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by

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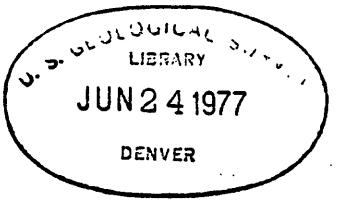

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Abstract

SIPB is a Fortran computer program that was developed for use with a batch processing computer system with program control information and input data submitted on cards or tape and output data printed on a line printer. The program is an upgraded version of FSIP1 (Scott, Tibbetts, and Burdick, 1972) with several major improvements. It is a batch-mode version of SIPT which was developed recently for interactive timeshare computer systems (Scott, 1977). The most significant improvement was made in the procedure for handling data from in-line offset shotpoints beyond the end shotpoints of the geophone spread. The changes and improvements are described, additions to user's instructions are given, examples of input and output data for a test problem are presented, and the Fortran program is listed in this report.

Introduction

SIPB is a Fortran-4 computer program for inverse modeling of seismic refraction data. Output of the program is printed in tables and as a plotted vertical cross section representing velocity layering

beneath a line of seismic spreads. SIPB evolved from FSIP1, a batch-mode Fortran program developed and described by Scott, Tibbetts, and Burdick (1972) and by Scott (1973). SIPB has been developed and tested on a DEC-1070 computer with an ANSI Standard Fortran Compiler, and should be operable with only minor modification on any similar machine with a virtual memory and a standard Fortran compiler.

This report describes the salient features of SIPB with emphasis on the changes and improvements that have been made over its predecessor FSIP1. An outline of user's instructions and examples of input and output data are presented along with a complete listing of the program.

Salient features of SIPB

The following basic assumptions apply to the inverse modeling procedure used in SIPB:

1. Layers are continuous and extend from one end of the line of refraction spreads to the other.
2. Layer velocity increases with layer depth.
3. Horizontal velocity is equal to or greater than vertical velocity for any given layer.
4. Although vertical and horizontal velocity for a given layer may be different from one another, both velocities are constant from one end of a spread to the other. Vertical and horizontal velocities may vary from one spread to another.

5. The program user determines and specifies the refraction layer that is represented by each arrival time entered as input data. If a refraction layer is not specified, that arrival time is not used in computing the depth model.

6. The program user determines and specifies the position (in 3-D space) of each shotpoint and geophone for which arrival times are entered as input data.

7. Limits of input data:

   Number of layers in a problem: 2-5.

   Number of geophone spreads in a problem: 1-5.

   Number of shotpoints per spread: 1-7.

   Number of geophones per spread: 2-25 (other ranges available).

   Number of problems per job: no limit.

The following changes and improvements over FSIP1 were made in developing SIPB:

1. Shotpoint explosive charges can be located in any layer in SIPB. In FSIP1 all shots were assumed to be in layer 1 which sometimes caused this layer to be distorted near the shotpoint when shots were located in deep holes.

2. In FSIP1 the refraction horizons were extrapolated beyond the end geophones of the end spreads using the dip that was determined for the horizon between the two end geophones. This procedure sometimes produced erroneous projections of refraction horizons, resulting in an unreasonable model, particularly when option JOFF=1 was selected, which caused

rays to be traced from distant in-line offset shotpoints along projected refraction horizons. In SIPB, under the JOFF=1 option, refraction horizons are extended beyond the spread ends to the actual entry point of the ray traced from the offset shotpoint into the refraction horizon during the previous iteration of ray tracing. Under the JOFF=0 option the refraction horizon is projected using the dip obtained by linear regression of depth points occurring under the half of the geophone spread in question. This procedure usually projects the refraction horizon at a much gentler and more reasonable dip. However, in cases where this approach still produces an unreasonable result, a new option called IDIP can be selected by placing a 1 (rather than zero or blank) in column 80 of the second control cord. This option (IDIP=1) causes the ray-tracing subroutine RAYUP to use the average slope of the ground surface along the geophone spread(s) in place of the computed dip of the refraction horizons in tracing a ray from a refractor to a target geophone or shotpoint, which is equivalent to making the assumption that the directions taken by rays entering and emerging from the refraction horizon are those that would occur if all layers were parallel with the ground surface. The model layers are not

forced to be parallel with the surface by this option. However, the selection of this option cannot result in a completely valid model unless the refraction horizons are actually parallel with the ground surface, and it should not be used except as a last resort to obtain a reasonable model when large and uncorrectable errors are associated with input data. The IDIP option of SIPB replaces the IFILL option of FSIP1, an option that was seldom used and never needed since it merely changed the selection of characters used in producing the printer plot of the vertical cross-sectional model. Removal of the IFILL option has simplified subroutine PLOT, resulting in more efficient operation.

3. The option JOFF=0, obtained by putting a blank or zero in column 79 of the second control card in FSIP1, has been improved significantly in SIPB. The objective of this option is to reference the arrival times associated with offset shotpoints (beyond the spread end shotpoints) to the arrival times of the end shotpoints and then to trace the rays from the end shotpoints to the target geophones rather than from the offset shotpoints to the target geophones. This approach has the advantage of avoiding the need for an error-prone extrapolation of the refraction horizon beyond the end shotpoints (as described in item 2 above). However, one of the limitations of selecting this option with the old FSIP1 program was that the offset shotpoint arrival times could

not be referenced to the end shotpoint times for a given layer unless at least one of the geophones received refraction arrivals (representing the layer in question) from both the offset shotpoint and the end shotpoint. In the new program SIPB, if the arrival times from the two shotpoints from the refractor do not overlap, two lines are fitted (by least squares) to the arrival times that are recorded from the two shotpoints for the refraction horizon, and the reference time correction (which is later subtracted from the offset shotpoint arrival times) is taken as the time difference between the two fitted lines at a point midway between the two inner geophones, one receiving an arrival from the offset shotpoint, the other from the end shotpoint.

4. As an extension of item 3 (above), in FSIP1 if no arrivals from the deepest refraction horizon were obtained by shooting the end shotpoint, then there was no way of referencing the arrivals obtained from the offset shotpoint to those obtained from the end shotpoint for the option JOFF=0, and the option JOFF=1 had to be used to obtain an interpretation down to the deepest layer. In SIPB, this problem is overcome by determining a reference correction time under the assumption that the two deepest layers are parallel. If this assumption is made, the times representing the deepest layer can be referenced to the arrivals representing the next shallower

layer (obtained from the same shotpoint) by subtracting

$$\Delta t_{i+1} = \frac{V_i}{V_{i+1}} \cdot \Delta t_i$$

from the arrivals representing the deepest layer. In the above formula Δt_i represents the reference correction time for referencing the arrivals from the offset shotpoint to the end shotpoint for the next shallower layer i (Δt_i is obtained by the technique described in item 3 above). V_i and V_{i+1} represent the apparent velocities for the deepest layer i+1 and the next shallower layer i, and are determined by fitting lines (by least squares) to the arrival times representing the two layers.

5. A new option called XTRUE is available in SIPT. Its normal (default) value is zero and is obtained by placing a zero or blank in column 20 of the spread control card. The purpose of the option is to correct for the slope of the ground surface and to compute new inline coordinate values (x) for geophone and shotpoint locations for XTRUE=0. If the inline coordinate values for shotpoints and geophones are corrected for surface slope prior to entry into input data files, then the option XTRUE=1 should be selected to skip the correction. When the slope correction option XTRUE=0 is selected, the position of geophone number 1 is left unchanged and all other shotpoints and geophones are referenced to it. Users

should be aware that the XSHIFT option (4th word on spread control card or record) is not affected by this new option (XSHIFT is not corrected for slope of the ground surface when XTRUE=0) and it is the user's responsibility to correct XSHIFT for surface slope before it is entered into the input data file.

6. A new option called IPLOT is available for selecting the type of time-distance plot desired for printer output. In the old program FSIP1, the time-distance plot was selected automatically as a function of the exit number. The use of IPLOT makes it possible for the user to control this selection.

User's instructions

Data cards are prepared using formats described by Scott, Tibbets and Burdick (1972, Appendix A, p. 27-32) with the following additions:

1. The new control card option IPLOT, used to select the type of time-distance plot desired, is punched in column 4 of the second control card. IPLOT=1 is used to select a plot of raw times, IPLOT=2 gives a datum-corrected plot, IPLOT=3 gives a plot with offset shotpoint times tied to end shotpoint times, and IPLOT=4 gives a plot with layer 1 removed. If column 4 is left blank, the default value of IPLOT is the absolute value of the exit number, or 4, whichever is smaller.
2. The new control variable IDIP replaces IFILL in column 80 of the second control card. (See item 2 on p. 3-5 of this report.)

3. The new variable XTRUE is available for correcting x-distances for the slope of the ground surface—default action is to apply the correction (blank or zero, column 20, spread control card, see item 5, p. 7-8).

The program is executed by the same procedures used for FSIP1 (Scott, Tibbetts, and Burdick, 1972).

References

Scott, J. H., Tibbetts, B. L., and Burdick, R. G., 1972, Computer analysis of seismic refraction data: USBM R.I. 7595, 95 p.

Scott, J. H., 1973, Seismic refraction modeling by computer: Geophysics, v. 38, no. 2, p. 271-284.

Scott, J. H., 1977, SIPT--A seismic refraction inverse modeling program for timeshare terminal computer systems: U.S. Geol. Survey Open-File Rept. 77-365, 107 p.

APPENDIX A. -- Input data examples

Input data cards for two data sets are listed below. The two sets are identical except that the exit number for the first set is 6, and for the second set, -6. Output results for both sets are given in Appendix B.

SET 1.

```
SIPTST.J06  SPREADS S AND $      DEMONSTRATION OF EXIT 6
2 6 4 4  2.5    00
1  1520
2  5900
3  9500
4 15000
S  3 12
S  A  24869   -29          2
S  C  24930   400          2
S  B  25075   900          2
S  1  24956     0         13  2  69  3  97  4
S  2  24941    75         24  2  57  3  93  4
S  3  24840   150         36  2  47  3  87  4
S  4  24873   225        485  2  43  2  805 4
S  5  24902   300         62  3  37  2  80  4
S  6  24843   375         66  3  19  2  75  4
S  7  25010   450         78  3  25  2  75  4
S  8  24911   497         73  3  24  2  64  3
S  9  24987   600         91  4  43  2  60  3
S 10  25132   675         93  4  65  3  56  2
S 11  25005   775         91  4  69  3  34  2
S 12  25059   875         99  4  78  3  18  2
$  4 12       675
$  L  24869  -704          2
$  A  24987   -75          2
$  C  25117   275          2
$  B  25499   563          2
$  1  25132     0         92  4  275 2  65  3  87  4
$  2  25003    50         86  4  275 2  50  3  74  4
$  3  25005   100         88  4  37  2  44  3  71  4
$  4  25024   150         96  4  485 2  40  2  72  4
$  5  25059   200         99  4  56  2  30  2  685 4
$  6  25096   250        995  4  57  4  19  2  62  4
$  7  25137   300        105  4  62  4  20  2  59  4
$  8  25174   350        107  4  645 4  30  2  55  4
$  9  25207   400        108  4  65  4  39  2  49  4
$ 10  25293   450        113  4  70  4  50  2  47  4
$ 11  25381   500       1165  4  74  4  55  3  45  2
$ 12  25445   525        119  4  77  4  60  3  46  1
END
```

SET 2

```
SIPTST.J06  SPREADS S AND $      DEMONSTRATION OF EXIT =6
2=6 4 4  2,5    00
1   1520
2   5900
3   9500
4  15000
S   3 12                1
S   A   24869    =29             2
S   C   24930    400             2
S   B   25075    900             2
S   1   24856      0            13  2  69  3  97  4
S   2   24841     75            24  2  57  3  93  4
S   3   24840    150            36  2  47  3  87  4
S   4   24873    225           485  2  43  2  865 4
S   5   24902    300            62  3  37  2  86  4
S   6   24843    375            66  3  19  2  75  4
S   7   25010    450            78  3  25  2  75  4
S   8   24911    497            73  3  24  2  64  3
S   9   24987    600            81  4  43  2  60  3
S  10   25132    675            93  4  65  3  56  2
S  11   25005    775            91  4  69  3  34  2
S  12   25059    875            99  4  78  3  18  2
$   4 12          675   1
$   L   24869   =704             2
$   A   24987   = 75             2
$   C   25117    275             2
$   B   25499    563             2
$   1   25132      0            92  4 275  2  65  3  87  4
$   2   25003     50            86  4 275  2  50  3  74  4
$   3   25005    100            88  4  37  2  44  3  71  4
$   4   25024    150            96  4 485  2  40  2  72  4
$   5   25059    200            99  4  56  2  30  2 685  4
$   6   25096    250           995  4  57  4  19  2  62  4
$   7   25137    300           105  4  62  4  20  2  59  4
$   8   25174    350           107  4 645  4  30  2  55  4
$   9   25207    400           108  4  65  4  39  2  49  4
$  10   25293    450           113  4  70  4  50  2  47  4
$  11   25381    500          1165  4  74  4  55  3  45  2
$  12   25445    525           119  4  77  4  60  3  46  1
END
```

APPENDIX B. -- Output data examples

Printer output for test problem SIPTST.J06 is given on the following pages. The first set shows the results obtained by selecting exit 6, and the second set, those obtained by selecting exit -6. The two sets are the same except that for exit -6 the amount of printout is reduced substantially. Input cards for both data sets are listed in Appendix A.

