

MODELLING OF THE PIPIPA DEEP
SEISMIC AMPLITUDE ANOMALY
PERMIT T/22P, BASS BASIN

AR WALDRON
for SAGASCO Resources Limited
on behalf of the T/22P Joint Venture

MAY 1990

JMB8806035

IMPORTANT NOTICE

This document was prepared by SAGASCO Resources Limited ("the Company") and its provision to the recipient is strictly subject to and conditional upon the terms of the disclaimer set forth below.

The Company declares and the recipient accepts:-

- (1) That this document is provided for the personal use of the recipient only and may not be provided to any third party without the consent in writing of the Company and without that third party being informed that the Company accepts no legal liability whatsoever whether in contract or negligence or otherwise towards that third party and without the terms of this disclaimer being drawn to the attention of such third party.
- (2) That whilst the Company believes that, save as is stated to the contrary, information contained in this document is accurate, it does come from a variety of primary and secondary sources. Further, whilst it believes that the conclusions and recommendations contained in it are reasonably and soundly based, no warranty is given as to the correctness of any such information and no reliance should be placed on the same or on any such conclusions or recommendations as no liability is accepted by the Company for any statement, opinion, error or omission contained herein or implied hereby whether the result of negligence or mistake or any other cause whatsoever. Any party (including but not limited to the recipient) in any way contemplating action based upon or related to the contents of this document should, beforehand, seek complete and objective professional and/or technical information analyses and assessments in relation thereto and should proceed with any such action specifically on the basis of such analyses and assessments rather than on the basis of the contents of this document.
- (3) This disclaimer excludes all warranties and liabilities imposed upon the Company with regard to the provision of this document by any statute or rule of law to the extent that such statutes and rules of law are legally excludable, but to the extent that they are non-excludable and are repugnant to this disclaimer this disclaimer is overridden to the extent of such repugnancy and no further and any Court or tribunal interpreting such statutes and rules of law is empowered to read down or sever this disclaimer so as to preserve for it the widest possible operation consistent with any such overriding legislation.

CONTENTS

	PAGE NO
INTRODUCTION	1
MODELLING PROGRAM	1
MODEL CONSTRUCTION	1
RESULTS	2
IMPLICATIONS	3
CONCLUSIONS	3

LIST OF FIGURES AND ENCLOSURES

- Figure 1. Top Seismic Amplitude Anomaly Depth Structure Map.
Figure 2. Initial Gas Sand Model.
Figure 3. Initial High Velocity Intrusive Model.
Figure 4. Seismic Line TNK4-79 Reprocessed by Shell, 1990.
Enclosure 1. Pipipa Deep Seismic Modelling Montage.

INTRODUCTION

An amplitude anomaly is present on the seismic data over the Pipipa Deep Prospect within the top mid M.diversus - base lower M.diversus palynological zones (Pelican Zone). It lies between 1.8 and 2.0 seconds two-way time on the seismic data, and has an areal extent of up to 30 square kilometres (Figure 1). Seismic line TNK4-79, shown on the montage of Enclosure 1, is a dip line through the proposed Pipipa Deep well location. The anomaly is readily identifiable between shotpoints 720-920; a horizontal distance of 6,000 metres, and it has a vertical relief of over 300 metres. *on SL TNK4-79*

The aim of the seismic modelling project was to introduce gas into a sand sequence within the Pelican Zone predicted to have a lithology distribution similar to that encountered in the Pelican 5 well, and see if the observed characteristics of the anomaly could be reproduced by modelling.

MODELLING PROGRAM

The modelling program available at SAGASCO Resources is part of an integrated seismic data management and processing system based on a suite of programs supplied by Sattlegger Ingenieurburo Fur Angewandte Geophysik. It is a two-dimensional modelling program simulating a Huygens-Fresnel approximation to an upgoing wave field. Ray fans emitted from closely spaced points along the interfaces in the depth domain are traced upwards in order to obtain diffraction travel time curves. The amplitudes of each diffraction curve depend on the reflection coefficients at the point sources. Additionally, a geometric correction is applied to the amplitudes in order to take focussing or defocussing of reflection energy into account. The resulting spike trace file is filtered with a minimum phase wavelet to produce the synthetic time section.

