CODAS
A METHOD OF OBTAINING MOVEOUT, VELOCITY AND MULTIPLE INFORMATION FROM ROUTINE SEISMIC SHOOTING

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ABSTRACT

CODAS (Common Offset Distance Artificial Split) is a system of stacking traces which are at equal distances from the shot point. A reverse coverage artificial split can be developed from uni-directional multiple coverage shooting. Such a spread may be used to measure move-outs and calculate apparent velocities.

The quality of the artificial split may be improved considerably by stacking traces which are at a common distance from their respective shot points. The result is a considerably enhanced record, the reflection times of which may be used to determine velocities.

INTRODUCTION

The letters CODAS stand for Common Offset Distance Artificial Split. As the name implies, the system consists of stacking traces which are at equal distances from the shot point. The purpose of the stack is to reduce random noise.

This procedure does not share the popularity nor the mathematical acceptability of the common depth point technique. However, under certain conditions it can be a valuable tool.

A system is presented whereby reverse coverage can be obtained from uni-directional shooting (artificial split). This eliminates errors in move-out measurement due to dipping beds or a uniformly dipping weathering pattern.

THE ARTIFICIAL SPLIT

Consider the simple case of uni-directional 6-Fold Roll-along shooting. Shot point and cable are moved the distance of two geophone groups after each shot (see Fig. 1). Location "S" on the surface represents trace 24 of S.P. "F," trace 22 of S.P. "G," etc., down to trace 2 of S.P. "Q."

If we take each individual trace listed above and display them side by side, in the order listed, the result would be the same as shooting a twelve trace record from shot point "S" into geophones located at F, G, H, I, J, K, L, M, N, O, P and Q. The near trace would be trace 2, from S.P. "Q" and the far trace would be trace 24 from S.P. "F." The direction of "shooting" would be reversed with respect to regular production records.

Sub-surface coverage would be as shown in Fig. 1a. This is almost identical with sub-surface coverage from shot point "L" traces 2 to 24

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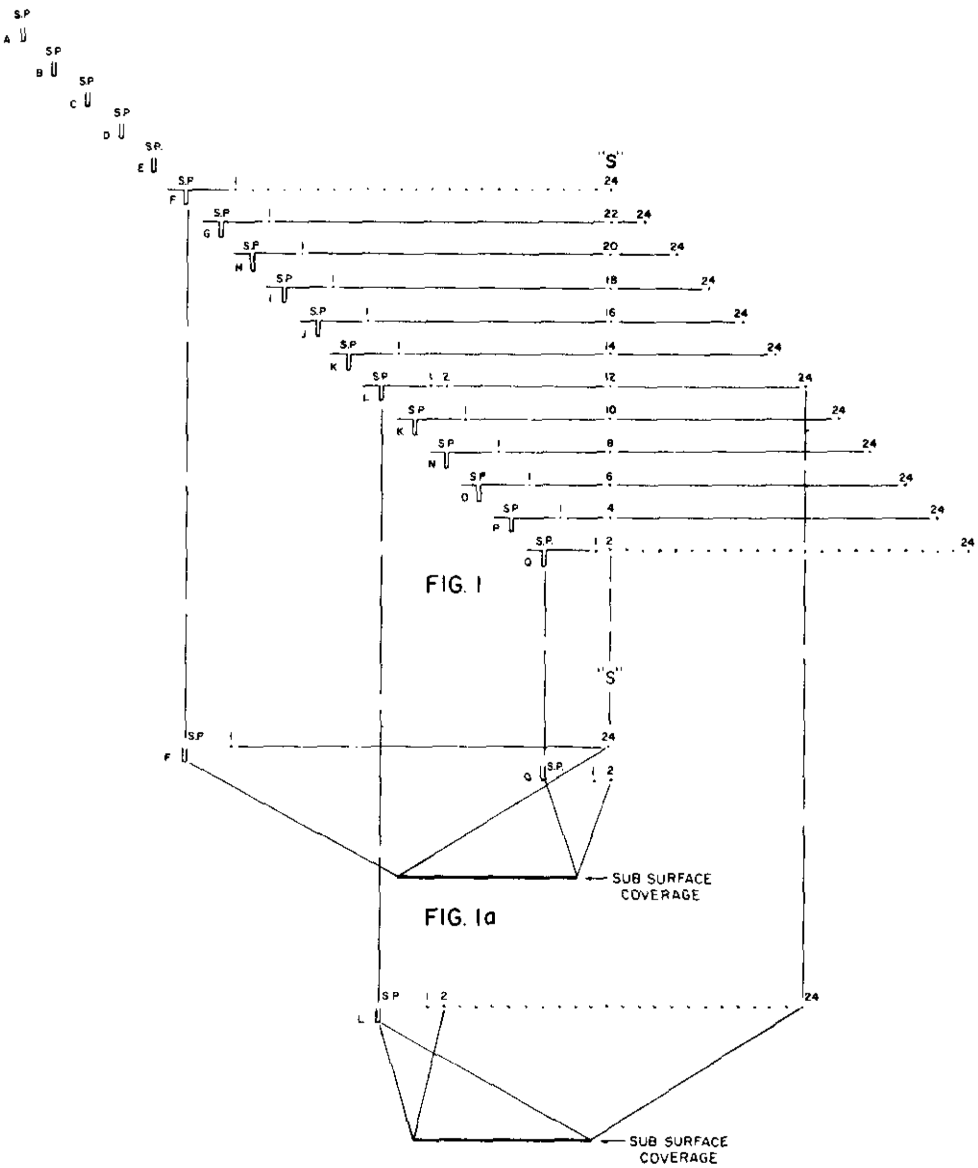