SIPTST.J06 SPREADS S AND $ DEMONSTRATION OF EXIT 6

CONTROL CARD DATA — PLOT SCALES — DATUM OVERRIDE VALUES

SPRDS	EXIT	LAYERS	VCARDS	PLOT SCALES ELEV FT/COL	PLOT SCALES HORIZ FT/ROW	PLOT SCALES TIME MS/COL	DATUM OVERRIDE VALUES POINT 1 ELEV	POINT 1 X POS	POINT 2 ELEV	POINT 2 X POS	SLOPE	INTCPT	BLIM	TLIM	TRACE	OFF	DIP
2	6	4	4	2.5	8.3	1.0	0.0	0.0	0.0	0.0	0.0000	0.0	0.50	10.0	0	0	0

VELOCITY CARDS

LAYER	SPREAD 1 VV	SPREAD 1 VH	SPREAD 2 VV	SPREAD 2 VH	SPREAD
1	1520.	0.	0.	0.	
2	5900.	0.	0.	0.	
3	9500.	0.	0.	0.	
4	15000.	0.	0.	0.	

SHOTPOINT AND GEOPHONE DATA

SPREAD S, 3 SHOTPOINTS, 12 GEOPHONES, XSHIFT = 0.0, XTRUE = 1

SP	ELEV	X LOC	Y LOC	DEPTH	UPHOLE T	FUDGE T	END SP
A	2486.9	-29.0	0.0	2.0	0.0	0.0	0
C	2493.0	400.0	0.0	2.0	0.0	0.0	0
B	2507.5	900.0	0.0	2.0	0.0	0.0	0

GEO	ELEV	X LOC	Y LOC	ARRIVAL TIMES + FUDGE T AND LAYERS REPRESENTED SP A	SP	SP C	SP	SP B	SP
1	2485.6	0.0	0.0	13.0	2	69.0	3	97.0	4
2	2484.1	75.0	0.0	24.0	2	57.0	3	93.0	4
3	2484.0	150.0	0.0	36.0	2	47.0	3	87.0	4
4	2487.3	225.0	0.0	48.5	2	43.0	2	86.5	4
5	2490.2	300.0	0.0	62.0	3	37.0	2	86.0	4
6	2484.3	375.0	0.0	66.0	3	19.0	2	75.0	4
7	2501.0	450.0	0.0	78.0	3	25.0	2	75.0	4
8	2491.1	497.0	0.0	73.0	3	24.0	2	64.0	3
9	2498.7	600.0	0.0	81.0	4	43.0	2	60.0	3
10	2513.2	675.0	0.0	93.0	4	65.0	3	56.0	2
11	2500.5	775.0	0.0	91.0	4	69.0	3	34.0	2
12	2505.9	875.0	0.0	99.0	4	78.0	3	18.0	2

SET 1

SIPTST.J06 SPREADS 3 AND 4 DEMONSTRATION OF EXIT 6

SHOTPOINT AND GEOPHONE DATA

SPREAD 3, 4 SHOTPOINTS, 12 GEOPHONES, XSHIFT = 675.0, XTRUE = 1

SP	ELEV	X LOC	Y LOC	DEPTH	UPHOLE T	FUDGE T	END SP
L	2486.9	-704.0	0.0	2.0	0.0	0.0	0
A	2498.7	-75.0	0.0	2.0	0.0	0.0	0
C	2511.7	275.0	0.0	2.0	0.0	0.0	0
B	2549.9	563.0	0.0	2.0	0.0	0.0	0

GEO	ELEV	X LOC	Y LOC	ARRIVAL TIMES + FUDGE T AND LAYERS REPRESENTED SP L	SP A	SP C	SP B	SP
1	2513.2	0.0	0.0	92.0 4	27.5 2	65.0 3	87.0 4	
2	2500.3	50.0	0.0	86.0 4	27.5 2	50.0 3	74.0 4	
3	2500.5	100.0	0.0	88.0 4	37.0 2	44.0 3	71.0 4	
4	2502.4	150.0	0.0	96.0 4	48.5 2	40.0 2	72.0 4	
5	2505.9	200.0	0.0	99.0 4	56.0 2	30.0 2	68.5 4	
6	2509.6	250.0	0.0	99.5 4	57.0 4	19.0 2	62.0 4	
7	2513.7	300.0	0.0	105.0 4	62.0 4	20.0 2	59.0 4	
8	2517.4	350.0	0.0	107.0 4	64.5 4	30.0 2	55.0 4	
9	2520.7	400.0	0.0	108.0 4	65.0 4	39.0 2	49.0 4	
10	2529.3	450.0	0.0	113.0 4	70.0 4	50.0 2	47.0 4	
11	2538.1	500.0	0.0	118.5 4	74.0 4	55.0 3	45.0 2	
12	2544.5	525.0	0.0	119.0 4	77.0 4	60.0 3	46.0 1	

SET 1 cont'.

SIPTST.J06 SPREADS S AND $ DEMONSTRATION OF EXIT 6

V1 FOR DIRECT PAYS AND DIRECT DISTANCES DD

SPREAD S	SP	GEO	DD	V1	AVG V1
SPREAD $	SP	GEO	DD	V1	AVG V1
	B	12	38.2	829.	
					829.
AVG OF ALL	829.				

SET 1 cont.

SIPTST.J06 SPREADS S AND $ DEMONSTRATION OF EXIT 6

ARRIVAL TIMES CORRECTED TO DATUM (DATUM ELEV = 2476.4 + (0.0420)X), AND PLOT POSITIONS D

SPREAD S			Sp A		SP C		SP B		SP
ELEV			2475.2		2493.2		2514.2		
	CURR T		-6.4		1.5		5.7		
GEO			T	D	T	D	T	D	
1	2476.4	-6.0	0.6	0.0	64.4	-0.1	95.7	-0.3	
2	2479.6	-3.0	14.7	75.0	55.5	74.9	95.8	74.7	
3	2482.7	-0.8	28.8	150.0	47.6	149.8	91.9	149.6	
4	2485.9	-0.9	41.2	225.0	43.5	224.9	91.3	224.7	
5	2489.0	-0.8	54.9	300.0	37.7	300.0	91.0	299.8	
6	2492.2	5.2	64.8	375.0	25.6	373.5	85.9	374.5	
7	2495.3	-3.7	67.9	450.2	22.7	450.6	77.0	450.0	
8	2497.3	4.1	70.7	497.0	29.5	497.0	73.8	496.7	
9	2501.6	1.9	76.5	600.1	46.4	600.1	67.6	599.9	
10	2504.8	-5.6	81.1	675.5	60.9	675.7	56.2	674.9	
11	2509.0	5.6	90.2	775.1	76.0	775.1	45.3	774.8	
12	2513.2	4.8	97.4	875.2	84.2	875.2	28.5	874.9	

SPREAD S			SP L		SP A		SP C		SP B		SP
ELEV			2484.9		2501.6		2516.3		2528.4		
	CORR T		0.0		3.2		4.3		-12.8		
GEO			T	D	T	D	T	D	T	D	
1	2504.8	-5.6	86.4	675.5	25.2	676.4	63.8	675.0	68.6	673.8	
2	2506.9	4.3	90.3	725.1	35.0	725.0	58.7	724.7	65.5	722.6	
3	2509.0	5.6	93.6	775.1	45.8	775.0	53.9	774.6	63.7	772.4	
4	2511.1	5.7	101.7	825.1	57.4	825.0	50.0	824.7	64.9	822.3	
5	2513.2	4.8	103.8	875.2	64.0	875.1	39.1	874.8	60.4	872.3	
6	2515.3	3.7	103.2	925.3	64.0	925.2	27.1	924.9	52.9	922.4	
7	2517.4	2.4	107.4	975.4	67.6	975.3	26.7	975.1	48.6	972.5	
8	2519.4	1.3	108.3	1025.4	69.1	1025.4	35.7	1025.2	43.5	1022.5	
9	2521.5	0.6	108.6	1075.5	68.8	1075.5	43.9	1075.3	36.7	1072.4	
10	2523.6	-3.7	109.3	1125.8	69.5	1125.9	50.6	1125.9	30.4	1123.1	
11	2525.7	-8.1	104.4	1176.1	69.1	1176.3	51.2	1176.5	24.0	1173.9	
12	2526.8	-11.6	107.4	1201.3	68.6	1201.7	52.7	1202.1	46.0	1199.8	

SET 1 cont'.

SIPTST.J06 SPREADS $ AND $ DEMONSTRATION OF EXIT 6
LAYER 2 VELOCITY AND TIME INTERCEPTS COMPUTED BY REGRESSION

SPREAD $ VEL	TIME	GEOS	SP	GEOS	TIME	VEL		AVG V	AVG T	PTS
000.	0.0	0 0	A	1 4	-4.3	5517.		5517.	-4.3	4.
8320.	23.5	4 6	C	7 9	14.4	6284.		7160.	19.0	6.
7227.	26.0	10 12	B	0 0	0.0	000.		7227.	26.0	3.
							AVG	6572.		13.

SPREAD $ VEL	TIME	GEOS	SP	GEOS	TIME	VEL		AVG V	AVG T	PTS
000.	0.0	0 0	A	1 5	10.2	4974.		4974.	10.2	5.
4364.	21.5	4 6	C	7 10	23.3	6295.		5291.	22.4	7.
							AVG	5154.		12.
								-------		---
							AVG OF ALL	5805.		25.

LAYER 2 VELOCITY COMPUTED BY HOBSON-OVERTON METHOD

SPREAD $ VEL	SPS	GEOS	TDSP	SE EP	EP	GEO	5 HIGHEST EPS EP	GEO	EP	GEO	EP	GEO	EP	GEO
5725.	A C	4 5	-10.0	0.000	-0.000	4	0.000	5	0.000	0	0.000	0	0.000	0

AVG= 5725. FOR 2. POINTS

AVG OF ALL= 5725. FOR 2. POINTS
OVERRIDE V2 = 5900.

SET 1 cont.

SIPTST.JOS SPREADS S AND 8   DEMONSTRATION OF EXIT 6
LAYER 3 VELOCITY AND TIME INTERCEPTS COMPUTED BY REGRESSION

SPREAD S	VEL	TIME	GEOS	SP	GEOS	TIME	VEL	AVG V	AVG T	PTS
	000.	0.0	0 0	A	5 8	31.1	12987.	12987.	31.1	4.
	8920.	19.4	1 3	C	10 12	29.8	8554.	8733.	24.6	6.
	16764.	49.7	8 9	B	0 0	0.0	000.	16764.	49.7	2.
							AVG	10769.		12.