MODEL CONSTRUCTION

The depth model is shown on the montage (Enclosure 1), and was constructed using the dip line TNK4-79 to define structure and relief. The velocity boundaries of the depth model are based on those defined for the Pelican Zone of the Pelican 5 well, where a generalised lithology model was used. The major velocity boundaries, such as those associated with coals, were maintained, while other intervals that are relatively indistinguishable by velocity were combined together, and an average velocity function applied. The velocity and density information was taken directly from the Pelican 5 well logs.

The effect of changing the fluid content of a sandstone reservoir from water to gas will reduce the interval velocity by 15-20%. The velocity of the water-saturated sands was taken from the Pelican 5 logs to be 3950 m/sec, and the gas-sand velocity was calculated to be approximately 3300 m/sec. Note that if the sands were oil filled, then a corresponding increase of approximately 6 porosity units would be required to reduce the interval velocity of the reservoir by 15% (Schlumberger Chart Book, 1989).

A high velocity igneous intrusive was also modelled and compared to the original data. A velocity of 8060 m/sec and a density of 2.56 g/cc were used in the model. These values are taken from a dolerite sill that was encountered in the Yolla 1 well between 2584-2651 metres.

RESULTS

The synthetic time section was generated using a 30 Hz minimum phase wavelet and is shown on Enclosure 1. The top of the water-sand corresponds to the beginning of a white trough on the synthetic section, while the gas sand is associated with a high amplitude black peak. Comparison between the real and the synthetic data results in the following observations:

1. Similar high amplitude "bright-spots" occur on both real and synthetic data.
2. Similar phase changes occur at the base of the anomaly on both data.
3. A second peak, associated with the base of the gas sand, is seen only on the synthetic section. This results from the simple geometry of the depth model. Inspection of the real data suggest the presence of an unconformity beneath the anomaly, which would not have the same seismic signature as a series of conformable velocity boundaries.

In an attempt to approximate the data more realistically, a number of changes to the initial depth model were introduced. Firstly, the real section appears to lose reflection strength and continuity within the Pelican Zone interval in a direction towards the Pipipa fault. To account for this the velocity of the coals of the depth model were increased towards the flank to reduce the acoustic contrasts within the section. Generally, this produced the desired result in the synthetic time section. Secondly, the initial depth model included an abrupt hydrocarbon/water contact producing a sharp horizontal velocity boundary between the hydrocarbon and water saturated components of the sand. As seen in Figure 2, a strong flat spot was produced at the base of the anomaly. However, as this affect could not be seen on the original section TNK4-79, the velocities were smoothed through a Transition Zone, and the flat spot was effectively removed from the synthetic section.