FIG. 1

FIG. 1a

FIG. 1b

(Fig. 1b). Combining even traces from shot point "L" as in Table I will produce first arrival patterns similar to those shown in Fig. II.

A record constructed in the above manner is similar to an expanded spread. It can be used to measure moveouts and calculate apparent

SHOT-POINTS	TRACES ON NEW ARTIFICIAL SPLIT 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
F	24																							
G		22																						
H			20																					
I				18																				
J					16																			
K						14																		
L							12						2	4	6	8	10	12	14	16	18	20	22	24
M								10																
N									8															
O										6														
P											4													
Q												2												

TRACES FROM REGULAR SHOT POINTS

TABLE I

velocities. Because it represents the same sub-surface area shot from both directions it would compensate for errors introduced by dipping beds. Such a record is shown in Plate I. An artificial split should be located where topography and sub-surface dips are gentle.

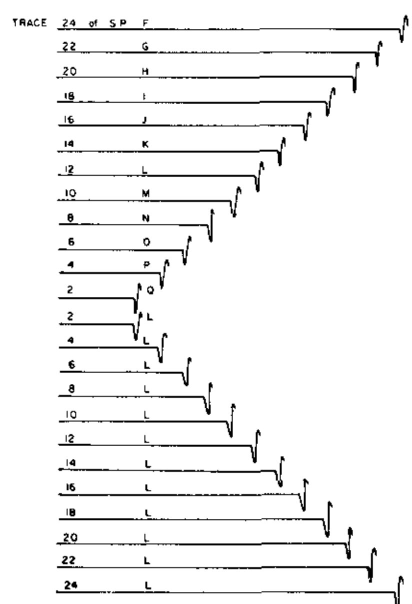

FIG. II

COMMON OFFSET DISTANCE STACK

The accuracy of information from the artificial split is limited by the quality of the data.

This quality can be improved considerably by stacking traces which are a common distance from their respective shot points. Consider the shooting arrangement of Figure 1. If we were to include information from shot points "A" to "E" to the top 12 traces we could construct a stacking arrangement as in Table II. Weathering corrections should be applied to individual traces before stack. See Appendix.