SPREAD 8	VEL	TIME	GEOS	SP	GEOS	TIME	VEL	AVG V	AVG T	PTS
	10082.	36.4	1 3	C	11 12	38.1	17301.	12102.	37.3	5.
							AVG	12102.		5.
								-------		---
							AVG OF ALL	11129.		17.

LAYER 3 VELOCITY COMPUTED BY HUBSON-OVERTON METHOD

NOT ENOUGH POINTS
OVERRIDE VJ = 9500.

SET 1 cont.

SIPTST.J06 SPREADS $ AND $ DEMONSTRATION OF EXIT 6
LAYER 4 VELOCITY AND TIME INTERCEPTS COMPUTED BY REGRESSION

SPREAD $	VEL	TIME	GEOS	SP	GEOS	TIME	VEL	AVG V	AVG T	PTS
	000.	0.0	0 0	A	9 12	27.2	12863.	12863.	27.2	4.
	26328.	64.3	1 7	B	0 0	0.0	000.	26328.	64.3	7.
							AVG	19069.		11.

SPREAD $	VEL	TIME	GEOS	SP	GEOS	TIME	VEL	AVG V	AVG T	PTS
	000.	0.0	0 0	L	1 12	63.4	25117.	25117.	63.4	12.
	000.	0.0	0 0	A	6 12	61.8	74583.	74583.	61.8	7.
	11732.	24.5	1 10	B	0 0	0.0	000.	11732.	24.5	10.
							AVG	20365.		29.
								-------		---
							AVG OF ALL	19992.		40.

LAYER 4 VELOCITY COMPUTED BY HOBSON-OVERTON METHOD

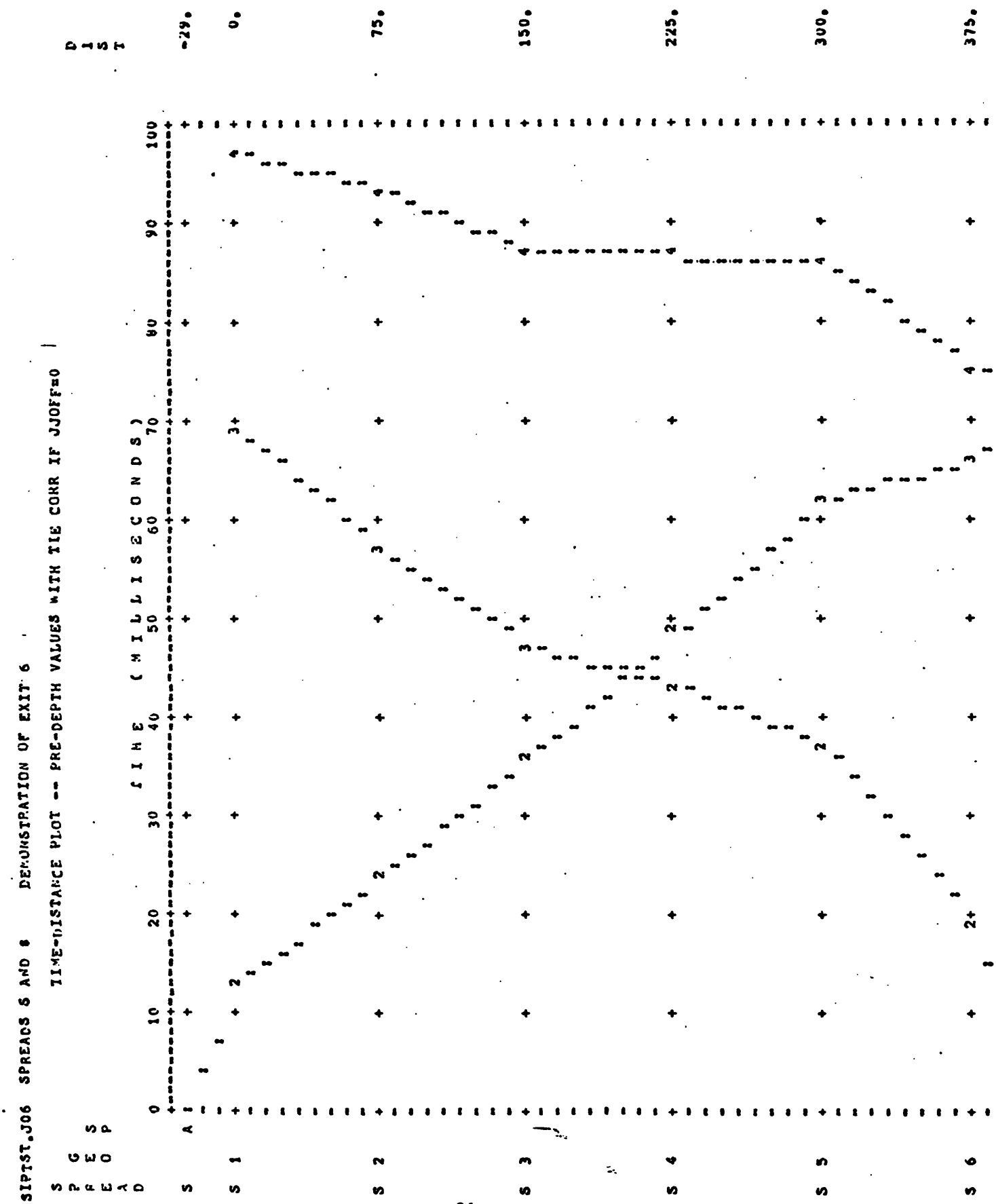
SPREAD $ VEL	SPS	GEOS	TDSP	SE EP	5 HIGHEST EPS EP	GEO	EP	GEO	EP	GEO	EP	GEO	EP	GEO
14655.	L B	1 10	7.5	0.709	1.001	2	-0.958	5	0.872	7	-0.807	3	-0.791	6
14536.	A B	6 10	10.9	0.375	0.596	7	-0.509	6	0.208	8	-0.170	9	-0.126	10

AVG= 14615. FOR 15. POINTS

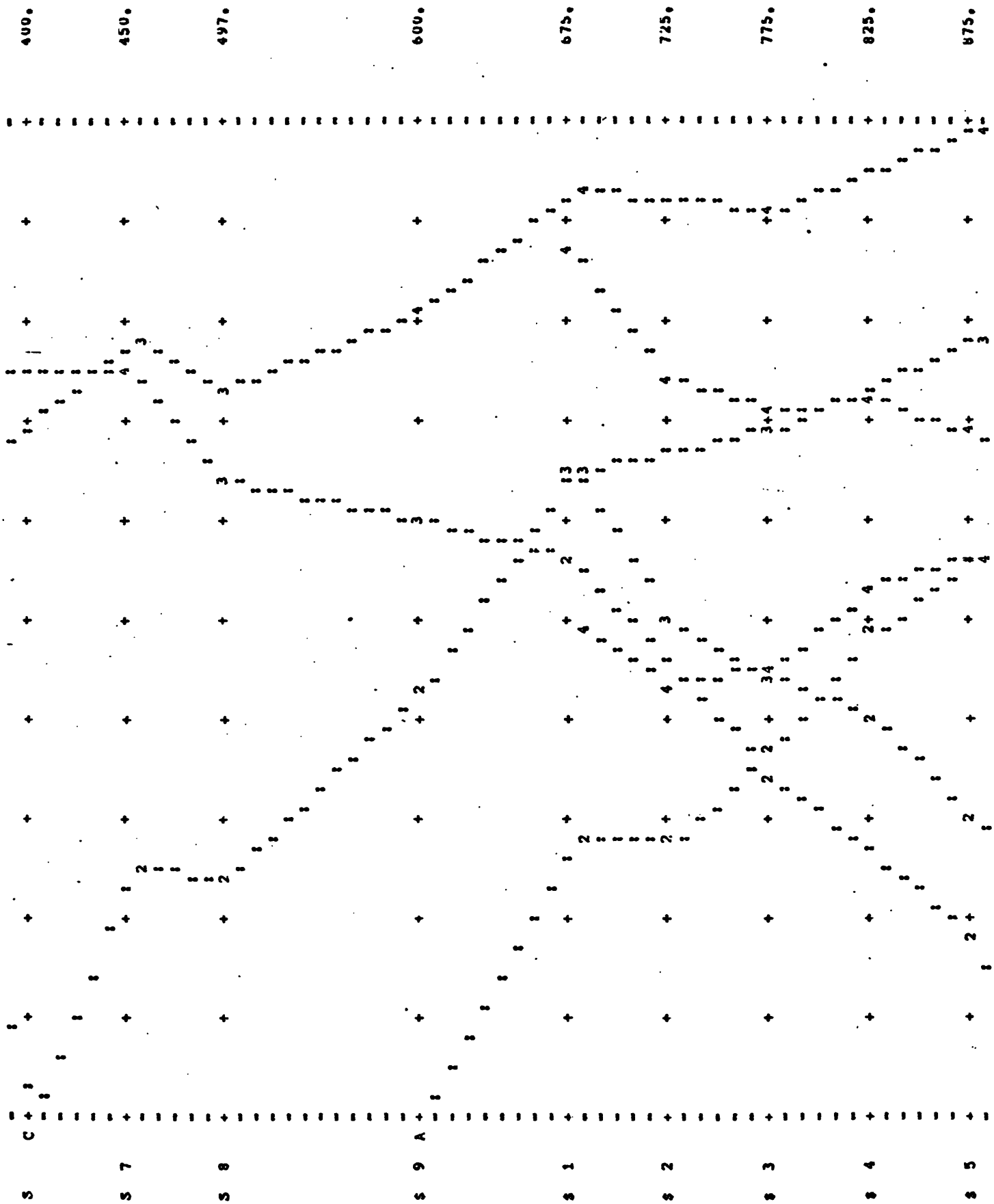
AVG OF ALL= 14615. FOR 15. POINTS
OVERRIDE V4 = 15000.

SET 1 cont'.

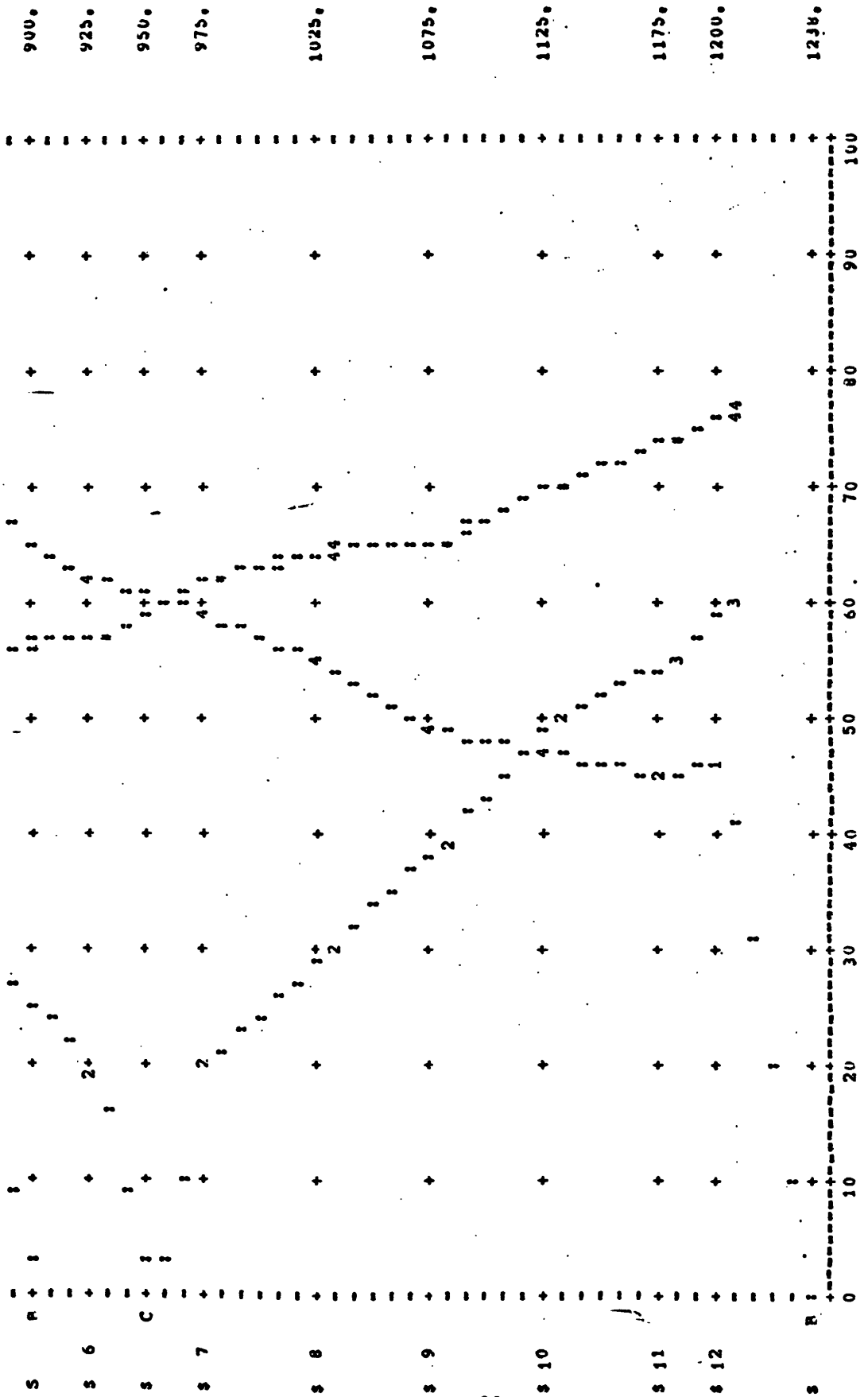
SET 1 cont'.