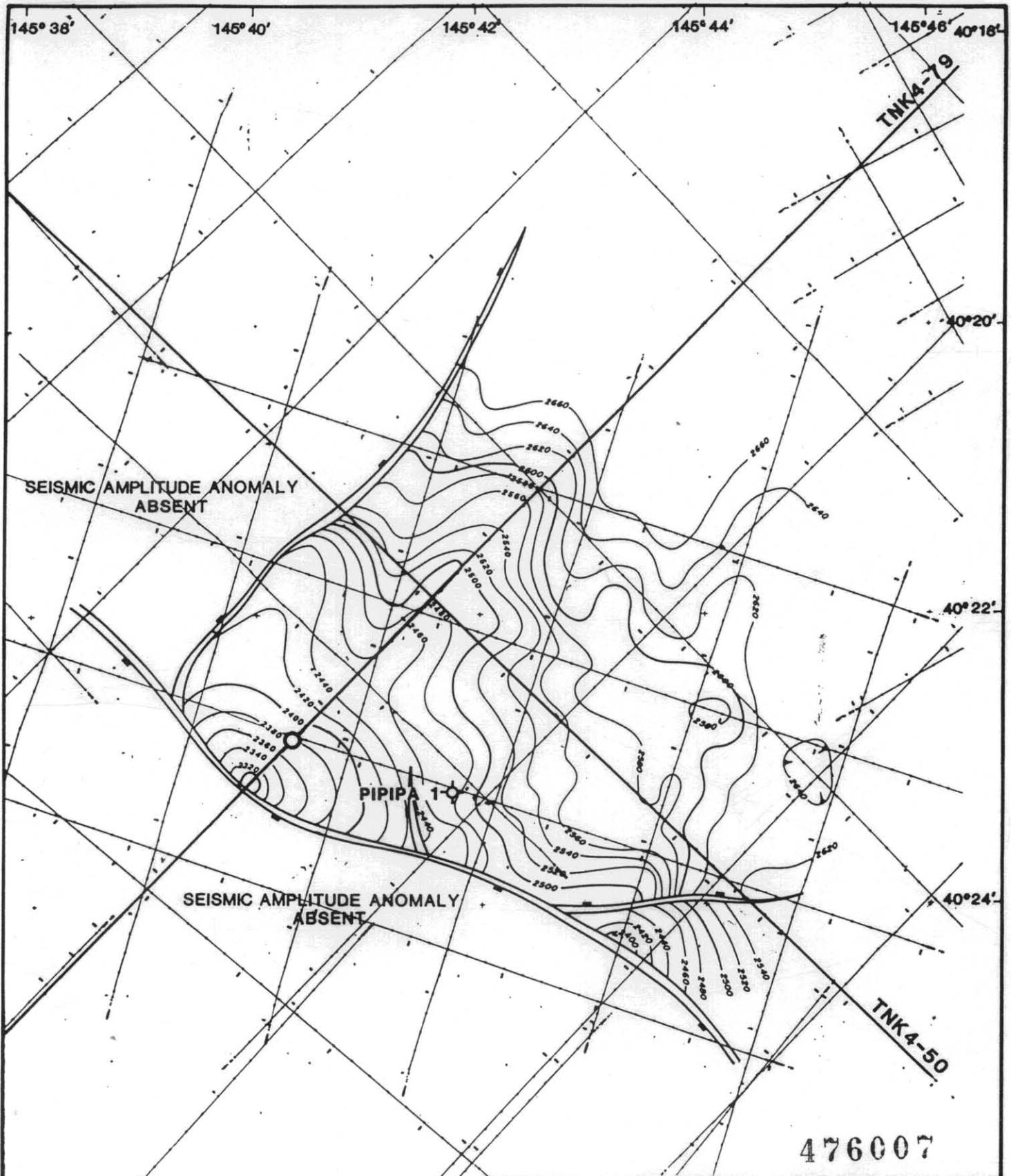
The depth model containing a 50-60 m thick high-velocity intrusive produced the synthetic time section of Figure 3. A seismic amplitude anomaly is associated with the intrusive, while the amplitudes of all other events have been suppressed artificially by a normalisation factor built into the model software. While there are similarities to the real data in terms of amplitude, there is no phase change at the base of the anomaly and there are diffraction events produced by the model at the edge of the intrusive not seen on the real data.

IMPLICATIONS

Figure 4 contains part of seismic line TNK4-79 that was reprocessed internally by Shell Company of Australia. It is a zero phase, DMO migrated section. The feature to note is the presence of a flat event at the base of the anomaly that occurs in a position corresponding to a possible hydrocarbon/water contact as predicted by the model of Figure 2. This provides evidence that a 300 metre gross hydrocarbon column could be present at the mid Pelican Zone level.

CONCLUSIONS

- . A synthetic time section can be produced showing all the seismic attributes of the anomaly as seen on real data, by using the Pelican 5 well logs as control for lithology distribution in the Pelican Zone and by introducing a gas charged sandy sequence coincident with the anomaly.
- . A model using a high velocity igneous intrusive shows only some features of the real data.
- . Reprocessed data produced a flat spot corresponding to a modelled gas/water contact.
- . The preferred interpretation is that the observed amplitude anomaly represents the presence of a 300 metre hydrocarbon column. The hydrocarbon being either gas, or oil associated with porosity improvement of reservoirs updip of the Pelican Trough.



5 cm

0 5
Kilometres



SAGASCO Resources Ltd.