Individual traces from the CODAS record constructed in this manner now contain information averaged from six separate sub-surface points. This has shifted the average location of the sub-surface coverage to the left for the top twelve traces and to the right for the bottom twelve. We are no longer shooting the same sub-surface from both directions. However, there is still compensation for errors introduced by dipping horizons.

SHOT-POINTS	TRACES ON C.O.D.A.S.																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	24																							
B	24	22																						
C	24	22	20																					
D	24	22	20	18																				
E	24	22	20	18	16																			
F	24	22	20	18	16	14																		
G		22	20	18	16	14	12																	
H			20	18	16	14	12	10																
I				18	16	14	12	10	8															
J					16	14	12	10	8	6														
K						14	12	10	8	6	4													
L							12	10	8	6	4	2	2	4	6	8	10	12	14	16	18	20	22	24
M								10	8	6	4	2	2	4	6	8	10	12	14	16	18	20	22	24
N									8	6	4	2	2	4	6	8	10	12	14	16	18	20	22	24
O										6	4	2	2	4	6	8	10	12	14	16	18	20	22	24
P											4	2	2	4	6	8	10	12	14	16	18	20	22	24
Q												2	2	4	6	8	10	12	14	16	18	20	22	24

TABLE II

The record obtained in this manner will be enhanced considerably (Plate II) and measurements made from it will represent a statistical average of six rather than one reading. It should be pointed out that, because we are stacking common distance traces, both reflections and multiples will be enhanced.

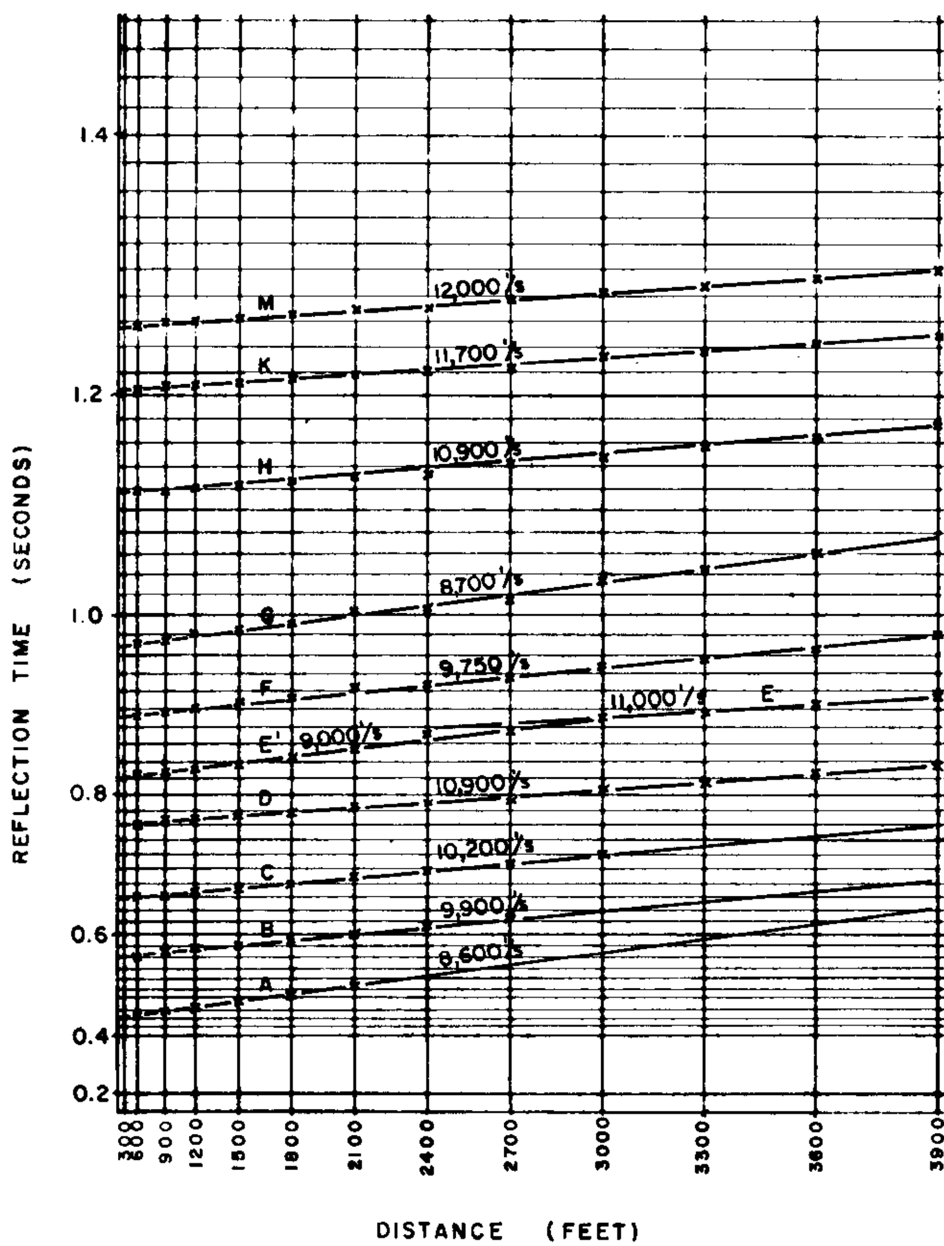
M
12,000'/s
K
11,700'/s
H
10,900'/s
8,700'/s
G
F
9,750'/s
11,000'/s
E
E'
9,000'/s
D
10,900'/s
C
10,200'/s
B
9,900'/s
8,600'/s
A
1.4
1.2
1.0
0.8
0.6
0.4
0.2
REFLECTION TIME (SECONDS)
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
3900
DISTANCE (FEET)