SIPTST.J06 SPREADS 5 AND 6 DEMONSTRATION OF EXIT 6
TIME-DISTANCE PLOT -- PRE-DEPTH VALUES WITH TIE CORR IF JJOFF=0
SPREAD
TIME (MILLISECONDS)
DIST
-29.
0.
75.
150.
225.
300.
375.
0
10
20
30
40
50
60
70
80
90
100
S 1
S 2
S 3
S 4
S 5
S 6

SET 1 cont'



SET 1 cont'.


900.
925.
950.
975.
1025.
1075.
1125.
1175.
1200.
1250.
0
10
20
30
40
50
60
70
80
90
100
S 6
S 7
S 8
S 9
S 10
S 11
S 12

SIPTST.J06 SPREADS S AND $ DEMONSTRATION OF EXIT 6

ARRIVAL TIMES CORRECTED TO BASE OF LAYER 1, AND ELEV OF BASE OF LAYER 1

SPREAD S			Sp A		SP C		SP B		SP
ELEV			2475.6		2480.8		2494.2		
	CORR T		6.1		6.7		7.4		
GEO			T	D	T	D	T	D	
1	2475.8	6.4	0.4	0.0	55.9	-0.1	83.1	-0.3	
2	2475.1	5.9	11.9	75.0	44.4	74.9	79.6	74.7	
3	2479.9	2.7	27.1	150.0	37.6	149.8	76.9	149.6	
4	2482.4	3.2	39.1	225.0	33.1	224.9	75.8	224.7	
5	2476.4	9.1	46.8	300.0	21.2	300.0	69.5	299.8	
6	2479.0	3.5	56.4	375.0	6.8	373.5	64.1	374.5	
7	2484.4	10.9	60.9	450.2	7.4	450.6	56.6	450.0	
8	2486.4	1.8	65.0	497.0	15.5	497.0	54.8	496.7	
9	2493.5	3.4	71.4	600.1	32.9	600.1	49.2	599.9	
10	2493.6	12.9	74.0	675.5	45.1	675.7	35.7	674.9	
11	2490.6	6.5	78.3	775.1	55.8	775.1	20.0	774.8	
12	2491.9	9.2	83.6	875.2	62.1	875.2	1.4	874.9	

SPREAD $			Sp L		SP A		SP C		SP B		SP
ELEV			0.0		2493.5		2497.9		2518.4		
	CORR T		0.0		2.1		7.8		19.4		
GEO			T	D	T	D	T	D	T	D	
1	2493.7	12.8	36.6	675.5	12.6	676.4	44.4	675.0	54.8	673.8	
2	2493.4	4.5	39.8	725.1	20.8	725.0	37.7	724.7	50.0	722.6	
3	2491.3	6.1	39.3	775.1	28.8	775.0	30.2	774.6	45.5	772.4	
4	2487.5	9.8	43.5	825.1	36.6	825.0	22.4	824.7	42.7	822.3	
5	2492.1	9.1	47.3	875.2	44.8	875.1	13.2	874.8	40.0	872.3	
6	2496.3	0.8	48.1	925.3	46.1	925.2	2.5	924.9	33.8	922.4	
7	2499.4	9.4	53.0	975.4	50.5	975.3	2.8	975.1	30.2	972.5	
8	2501.8	10.2	54.1	1025.4	52.2	1025.4	12.0	1025.2	25.3	1022.5	
9	2504.7	10.5	54.8	1075.5	52.4	1075.5	20.7	1075.3	19.1	1072.4	
10	2509.2	13.2	57.1	1125.9	54.7	1125.9	29.0	1125.9	14.4	1123.1	
11	2513.8	16.0	57.9	1176.1	55.9	1176.3	31.3	1176.5	9.6	1173.9	
12	2515.6	19.0	57.3	1201.3	55.9	1201.7	33.2	1202.1	0.0	1199.8	

SET 1. cont'

SIPTST.J06 SPREADS S AND 8 DEMONSTRATION OF EXIT 6

SPREAD S RAY END POINTS BENEATH GEOPHONES

GEO		Sp A	L	Sp C	L	Sp B	L	SP
1	POS	-2.2	2	68.5	3	38.0	4	
	ELEV	2476.1		2408.8		2391.8		
2	POS	72.4	2	128.8	3	129.7	4	
	ELEV	2474.9		2426.2		2372.6		
3	POS	149.1	2	204.1	3	212.8	4	
	ELEV	2479.9		2429.4		2354.4		
4	POS	224.0	2	226.0	2	296.7	4	
	ELEV	2482.4		2482.4		2324.2		
5	POS	277.9	3	304.4	2	443.4	4	
	ELEV	2446.5		2476.0		2314.0		
6	POS	350.9	3	376.9	2	553.6	4	
	ELEV	2445.2		2478.5		2327.5		
7	POS	435.5	3	446.9	2	602.9	4	
	ELEV	2464.0		2484.1		2350.7		
8	POS	481.0	3	496.2	2	516.6	3	
	ELEV	2469.9		2488.3		2452.4		
9	POS	534.4	4	598.7	2	645.7	3	
	ELEV	2346.8		2493.5		2425.5		
10	POS	617.8	4	597.0	3	679.6	2	
	ELEV	2372.8		2415.2		2493.7		
11	POS	722.0	4	713.9	3	777.4	2	
	ELEV	2388.8		2412.2		2490.7		
12	POS	826.4	4	830.5	3	879.8	2	
	ELEV	2396.5		2431.0		2492.6		

RAY END POINTS BENEATH SHOTPOINTS

L=2	RIGHT	POS	-26.4	403.2	0.0
		ELEV	2475.9	2480.6	0.0
L=2	LEFT	POS	0.0	398.0	898.0
		ELEV	0.0	2480.2	2494.2
L=3	RIGHT	POS	32.4	442.0	0.0
		ELEV	2415.8	2439.9	0.0
L=3	LEFT	POS	0.0	378.9	857.1
		ELEV	0.0	2449.5	2434.0
L=4	RIGHT	POS	8.4	0.0	0.0
		ELEV	2392.1	0.0	0.0
L=4	LEFT	POS	0.0	0.0	838.9
		ELEV	0.0	0.0	2379.6

SET 1 cont.

SIPTST,J06 SPREADS 5 AND 8 DEMONSTRATION OF EXIT 6

SPREAD 8 RAY END POINTS BENEATH GEOPHONES

GEO		Sp D	L	Sp A	L	Sp C	L	Sp B	L	SP
1	POS	614.6	4	669.9	2	732.1	3	749.5	4	
	ELEV	2306.5		2493.8		2428.7		2384.7		
2	POS	671.4	4	723.5	2	777.9	3	792.5	4	
	ELEV	2381.7		2493.4		2435.4		2394.0		
3	POS	724.9	4	772.4	2	818.2	3	841.0	4	
	ELEV	2393.2		2491.9		2444.2		2399.3		
4	POS	767.7	4	819.4	2	830.7	2	905.3	4	
	ELEV	2382.7		2487.4		2487.5		2392.0		
5	POS	818.5	4	872.8	2	879.8	2	963.6	4	
	ELEV	2384.1		2492.0		2492.6		2392.9		
6	POS	880.6	4	880.4	4	929.1	2	1007.8	4	
	ELEV	2402.3		2402.1		2496.8		2418.0		
7	POS	925.0	4	926.7	4	972.0	2	1065.7	4	
	ELEV	2395.3		2398.2		2499.4		2428.1		
8	POS	992.0	4	992.8	4	1021.5	2	1107.7	4	
	ELEV	2413.2		2413.0		2501.6		2442.7		
9	POS	1057.3	4	1056.3	4	1071.3	2	1136.3	4	
	ELEV	2437.9		2440.7		2504.4		2465.7		
10	POS	1112.9	4	1113.8	4	1121.5	2	1171.3	4	
	ELEV	2456.0		2458.8		2506.9		2480.1		
11	POS	1172.7	4	1172.7	4	1163.7	3	1183.0	2	
	ELEV	2487.9		2486.0		2494.5		2514.6		
12	POS	1199.7	4	1198.7	4	1190.5	3	0.0	1	
	ELEV	2504.6		2501.9		2500.5		0.0		

RAY END POINTS BENEATH SHOTPOINTS

L=2 RIGHT	POS	0.0	601.0	953.6	0.0	
	ELEV	0.0	2493.5	2498.3	0.0	
L=2 LEFT	POS	0.0	0.0	947.8	1232.4	
	ELEV	0.0	0.0	2497.9	2518.2	
L=3 RIGHT	POS	0.0	639.7	991.7	0.0	
	ELEV	0.0 *	2433.9	2462.7	0.0	
L=3 LEFT	POS	0.0	0.0	930.2	1231.7	
	ELEV	0.0	0.0	2453.6	2509.8	
L=4 RIGHT	POS	669.3	669.3	0.0	0.0	
	ELEV	2389.3 *	2389.3	0.0	0.0	
L=4 LEFT	POS	0.0	0.0	0.0	1236.2	
	ELEV	0.0	0.0	0.0	2505.8	

SET 1 cont.

SIPTST.J06 SPREADS S AND 8 DEMONSTRATION OF EXIT 6

SPREAD S SMOOTHED POSITION OF LAYERS BENEATH SHOTPOINTS AND GEOPHONES

			LAYER 2		LAYER 3		LAYER 4		LAYER
SP	POSITION	SURF ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	
A	-29.0	2486.9	11.3	2475.6	81.6	2405.3	95.3	2391.6	
C	400.0	2493.0	12.2	2480.8	42.0	2451.0	143.8	2349.2	
B	900.0	2507.5	13.3	2494.2	58.9	2448.6	109.5	2398.0	
GEO									
1	0.0	2465.6	9.8	2475.8	77.1	2408.5	98.1	2387.5	
2	75.0	2484.1	9.0	2475.1	67.8	2416.3	101.9	2382.2	
3	150.0	2484.0	4.1	2479.9	57.9	2426.1	118.0	2366.0	
4	225.0	2487.3	4.9	2482.4	51.8	2435.5	139.6	2347.7	
5	300.0	2490.2	13.8	2476.4	46.8	2443.4	153.3	2336.9	
6	375.0	2484.3	5.3	2479.0	35.8	2448.5	141.1	2343.2	
7	450.0	2501.0	16.6	2484.4	45.1	2455.9	139.8	2361.2	
8	497.0	2491.1	2.7	2488.4	38.6	2452.5	133.1	2358.0	
9	600.0	2498.7	5.2	2493.5	65.7	2433.0	139.0	2359.7	
10	675.0	2513.2	19.6	2493.6	87.7	2425.5	135.3	2377.9	
11	775.0	2500.5	9.9	2490.6	68.9	2431.6	111.8	2388.7	
12	875.0	2505.9	14.0	2491.9	61.2	2444.7	110.2	2395.7	

VELOCITIES USED:

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER
VERTICAL	1520.	5900.	9500.		
HORIZONTAL		5900.	9500.	15000.	