BASS BASIN - SOUTH AUSTRALIA

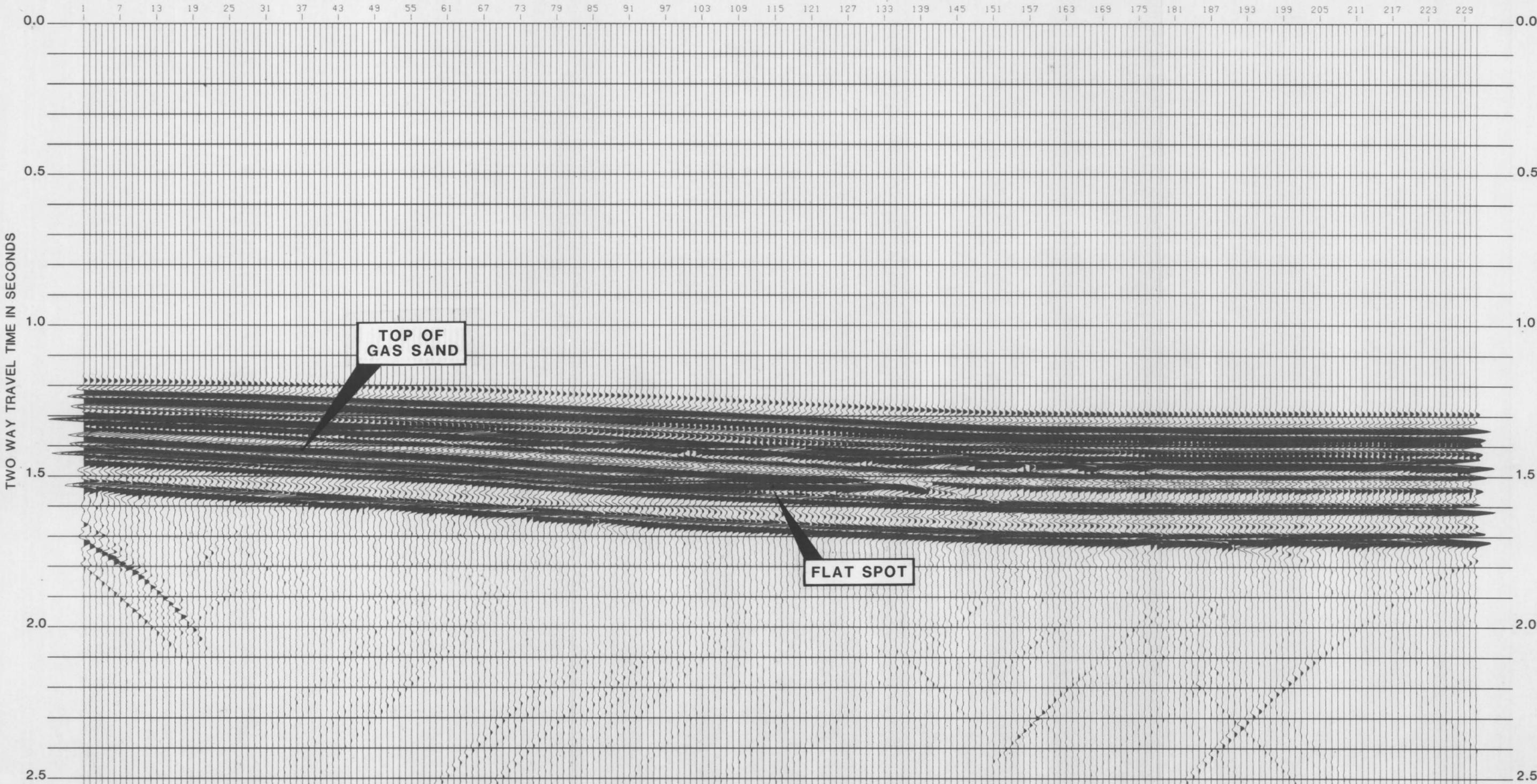
T-22-P BLOCK

**PIPIPA DEEP PROSPECT
TOP SEISMIC AMPLITUDE
ANOMALY-DEPTH STRUCTURE**

AUTHOR	A. Waldron	DATE	June 1990	PLAN	PIP00.7677
DRAWN	P. Oldham	DATUM	M.S.L.	CHECKED	FIG 1
SCALE	As shown	CONTOUR INTERVAL			