FIG. 111

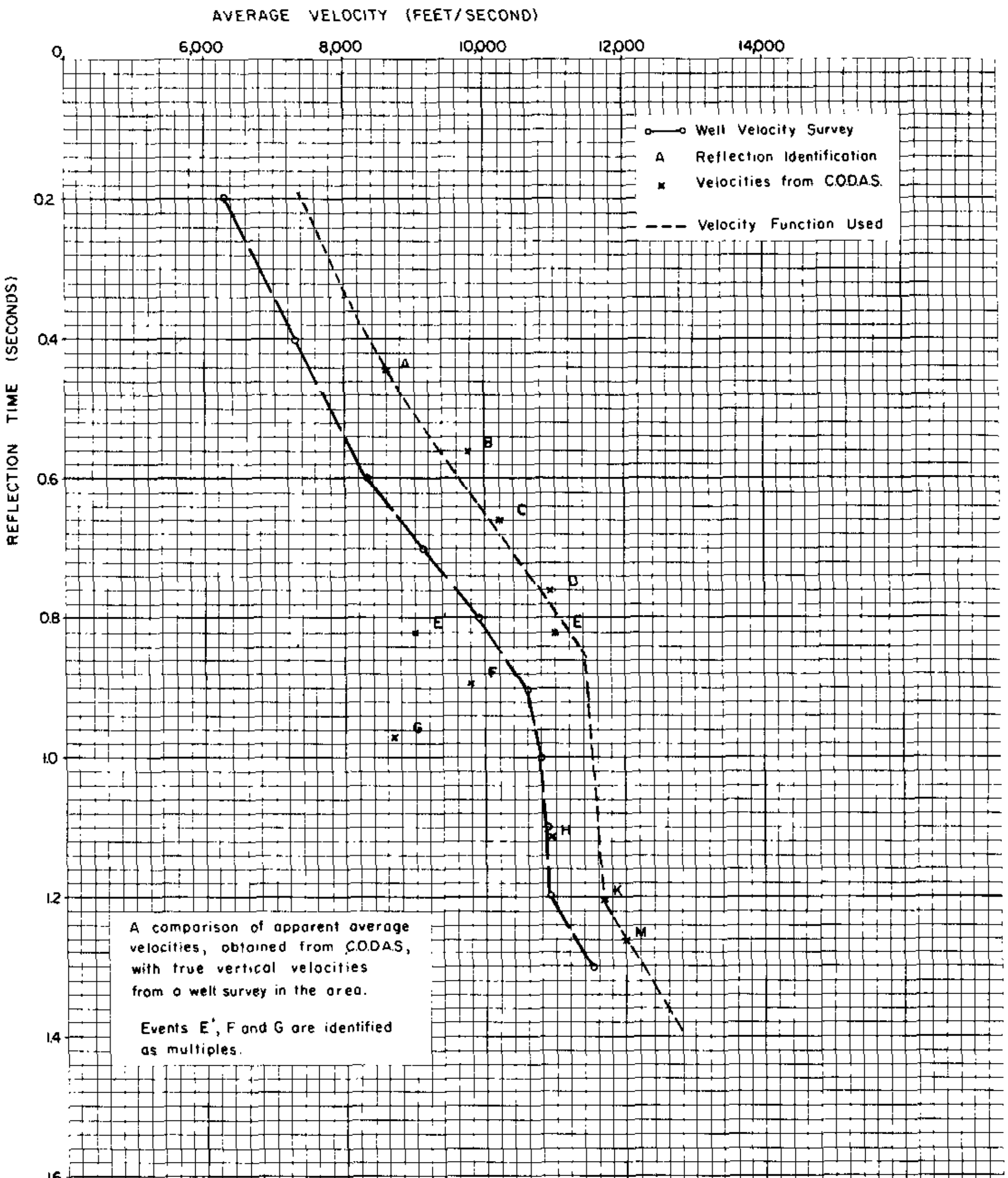
AVERAGE VELOCITY (FEET/SECOND)
0
6,000
8,000
10,000
12,000
14,000
REFLECTION TIME (SECONDS)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Well Velocity Survey
A Reflection Identification
Velocities from C.O.D.A.S.
Velocity Function Used
A
B
C
D
E
E'
F
G
H
K
M
A comparison of apparent average velocities, obtained from C.O.D.A.S, with true vertical velocities from a well survey in the area.
Events E', F and G are identified as multiples.