SET 1 cont.

SIPTST.J06 SPREADS 5 AND 8 DEMONSTRATION OF EXIT 6

SPREAD 8 SMOOTHED POSITION OF LAYERS BENEATH SHOTPOINTS AND GEOPHONES

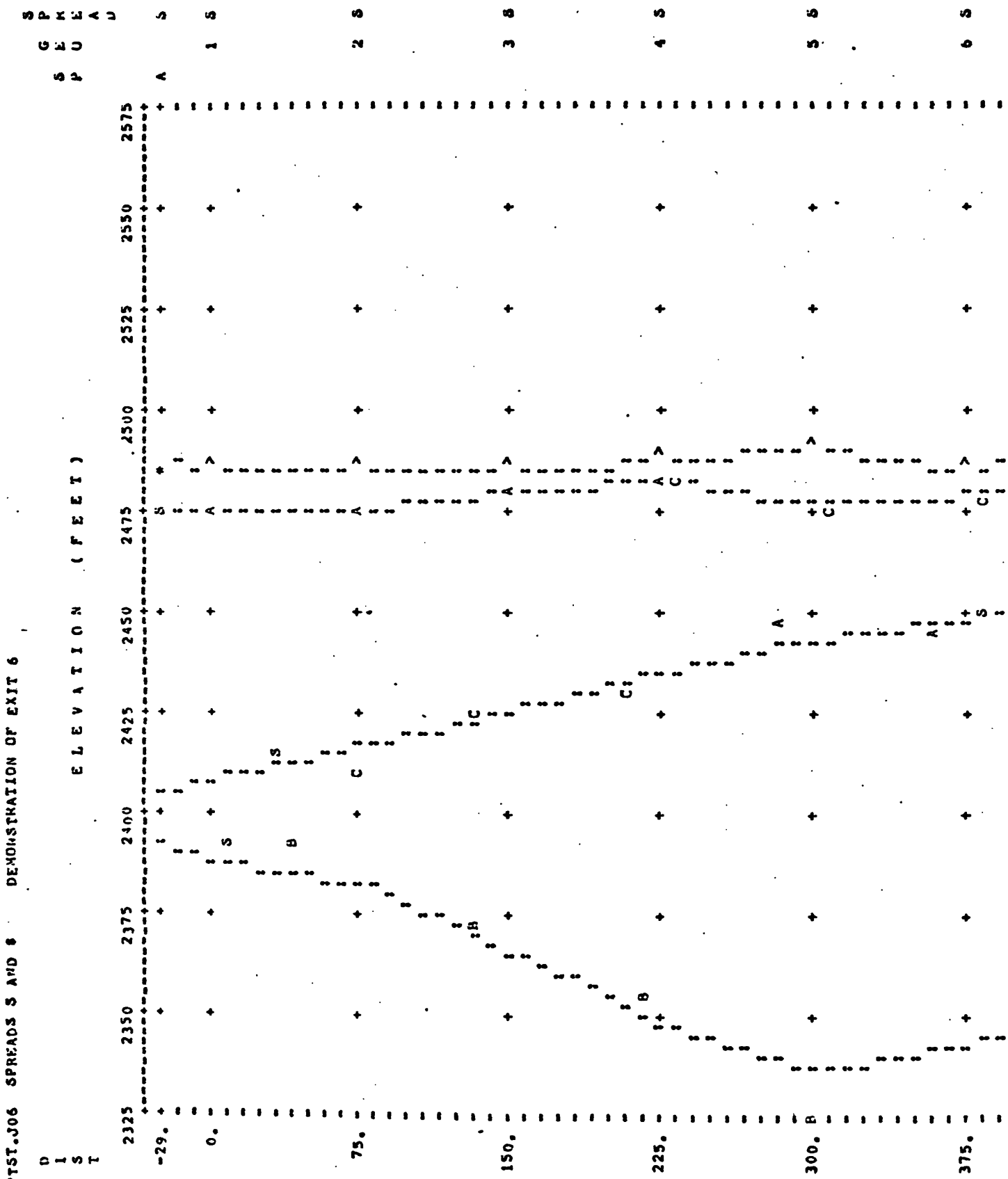
			LAYER 2		LAYER 3		LAYER 4		LAYER
SP	POSITION	SURF ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	
A	600.0	2498.7	5.2	2493.5	65.7	2433.0	139.0	2359.7	
C	950.0	2511.7	13.8	2497.9	55.4	2456.3	106.9	2404.8	
B	1238.0	2549.9	31.5	2518.4	41.4	2508.5	41.4	2508.5	
GEO									
1	675.0	2513.2	19.5	2493.7	87.7	2425.5	135.3	2377.9	
2	725.0	2500.3	6.9	2493.4	71.8	2428.5	117.0	2383.3	
3	775.0	2500.5	9.2	2491.3	68.9	2431.6	111.8	2388.7	
4	825.0	2502.4	14.9	2487.5	64.3	2438.1	110.2	2392.2	
5	875.0	2505.9	13.8	2492.1	61.2	2444.7	110.2	2395.7	
6	925.0	2509.6	13.3	2496.3	57.2	2452.4	109.4	2400.2	
7	975.0	2513.7	14.3	2499.4	53.5	2460.2	104.3	2409.4	
8	1025.0	2517.4	15.6	2501.8	47.9	2469.5	93.6	2423.8	
9	1075.0	2520.7	16.0	2504.7	42.1	2478.6	80.3	2440.4	
10	1125.0	2529.3	20.1	2509.2	41.5	2487.8	69.5	2459.8	
11	1175.0	2538.1	24.3	2513.8	41.1	2497.0	50.3	2487.8	
12	1200.0	2544.5	28.9	2515.6	43.0	2501.5	48.1	2496.4	

VELOCITIES USED:

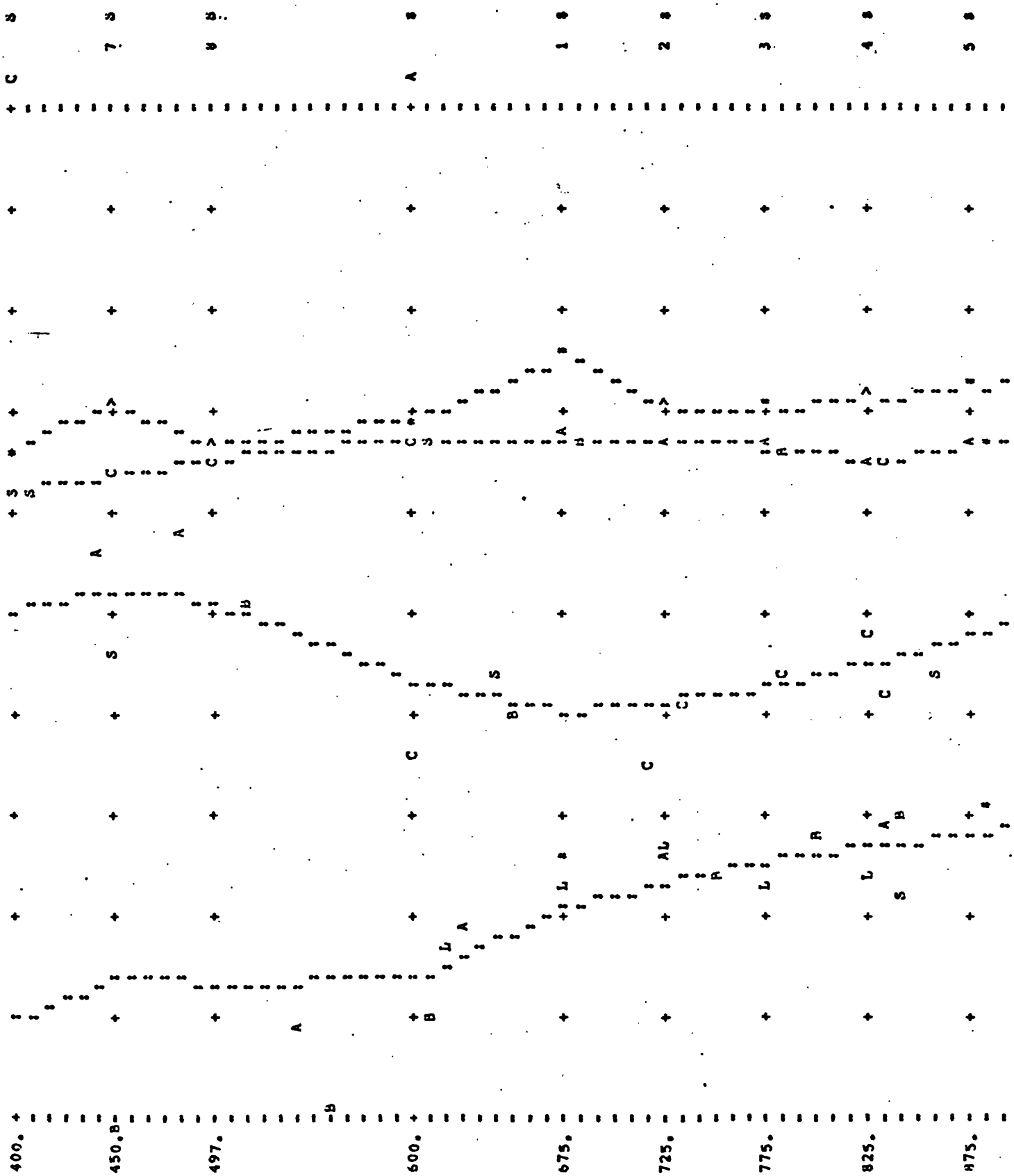
	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER
VERTICAL	1520.	5900.	9500.		
HORIZONTAL		5900.	9500.	15000.	

SET 1 cont.

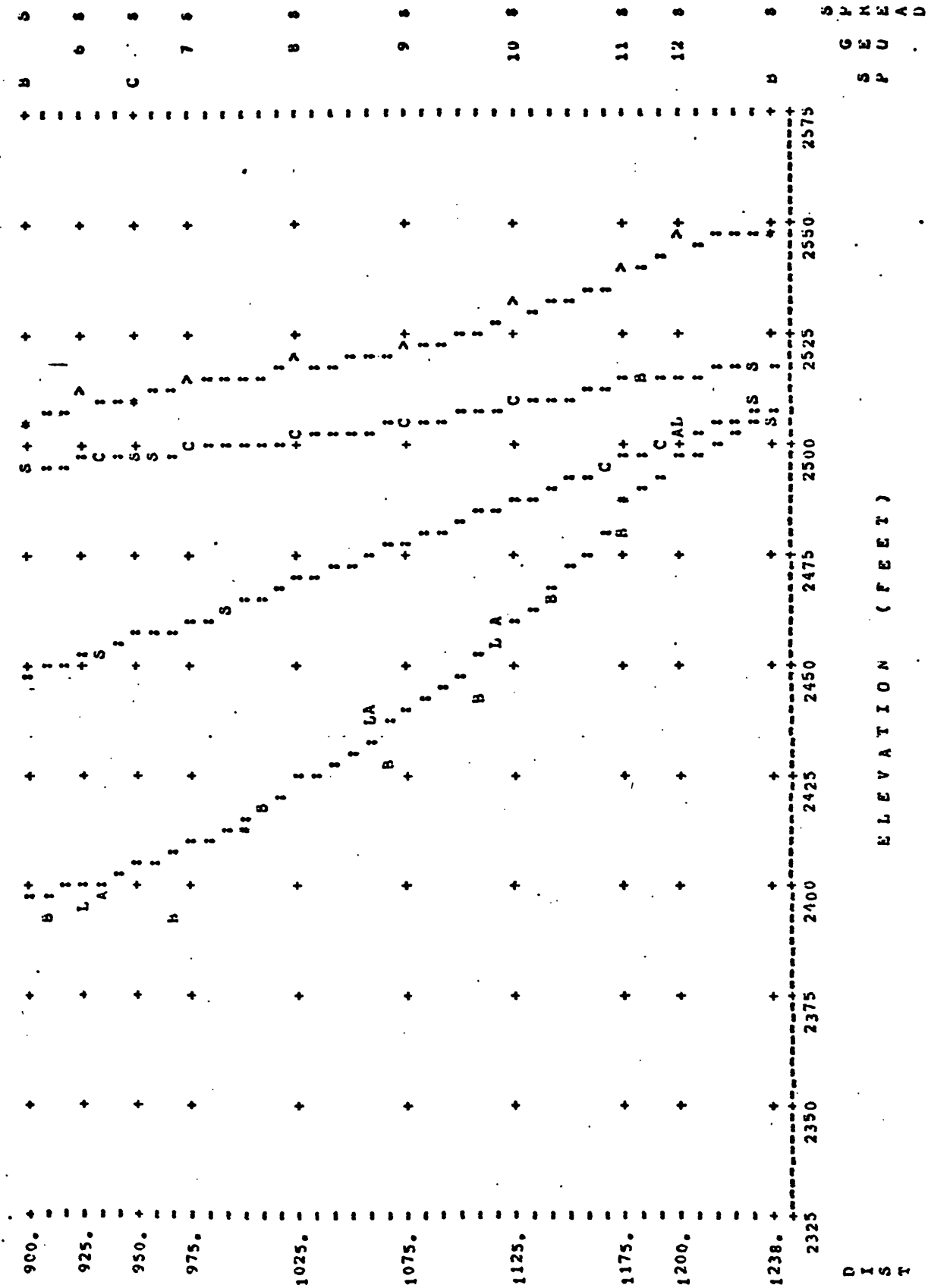
SET 1 cont.