476008

SOURCE COORD. 2500 2900 3300 3700 4100 4500 4900 5300 5700 6100 6500 6900 7300 7700 8100 8500 8900 9300 9700 10100 10500 10900 11300 11700 12100 12500 12900 13300 13700 (M)



TOP OF GAS SAND

FLAT SPOT

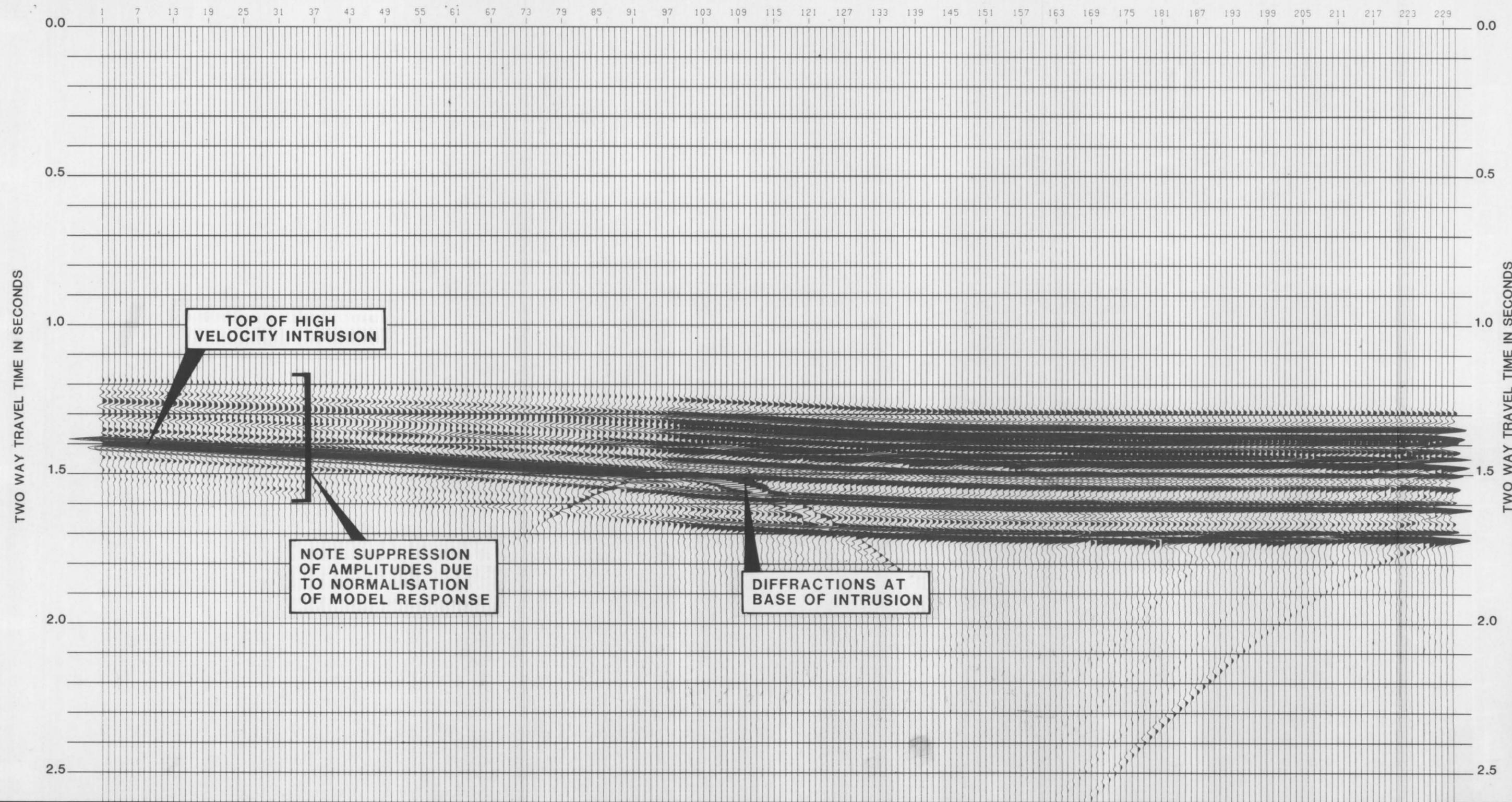
5 cm

SAGASCO Resources Ltd.