FIG. IV

VELOCITIES

Reflection times from the CODAS record can be plotted on X^2, T^2 paper (Fig. III). The slope of a best fit straight line through the points of each individual reflection represents the apparent average velocity to that reflection. This apparent velocity is the information that should be used to obtain the moveout function for the area. It is usually about 8% higher than the true vertical velocity obtained from well surveys.

MULTIPLES

Multiple reflections can be identified generally by their lower average velocity (Fig. IV). On Plate II, events E′, F and G are multiples. A study of the CODAS record will determine whether they present a problem to interpretation or not.

A comparison of the CODAS record with the final stacked section will show how well the stack is attenuating the multiples. Experience has shown that the severity of multiple reflections can change over a short distance. For this reason CODAS is not meant to replace the 100% long trace gather as a continuous check on multiples.

CONCLUSIONS

CODAS is a promising method of using conventional field data to obtain a moveout function for processing this same data. It also aids in identifying multiple reflections and designing spreads to attenuate these multiples.

The preceding presentation was treated in analog form for simplicity of presentation. The entire procedure is amenable to completely automatic treatment by the digital computer.

I would like to thank Banff Oil Ltd. for the time and facilities to prepare this paper and for permission to have it printed.

APPENDIX

Static Corrections

Best results are obtained from CODAS if static corrections are applied to individual traces before stack. The statics may be derived in many ways. The following is a system that works very well for this process. In order to use this system the same reflection must be present on all traces.

Table II lists the appropriate traces to be used from the various shot points in order to construct the CODAS record. The columns accommodate the time from time break to the specimen reflection (Table III).

The averaged reflection times for common distances are plotted on X^2, T^2 paper (Fig. V). A best fit line through the points represents the average velocity to that horizon. The resulting velocity should be analysed to determine that the reflection is not a multiple.