SIPTST.J06 SPREADS 5 AND 6 DEMONSTRATION OF EXIT 6
DIST
ELEVATION (FEET)
SPEED
-29.
0.
75.
150.
225.
300.
375.
2325
2350
2375
2400
2425
2450
2475
2500
2525
2550
2575

SET 1 cont.



SET 1 cont.


DIST
900.
925.
950.
975.
1025.
1075.
1125.
1175.
1200.
1238.
2325
2350
2375
2400
2425
2450
2475
2500
2525
2550
2575
ELEVATION (FEET)
SPEED
5
6
7
8
9
10
11
12

SIPTST.J06 SPREADS 8 AND 8 DEMONSTRATION OF EXIT 6

CONTROL CARD DATA — PLOT SCALES — DATUM OVERRIDE VALUES

SPRDS	EXIT	LAYERS	VCARDS	PLOT SCALES ELEV FT/COL	PLOT SCALES HORIZ FT/ROW	PLOT SCALES TIME MS/COL	DATUM OVERRIDE VALUES POINT 1 ELEV	POINT 1 X POS	POINT 2 ELEV	POINT 2 X POS	SLOPE	INTCPT	BLIM	TLIM	TRACE	OFF	DIP
2	-6	4	4	2,5	8,3	1,0	0,0	0,0	0,0	0,0	0,0000	0,0	0,50	10,0	0	0	0

VELOCITY CARDS

LAYER	SPREAD 1 VV	SPREAD 1 VH	SPREAD 2 VV	SPREAD 2 VH	SPREAD
1	1520,	0,	0,	0,	
2	5900,	0,	0,	0,	
3	9500,	0,	0,	0,	
4	15000,	0,	0,	0,	

SHOTPOINT AND GEOPHONE DATA

SPREAD S, 3 SHOTPOINTS, 12 GEOPHONES, XSHIFT = 0,0, XTRUE = 1

SP	ELEV	X LOC	Y LOC	DEPTH	UPHOLE T	FUDGE T	END SP
A	2486,9	-29,0	0,0	2,0	0,0	0,0	0
C	2493,0	400,0	0,0	2,0	0,0	0,0	0
B	2507,5	900,0	0,0	2,0	0,0	0,0	0

GEO	ELEV	X LOC	Y LOC	ARRIVAL TIMES + FUDGE T AND LAYERS REPRESENTED SP A	SP C	SP B	SP
1	2485,6	0,0	0,0	13,0 2	69,0 3	97,0 4	
2	2484,1	75,0	0,0	24,0 2	57,0 3	93,0 4	
3	2484,0	150,0	0,0	36,0 2	47,0 3	87,0 4	
4	2487,3	225,0	0,0	48,5 2	43,0 2	86,5 4	
5	2490,2	300,0	0,0	62,0 3	37,0 2	86,0 4	
6	2484,3	375,0	0,0	66,0 3	19,0 2	75,0 4	
7	2501,0	450,0	0,0	78,0 3	25,0 2	75,0 4	
8	2491,1	497,0	0,0	73,0 3	24,0 2	64,0 3	
9	2498,7	600,0	0,0	81,0 4	43,0 2	60,0 3	
10	2513,2	675,0	0,0	93,0 4	65,0 3	56,0 2	
11	2500,8	775,0	0,0	91,0 4	69,0 3	34,0 2	
12	2505,9	875,0	0,0	99,0 4	78,0 3	18,0 2	

SET 2

SIPTST,J06 SPREADS 5 AND 6 DEMONSTRATION OF EXIT 6

SHOTPOINT AND GEOPHONE DATA

SPREAD 6, 4 SHOTPOINTS, 12 GEOPHONES, XSHIFT = 675.0, XTRUE = 1

SP	ELEV	X LOC	Y LOC	DEPTH	UPHOLE T	FUDGE T	END SP
L	2486.9	-704.0	0.0	2.0	0.0	0.0	0
A	2498.7	-75.0	0.0	2.0	0.0	0.0	0
C	2511.7	275.0	0.0	2.0	0.0	0.0	0
B	2549.9	563.0	0.0	2.0	0.0	0.0	0

GEO	ELEV	X LOC	Y LOC	ARRIVAL TIMES + FUDGE T AND LAYERS REPRESENTED SP L	SP A	SP C	SP B	SP
1	2513.2	0.0	0.0	92.0 4	27.5 2	65.0 3	87.0 4	
2	2500.3	50.0	0.0	86.0 4	27.5 2	50.0 3	74.0 4	
3	2500.5	100.0	0.0	88.0 4	37.0 2	44.0 3	71.0 4	
4	2502.4	150.0	0.0	96.0 4	48.5 2	40.0 2	72.0 4	
5	2505.9	200.0	0.0	99.0 4	56.0 2	30.0 2	68.5 4	
6	2509.6	250.0	0.0	99.5 4	57.0 4	19.0 2	62.0 4	
7	2513.7	300.0	0.0	105.0 4	62.0 4	20.0 2	59.0 4	
8	2517.4	350.0	0.0	107.0 4	64.5 4	30.0 2	55.0 4	
9	2520.7	400.0	0.0	108.0 4	65.0 4	39.0 2	49.0 4	
10	2529.3	450.0	0.0	113.0 4	70.0 4	50.0 2	47.0 4	
11	2538.1	500.0	0.0	116.5 4	74.0 4	55.0 3	45.0 2	
12	2544.5	525.0	0.0	119.0 4	77.0 4	60.0 3	46.0 1	

SET 2 cont.

SIPTST,J06 SPREADS 5 AND 6 DEMONSTRATION OF EXIT 6

SPREAD 5 RAY END POINTS BENEATH GEOPHONES

GEO		SP A	L=	SP C	L=	SP B	L=	SP
1	POS	-2.2	2	68.5	3	38.0	4	
	ELEV	2476.1		2408.8		2391.8		
2	POS	72.4	2	128.8	3	129.7	4	
	ELEV	2474.9		2426.2		2372.6		
3	POS	149.1	2	204.1	3	212.8	4	
	ELEV	2479.9		2429.4		2354.4		
4	POS	224.0	2	226.0	2	296.7	4	
	ELEV	2482.4		2482.4		2324.2		
5	POS	277.9	3	304.4	2	443.4	4	
	ELEV	2446.5		2476.0		2314.0		
6	POS	350.9	3	376.9	2	553.6	4	
	ELEV	2445.2		2478.5		2327.5		
7	POS	435.5	3	446.9	2	602.9	4	
	ELEV	2464.0		2484.1		2350.7		
8	POS	481.0	3	496.2	2	516.6	3	
	ELEV	2469.9		2488.3		2452.4		
9	POS	534.4	4	598.7	2	645.7	3	
	ELEV	2346.8		2493.5		2425.5		
10	POS	617.8	4	597.0	3	679.6	2	
	ELEV	2372.8		2415.2		2493.7		
11	POS	722.0	4	713.9	3	777.4	2	
	ELEV	2388.8		2412.2		2490.7		
12	POS	826.4	4	830.5	3	879.8	2	
	ELEV	2396.5		2431.0		2492.6		

RAY END POINTS BENEATH SHOTPOINTS

L=2 RIGHT	POS	-26.4	403.2	0.0	
	ELEV	2475.9	2480.6	0.0	
L=2 LEFT	POS	0.0	398.0	898.0	
	ELEV	0.0	2480.2	2494.2	
L=3 RIGHT	POS	32.4	442.0	0.0	
	ELEV	2415.8	2439.9	0.0	
L=3 LEFT	POS	0.0	378.9	857.1	
	ELEV	0.0	2449.5	2434.0	
L=4 RIGHT	POS	8.4	0.0	0.0	
	ELEV	2392.1	0.0	0.0	
L=4 LEFT	POS	0.0	0.0	838.9	
	ELEV	0.0	0.0	2379.6	

SET 2 cont.

SIPTST,J06 SPREADS 5 AND 8 DEMONSTRATION OF EXIT 6

SPREAD 8 RAY END POINTS BENEATH GEOPHONES

GEO		Sp L	L	Sp A	L	Sp C	L	Sp B	L	SP
1	POS	614,6	4	669,9	2	732,1	3	749,5	4	
	ELEV	2366,5		2493,8		2428,7		2384,7		
2	POS	671,4	4	723,5	2	777,9	3	792,5	4	
	ELEV	2381,7		2493,4		2435,4		2394,0		
3	POS	724,9	4	772,4	2	818,2	3	841,0	4	
	ELEV	2393,2		2491,9		2444,2		2399,3		
4	POS	767,7	4	819,4	2	830,7	2	905,3	4	
	ELEV	2382,7		2487,4		2487,5		2392,0		
5	POS	818,5	4	872,8	2	879,8	2	963,6	4	
	ELEV	2384,1		2492,0		2492,6		2392,9		
6	POS	880,6	4	880,4	4	929,1	2	1007,8	4	
	ELEV	2402,3		2402,1		2496,8		2418,0		
7	POS	925,0	4	926,7	4	972,0	2	1065,7	4	
	ELEV	2395,3		2398,2		2499,4		2428,1		
8	POS	992,9	4	992,8	4	1021,5	2	1107,7	4	
	ELEV	2413,2		2413,0		2501,6		2442,7		
9	POS	1057,3	4	1058,3	4	1071,3	2	1136,3	4	
	ELEV	2437,9		2440,7		2504,4		2465,7		
10	POS	1112,9	4	1113,8	4	1121,5	2	1171,3	4	
	ELEV	2456,0		2458,8		2508,9		2480,1		
11	POS	1172,7	4	1172,7	4	1163,7	3	1183,0	2	
	ELEV	2487,9		2488,0		2494,5		2514,6		
12	POS	1199,7	4	1198,7	4	1190,5	3	0,0	1	
	ELEV	2504,6		2501,9		2500,5		0,0		

RAY END POINTS BENEATH SHOTPOINTS

L=2 RIGHT	POS	0,0	601,0	953,6	0,0		
	ELEV	0,0	2493,5	2498,3	0,0		
L=2 LEFT	POS	0,0	0,0	947,8	1232,4		
	ELEV	0,0	0,0	2497,9	2518,2		
L=3 RIGHT	POS	0,0	639,7	991,7	0,0		
	ELEV	0,0 *	2433,9	2462,7	0,0		
L=3 LEFT	POS	0,0	0,0	930,2	1231,7		
	ELEV	0,0	0,0	2453,6	2509,8		
L=4 RIGHT	POS	669,3	669,3	0,0	0,0		
	ELEV	2389,3 *	2389,3	0,0	0,0		
L=4 LEFT	POS	0,0	0,0	0,0	1236,2		
	ELEV	0,0	0,0	0,0	2505,8		

SET 2 cont.

