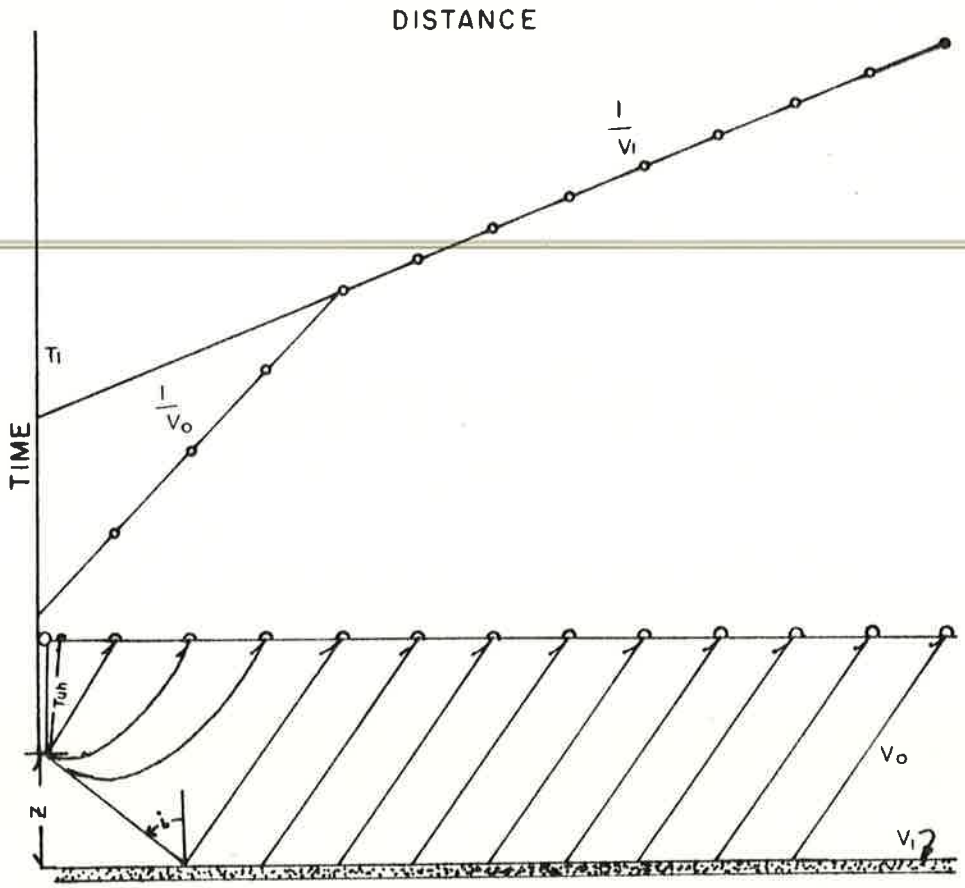
TYPICAL SPREAD

24 TRACES

12 SEIS. PER. TRACE

10' SEIS. SPACING

FIGURE 1.



CALCULATION - WEATHERING THICKNESS

$$Z = \frac{(T_1 - T_{uh})\, V_0}{2 \cos i}$$

WHERE

Z = DEPTH OF BASE OF WEATHERING BELOW SHOT

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

V_0 = WEATHERING VELOCITY

V_1 = SUBWEATHERING VELOCITY

$\sin i = \frac{V_0}{V_1} \therefore \cos i = \frac{\sqrt{V_1^2 \cdot V_0^2}}{V_1}$

T_{uh} = UPHOLE TIME OF SHOT

FIGURE 2.