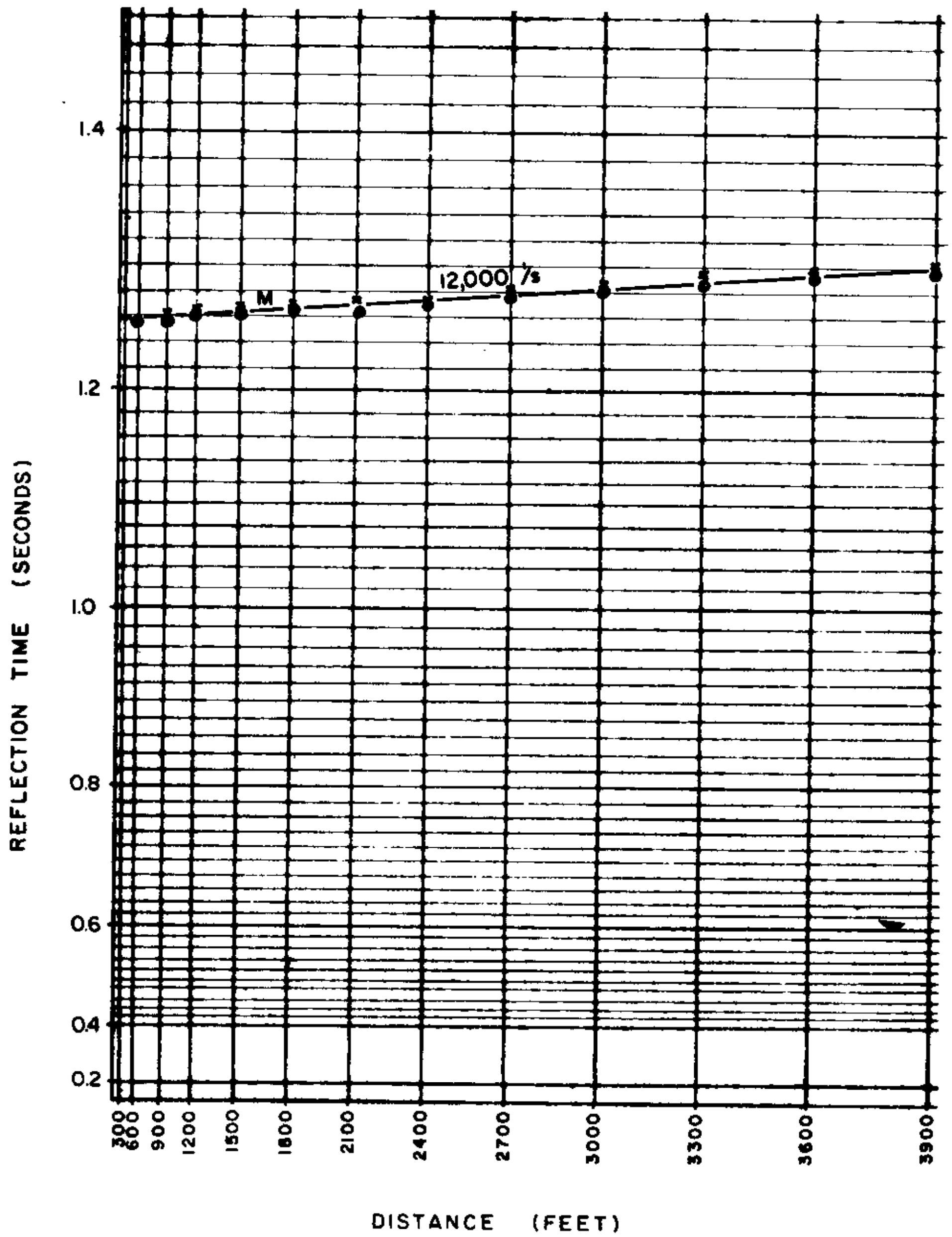
REFLECTION TIME (SECONDS)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
12,000 '/s
M
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
3900
DISTANCE (FEET)