SIPTST,J06 SPREADS 5 AND 6 DEMONSTRATION OF EXIT 6

SPREAD 5 SMOOTHED POSITION OF LAYERS BENEATH SHOTPOINTS AND GEOPHONES

			LAYER 2		LAYER 3		LAYER 4		LAYER
SP	POSITION	SURF ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	
A	-29.0	2486.9	11.3	2475.6	81.6	2405.3	95.3	2391.6	
C	400.0	2493.0	12.2	2480.8	42.0	2451.0	143.8	2349.2	
B	900.0	2507.5	13.3	2494.2	58.9	2448.6	109.5	2398.0	
GEO									
1	0.0	2485.6	9.8	2475.8	77.1	2408.5	98.1	2387.5	
2	75.0	2484.1	9.0	2475.1	67.8	2416.3	101.9	2382.2	
3	150.0	2484.0	4.1	2479.9	57.9	2426.1	118.0	2366.0	
4	225.0	2487.3	4.9	2482.4	51.8	2435.5	139.6	2347.7	
5	300.0	2490.2	13.8	2476.4	46.8	2443.4	153.3	2336.9	
6	375.0	2484.3	5.3	2479.0	35.8	2448.5	141.1	2343.2	
7	450.0	2501.0	16.6	2484.4	45.1	2455.9	139.8	2361.2	
8	497.0	2491.1	2.7	2488.4	38.6	2452.5	133.1	2358.0	
9	600.0	2498.7	5.2	2493.5	65.7	2433.0	139.0	2359.7	
10	675.0	2513.2	19.6	2493.6	87.7	2425.5	135.3	2377.9	
11	775.0	2500.5	9.9	2490.6	68.9	2431.6	111.8	2388.7	
12	875.0	2505.9	14.0	2491.9	61.2	2444.7	110.2	2395.7	

VELOCITIES USED:

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER
VERTICAL	1520.	5900.	9500.		
HORIZONTAL		5900.	9500.	15000.	

SET 2 cont.

SIPTST,J06 SPREADS 5 AND 8 DEMONSTRATION OF EXIT 6

SPREAD 8 SMOOTHED POSITION OF LAYERS BENEATH SHOTPOINTS AND GEOPHONES

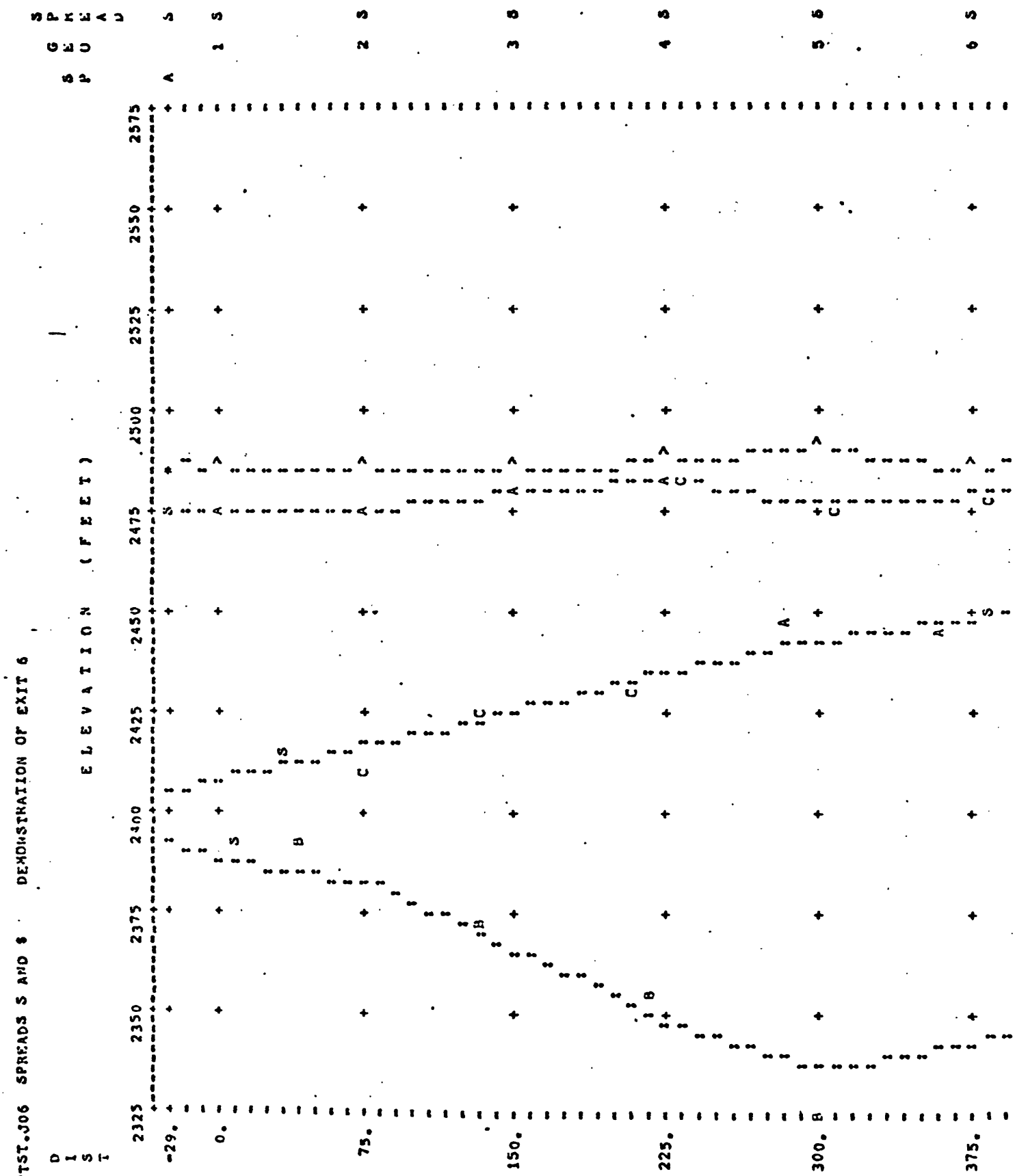
			LAYER 2		LAYER 3		LAYER 4		LAYER
SP	POSITION	SURF ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	
A	600.0	2498.7	5.2	2493.5	65.7	2433.0	139.0	2359.7	
C	950.0	2511.7	13.8	2497.9	55.4	2456.3	106.9	2404.8	
B	1238.0	2549.9	31.5	2518.4	41.4	2508.5	41.4	2508.5	
GEO									
1	675.0	2513.2	19.5	2493.7	87.7	2425.5	135.3	2377.9	
2	725.0	2500.3	6.9	2493.4	71.8	2428.5	117.0	2383.3	
3	775.0	2500.5	9.2	2491.3	68.9	2431.6	111.8	2388.7	
4	825.0	2502.4	14.9	2487.5	64.3	2438.1	110.2	2392.2	
5	875.0	2505.9	13.8	2492.1	61.2	2444.7	110.2	2395.7	
6	925.0	2509.6	13.3	2496.3	57.2	2452.4	109.4	2400.2	
7	975.0	2513.7	14.3	2499.4	53.5	2460.2	104.3	2409.4	
8	1025.0	2517.4	15.6	2501.8	47.9	2469.5	93.6	2423.8	
9	1075.0	2520.7	16.0	2504.7	42.1	2478.6	80.3	2440.4	
10	1125.0	2529.3	20.1	2509.2	41.5	2487.8	69.5	2459.8	
11	1175.0	2538.1	24.3	2513.8	41.1	2497.0	50.3	2487.8	
12	1200.0	2544.5	28.9	2515.6	43.0	2501.5	48.1	2496.4	

VELOCITIES USED:

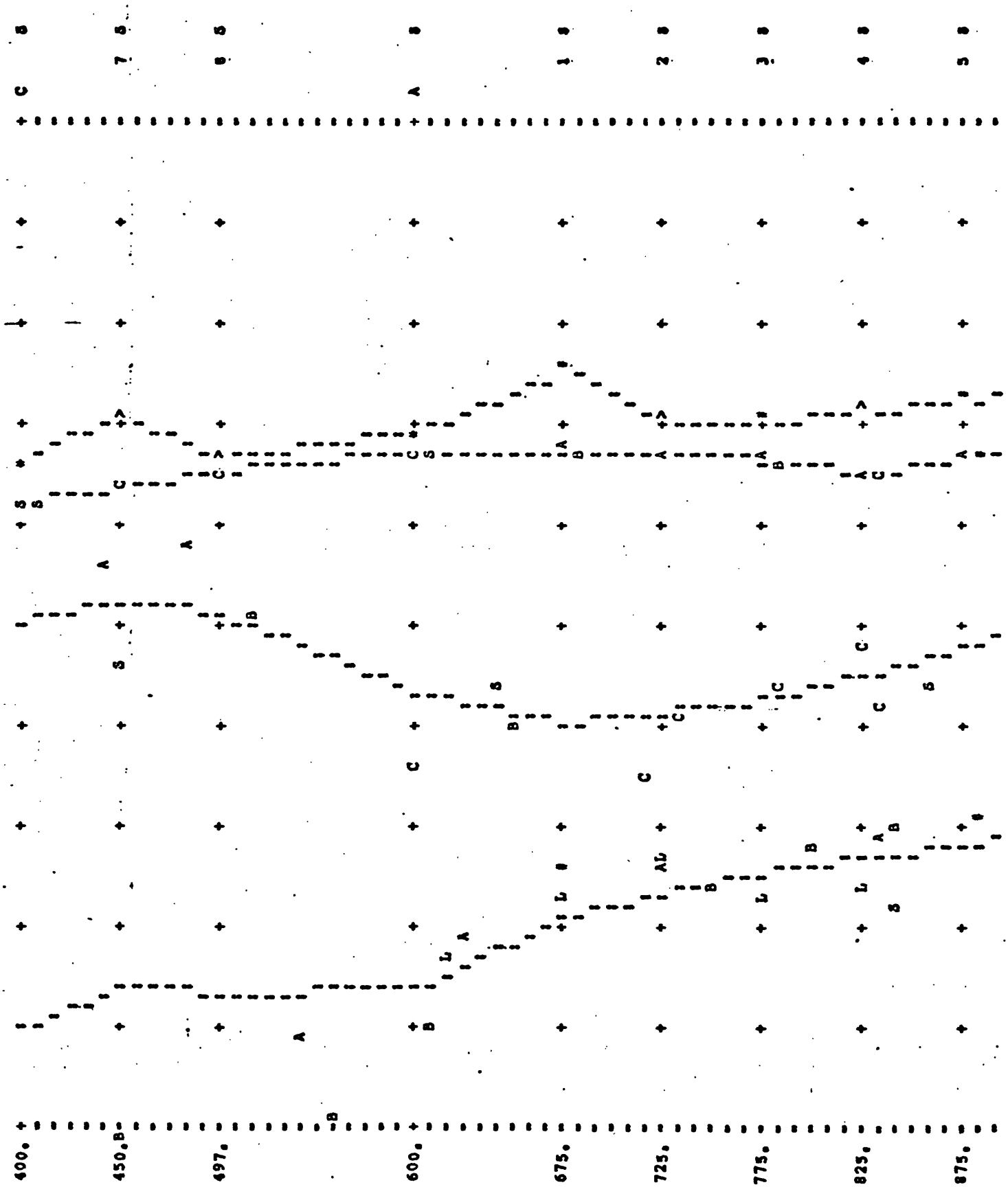
	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER
VERTICAL	1520.	5900.	9500.		
HORIZONTAL		5900.	9500.	15000.	

SET 2 cont.