BASS BASIN - SOUTH AUSTRALIA
T-22-P BLOCK
PIPIA DEEP PROSPECT
INITIAL GAS SAND MODEL

AUTHOR	A. Waldron	DATE	June 1990	PLAN No	PIP00.7674
DRAWN	P. Oldham	DATUM	M.S.L.	CHECKED	FIG 2
SCALE	As shown	CONTOUR INTERVAL			

SHOT NO. 115 117 119 121 123 125 127 129 131 133 135 137 139 141 143 145 147 149 151 153 155 157 159 161 163 165 167 169 171
 SOURCE COORD. 2500 2900 3300 3700 4100 4500 4900 5300 5700 6100 6500 6900 7300 7700 8100 8500 8900 9300 9700 10100 10500 10900 11300 11700 12100 12500 12900 13300 13700 (M)

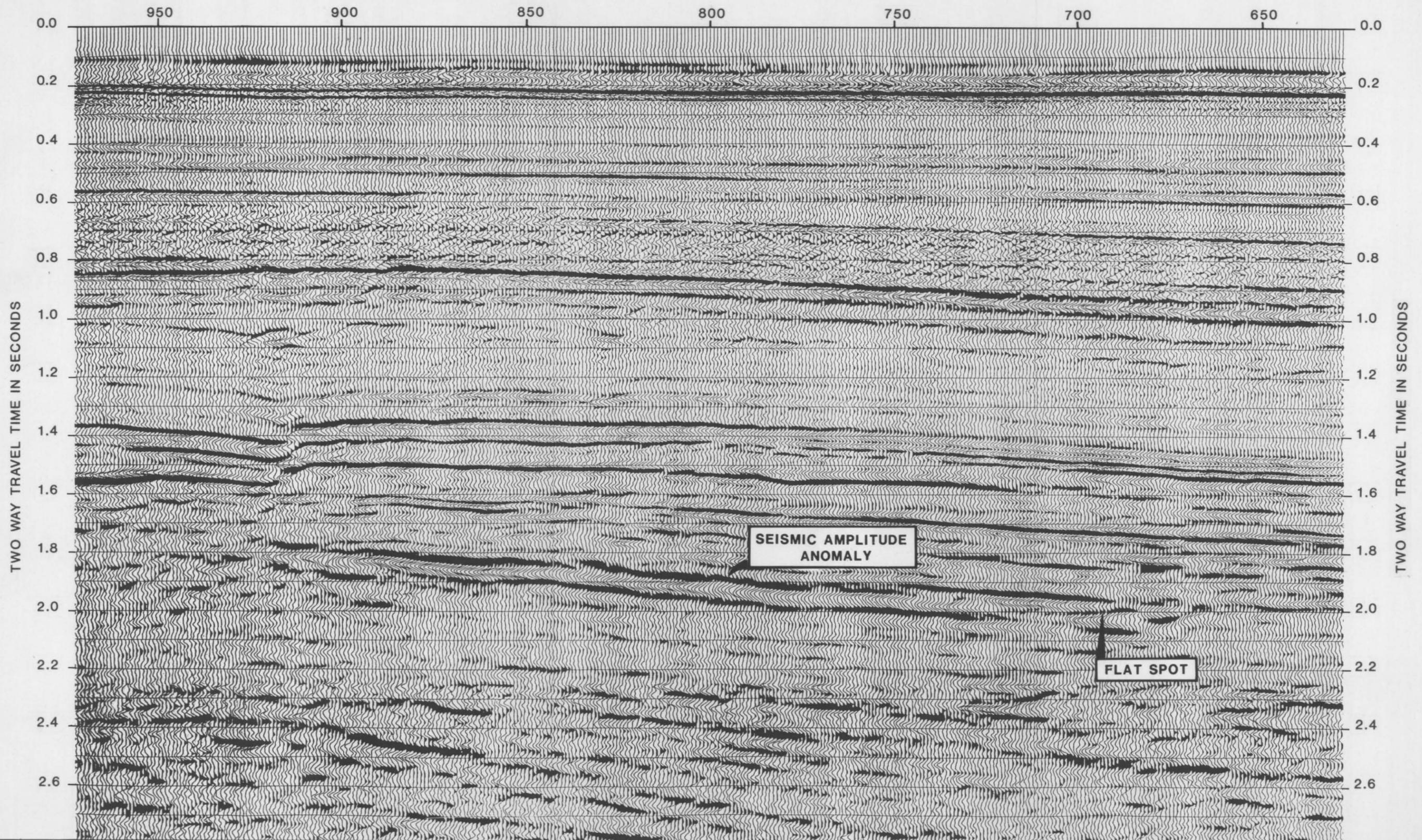


476009

5 cm

SAGASCO Resources Ltd.
 BASS BASIN - SOUTH AUSTRALIA
 T-22-P BLOCK
 PIIPA DEEP PROSPECT
 INITIAL HIGH VELOCITY MODEL

AUTHOR: A. Waldron	DATE: June 1990	PLAN No: PIP00.7675
DRAWN: P. Oldham	DATUM: M.S.L.	CHECKED:
SCALE: As shown	CONTOUR INTERVAL:	FIG: 3



476010

5 cm

SAGASCO Resources Ltd.

BASS BASIN - SOUTH AUSTRALIA
T-18-P BLOCK

SEISMIC LINE TNK4-79
REPROCESSED BY SHELL, 1990

AUTHOR	A. Waldron	DATE	June 1990	PLAN No	PIP00.7676
DRAWN	P. Oldham	DATUM	M.S.L.	CHECKED	FIG 4
SCALE	As shown	CONTOUR INTERVAL			

Pyspa

476011

POTENTIAL RESERVES:**(1) STRUCTURE AS DEFINED BY SEISMIC AMPLITUDE ANOMALY:**

AREAL CLOSURE (SQ. KM)	PAY (METRES)	OIL ONLY CASE		GAS ONLY CASE	