FIG. V

TRACE NUMBERS

SHOT-POINTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	1.302																							
B	1.308	1.300																						
C	1.306	1.303	1.297																					
D	1.305	1.300	1.299	1.291																				
E	1.300	1.295	1.295	1.294	1.285																			
F	1.300	1.294	1.294	1.287	1.287	1.280																		
G		1.295	1.289	1.287	1.285	1.284	1.275																	
H			1.289	1.284	1.288	1.283	1.280	1.274																
I				1.283	1.276	1.277	1.274	1.273	1.270															
J					1.277	1.272	1.275	1.272	1.268	1.266														
K						1.272	1.268	1.272	1.268	1.267	1.262													
L							1.267	1.263	1.269	1.263	1.263	1.259	1.259	1.263	1.263	1.269	1.263	1.267	1.268	1.273	1.276	1.283	1.287	1.304
M								1.266	1.265	1.270	1.265	1.266	1.266	1.265	1.270	1.265	1.266	1.266	1.273	1.275	1.279	1.285	1.302	1.298
N									1.266	1.265	1.271	1.265	1.265	1.271	1.265	1.266	1.265	1.270	1.271	1.277	1.285	1.296	1.296	1.300
O										1.266	1.261	1.266	1.266	1.261	1.266	1.263	1.267	1.263	1.272	1.276	1.290	1.289	1.293	1.295
P											1.261	1.260	1.260	1.261	1.259	1.264	1.263	1.269	1.273	1.284	1.288	1.292	1.292	1.294
Q												1.259	1.259	1.256	1.263	1.262	1.265	1.270	1.280	1.279	1.285	1.288	1.289	1.284
T = AVE TIME	1.304	1.298	1.294	1.286	1.283	1.278	1.273	1.270	1.268	1.266	1.264	1.263	1.263	1.263	1.265	1.265	1.265	1.268	1.273	1.277	1.283	1.289	1.293	1.296
T'	1.303	1.296	1.290	1.285	1.280	1.276	1.272	1.269	1.266	1.264	1.263	1.261	1.261	1.263	1.264	1.266	1.269	1.272	1.276	1.280	1.285	1.290	1.296	1.303

T' = TIME FROM BEST FIT STRAIGHT LINE

TABLE III

The time value of this line is noted at each distance location. This is shown as T' at the bottom of table III. The difference between T' and the raw reflection time will be the static correction for that trace (Table IV).

SHOT-POINTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	+1																							
B	-5	-4																						
C	-3	-7	-7																					
D	-2	-4	-9	-6																				
E	+3	+1	-5	-9	-6																			
F	+3	+2	-4	-2	-7	-4																		
G		+1	+1	-2	-5	-8	-3																	
H			+1	+1	-8	-7	-8	-5																
I				+2	+4	-1	-2	-4	-4															
J					+3	+4	-3	-3	-2	-2														
K						+4	+4	-3	-2	-3	+1													
L							+5	+6	-3	+1	0	+2	+2	0	+1	-3	+6	+5	+8	+7	+9	+7	+9	-1
M								+3	+1	-6	-2	-5	-5	-2	-6	+1	+3	+6	+3	+5	+6	+5	-6	+5
N									0	-1	-8	-4	-4	-8	-1	0	+4	+2	+5	+3	0	-6	0	+3
O										-2	+2	-5	-5	+2	-2	+3	+2	+9	+4	+4	-5	+1	+3	+8
P											+2	+1	+1	+2	+5	+2	+6	+3	+3	-4	0	-2	+4	+9
Q												+2	+2	+7	+1	+4	+4	+2	-4	+1	0	+2	+7	+19

TABLE IV

T' - T = STATIC CORRECTION

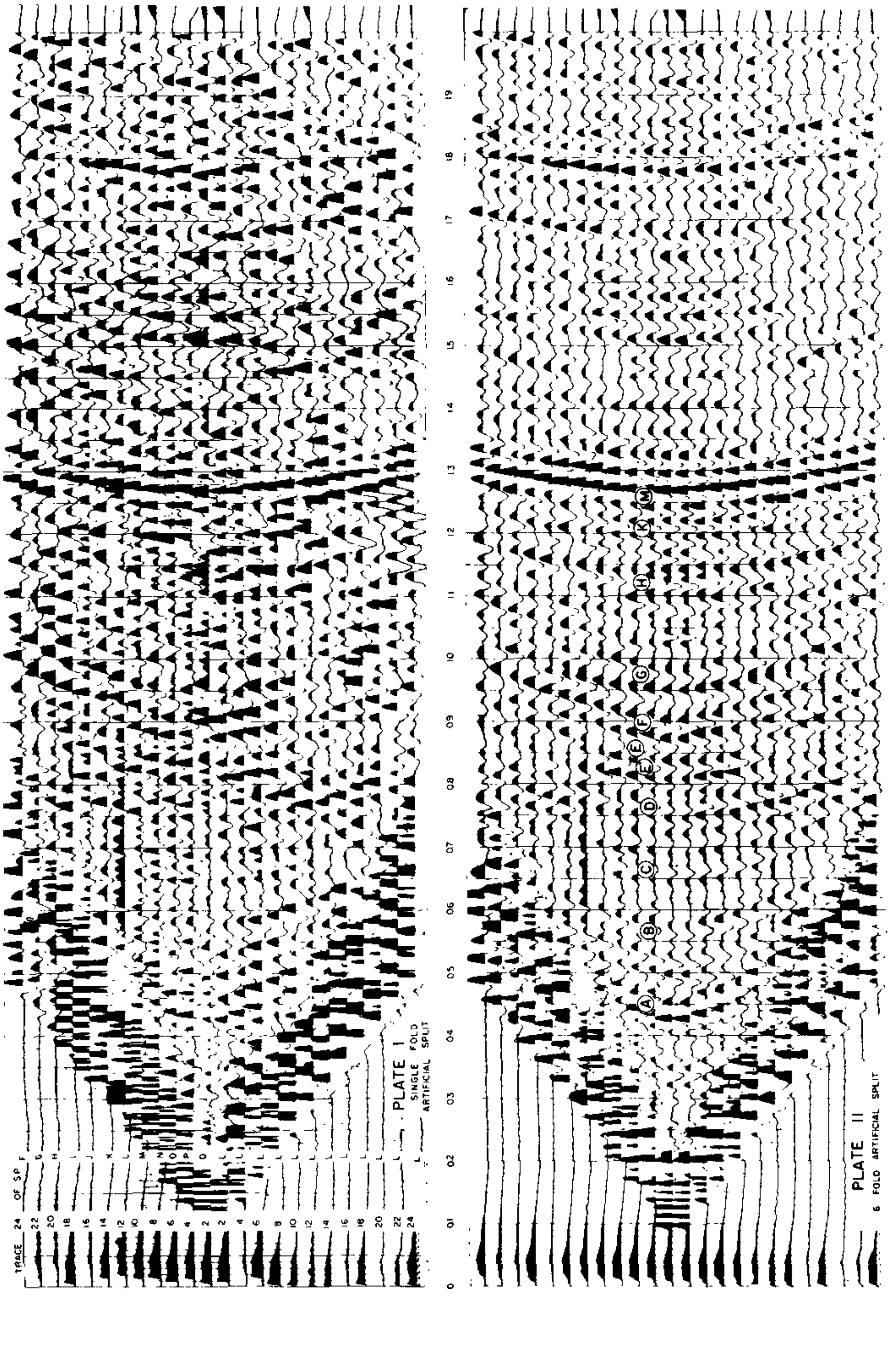
PLATE I
SINGLE FOLD
ARTIFICIAL SPLIT
PLATE II
6 FOLD ARTIFICIAL SPLIT
TRACE
OF SP