		OIP (MMBLS)	REC (MMBLS)	GIP (BCF)	REC (BCF)
28	10	185	45	300	225
	50	925	230	1495	1120

18%

- (2) POTENTIAL UPSIDE:**
- HIGHER NET/GROSS
 - ADDITIONAL RESERVOIR TARGETS BELOW SEISMIC AMPLITUDE ANOMALY EG. GOLDEN BEACH GROUP EQUIVALENTS.
 - HYDROCARBON ACCUMULATION EXTENDS TO THE NORTHWEST WHERE CLOSURE OCCURS BUT SEISMIC AMPLITUDE ANOMALY IS ABSENT.

$$28 \times 10 \times 2 \times 0.7 \times 238 = \frac{300107}{35.3} = 8.5 \text{ BCM.}$$

UPDIP RESERVES POTENTIAL OF THE POST PELICAN
ZONE SANDS ENCOUNTERED IN PIPIPA 1

KB DEPTH (METRES)	NET SAND (METRES)	AVERAGE POROSITY (%)	OIL-IN-PLACE (MMBLS)
1945.00-1954.00	4.27	20.2	35
1970.23-1982.00	5.49	20.9	47
1992.00-1997.50	4.57	17.4	33
2015.00-2019.00	2.13	21.9	19
2039.00-2047.80	7.16	20.1	59
AREA	=	11.2 SQUARE KILOMETRES	(2770 ACRES)
OIL SATURATION	=	70%	
EXPANSION FACTOR	=	1.2	
TOTAL OIL-IN-PLACE	=	193 MMBLS	
RECOVERABLE OIL	=	54 MMBLS	(RECOVERY FACTOR = 28%)

GAS-LIQUIDS RESERVES POTENTIAL OF THE PELICAN
ZONE SANDS AT THE PIPIPA DEEP PROSPECT

AREA (SQ KM)	PAY (METRES)	GIP (BCF)	REC (BCF)	SALES (BCF)	GAS-LIQUIDS (MMBLS)
28	10	300	225	135	30
	50	1495	1120	670	150

RECOVERY FACTOR = 75%
SHRINKAGE FACTOR = 60%
LIQUIDS FACTOR = 135 BBL/MMCF