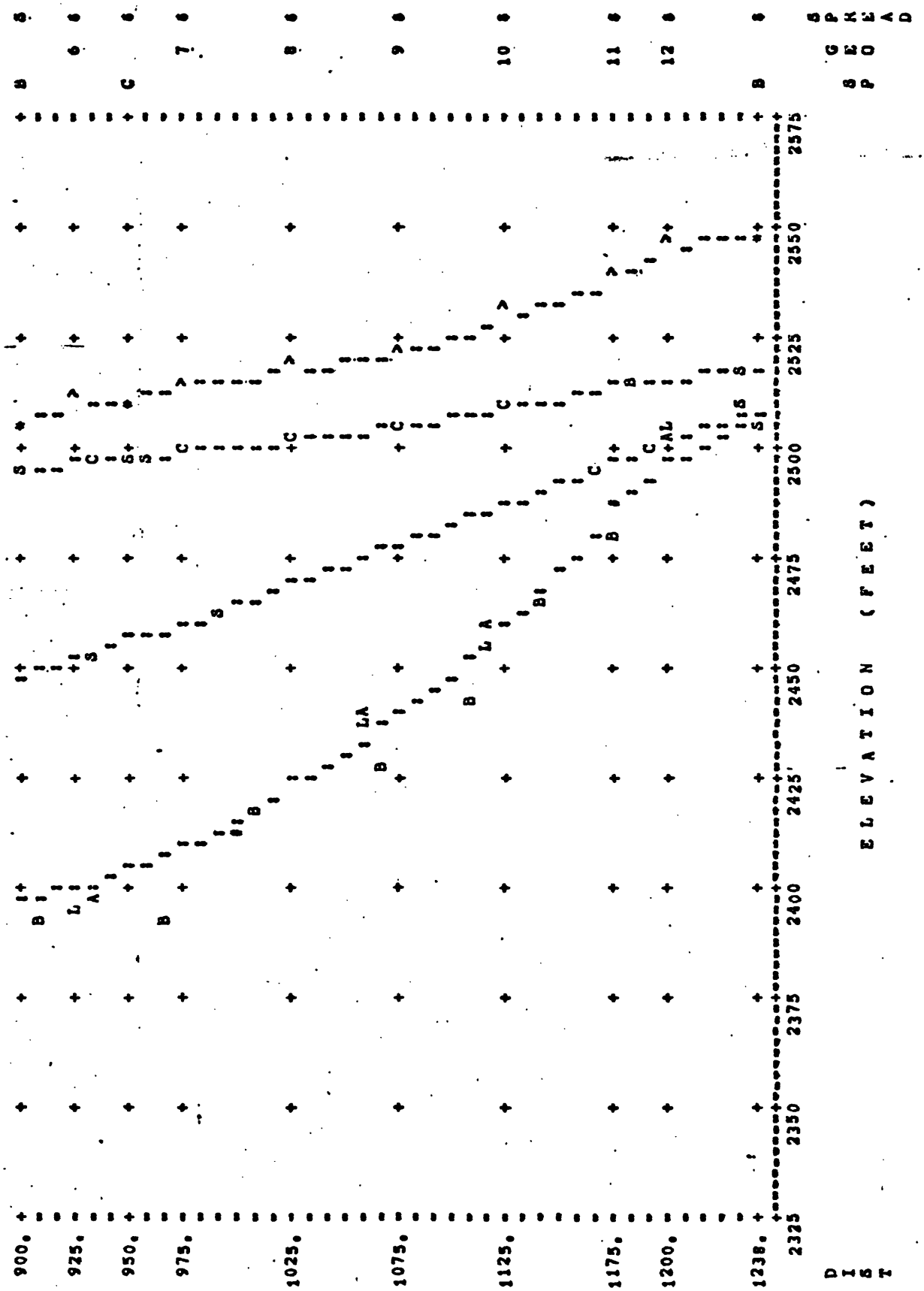
SET 2 cont.


SIPTST.306 SPREADS S AND B DEMONSTRATION OF EXIT 6
SPEED
1
2
3
4
5
6
ELEVATION (FEET)
2575
2550
2525
2500
2475
2450
2425
2400
2375
2350
2325
DIST
-29.
0.
75.
150.
225.
300.
375.

SET 2 cont.



SET 2 cont.


GPS BEARING
ELEVATION (FEET)
DIST
900.
925.
950.
975.
1025.
1075.
1125.
1175.
1200.
1238.
2325
2350
2375
2400
2425
2450
2475
2500
2525
2550
2575

APPENDIX C. -- Fortran program listing

The Fortran program for SIPB is given on the following pages.

```
C PROGRAM  SIPB  REV 20  2-10-77   DEC-10 (USGS DENVER)                          0
C                                                                              100
C THIS PROGRAM INTERPRETS REFRACTION SEISMIC DATA FOR UP TO 5 SPREADS          200
C OF UP TO 25 GEOS AND 7 SPS EACH, AND FOR 2 TO 5 LAYERS.                      300
C                                                                              400
C PART 1 COMPUTES ELEVATION CORRECTIONS AND PLOTS CORRECTED T-D GRAPH.         500
C                                                                              600
C PART 2 COMPUTES VELOCITIES, MAKES WEATH CORR, AND REPLOTS T-D GRAPH.         700
C                                                                              800
C PART 3 COMPUTES MIGRATED DEPTHS AND MAKES SMOOTHED DEPTH INTERP.             900
C                                                                             1000
C                                                                             1100
C UNLABLED COMMON                                                             1200
C                                                                             1300
      COMMON IBL,IQUES,IP,IT,ICOLN,IPLUS,ISQ,IDASH,IS,IAST,IDEE,IL,NL,        1400
     1LN,P,TSCALE,XSCALE,XSCO2,ESCALE,XLIM1,XLIM2,IPLOT,IDENT                 1500
C                                                                             1600
C LABLED COMMON                                                               1700
C                                                                             1800
      COMMON/BLK0/LG                                                          1900
     1       /BLK1/NM,NJ,NK                                                   2000
     2       /BLK2/XG,ERP,SLOPE,IDIP                                          2100
     3       /BLK3/TA,TR,DSG                                                  2200
     4       /BLK4/VVA,VHA                                                    2300
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                         2400
     6       /BLK6/TRP,JJOFF                                                  2500
     7       /BLK7/JA,JB,TRS,ERS,XSP,ESP,LS                                   2600
     8       /BLK8/PRG,ERG,KRG,PRS2,ERS2,KRS2,ZRSP,ZRG                        2700
     9       /BLK9/EG,ES                                                      2800
     9       /BLK10/BLIM,ITRACE,TANSG                                         2900
     9       /BLK11/VREG,PREG                                                 3000
     9       /BLK12/VHOB,PHOB                                                 3100
C                                                                             3200
      DIMENSION IDENT(16),IP(103),IT(53),                                     3300
     1 IL(5),VREG(5),VHOB(5),PREG(5),PHOB(5),ZSG(4),                          3400
     2 IDSPR(5),NJ(5),NK(5),XSHIFT(5),JA(5),JB(5),BL(5),                      3500
     2 VVA(5,5),VHA(5,5),                                                     3600
     3 TVS(7),AVVDD(7),ZRSP(7),                                               3700
     4 IDSP(7,5),ESP(7,5),XSP(7,5),YSP(7,5),ZSP(7,5),TUH(7,5),EDSP(7,5),      3800
     4 TFUDGE(7,5),ES(7,5),KL(7,5),KR(7,5),SPTC(7,5),SPPT(7,5),LS(7,5),       3900
     4 ZRG(25,7),                                                             4000
     4 PS2(7,5,2),ES2(7,5,2),TRS2(7,5,2),                                     4100
     5 ERS(7,5,4),TRS(7,5,4),                                                 4200
     5 ERS2(7,5,4,2),PRS2(7,5,4,2),KRS2(7,5,4,2),                             4300
     6 TVG(25),XVG(25),DSG(25),PRP(25),XS(25),ERX(25),                        4400
     6 PRG2(25,2),ERG2(25,2),TRG2(25,2),                                      4500
     7 TCG(25,2),XCG(25,2),XINTG(25,2),EINTG(25,2),                           4600
     8 EDG(25,5),EG(25,5),XG(25,5),YG(25,5),                                  4700
     8 GTC(25,5),GPT(25,5),                                                   4800
     8 PG2(25,5,2),EG2(25,5,2),TG2(25,5,2),                                   4900
     9 ERP(25,5,4),TRP(25,5,4),                                               5000
     9 TA(25,7,5),TR(25,7,5),LG(25,7,5),D(25,7,5),VDD(25,7,5),P(25,7,5),      5100
     9 PRG(25,7,5),ERG(25,7,5),TRG(25,7,5),KRG(25,7,5)                        5200
C                                                                             5300
C CONSTANTS                                                                   5400
C                                                                             5500
      DATA IEND,IBL,IS,ISQ,IAST,IPLUS,IDASH,ICOLN,IDEE,IQUES,IBEE,IX/         5600
     1'END  ','     ','S    ','#    ','*    ','+    ','-    ',':    ',       5700
     2'>    ','?    ','B    ','X    '/                                        5800
      DATA IL/'1   ','2   ','3   ','4   ','5   '/                            5900
```

```
      DATA MM,MJ,MK,ML,ML1,IZ,I1,IN1,BIG/5,7,25,5,4,0,1,10,9999999./        6000
C                                                                           6100
C*************************************************************************  6200
C PART 1                                                                    6300
C*************************************************************************  6400
C                                                                           6500
C  INITIALIZE                                                               6600
C                                                                           6700
    1 DO 2 K=1,MK                                                           6800
      TVG(K)=0.                                                             6900
      XVG(K)=0.                                                             7000
      DSG(K)=0.                                                             7100
      PRP(K)=0.                                                             7200
      XS(K)=0.                                                              7300
      DO 2 LR=1,2                                                           7400
      PRG2(K,LR)=0.                                                         7500
      ERG2(K,LR)=0.                                                         7600
      TRG2(K,LR)=0.                                                         7700
      TCG(K,LR)=0.                                                          7800
      XCG(K,LR)=0.                                                          7900
      XINTG(K,LR)=0.                                                        8000
    2 EINTG(K,LR)=0.                                                        8100
      DO 5 J=1,MJ                                                           8200
      AVVDD(J)=0.                                                           8300
      DO 5 M=1,MM                                                           8400
      IDSP(J,M)=IBL                                                         8500
      SPTC(J,M)=0.0                                                         8600
      SPPT(J,M)=0.0                                                         8700
      LS(J,M)=1                                                             8800
      ESP(J,M)=0.                                                           8900
      XSP(J,M)=0.                                                           9000
      YSP(J,M)=0.                                                           9100
      ZSP(J,M)=0.                                                           9200
      TUH(J,M)=0.                                                           9300
      EDSP(J,M)=0.                                                          9400
      TFUDGE(J,M)=0.                                                        9500
      ES(J,M)=0.                                                            9600
      KL(J,M)=0                                                             9700
      KR(J,M)=0                                                             9800
      DO 3 LR=1,2                                                           9900
      PS2(J,M,LR)=0.                                                       10000
      ES2(J,M,LR)=0.                                                       10100
    3 TR(J,M,LR)=0.                                                        10200
      DO 4 L=1,ML1                                                         10300
      ERS(J,M,L)=0.0                                                       10400
      TRS(J,M,L)=0.0                                                       10500
      DO 4 LR=1,2                                                          10600
      ERS2(J,M,L,LR)=0.0                                                   10700
      PRS2(J,M,L,LR)=0.0                                                   10800
      KRS2(J,M,L,LR)=IBL                                                   10900
    4 CONTINUE                                                             11000
      DO 5 K=1,MK                                                          11100
      PRG(K,J,M)=0.0                                                       11200
      ERG(K,J,M)=0.0                                                       11300
      TRG(K,J,M)=0.0                                                       11400
      KRG(K,J,M)=IBL                                                       11500
      VDD(K,J,M)=0.0                                                       11600
      D(K,J,M)=0.0                                                         11700
      LG(K,J,M)=0                                                          11800
      TR(K,J,M)=0.                                                         11900
```

```
      TA(K,J,M)=0.                                                      12000
      P(K,J,M)=0.                                                       12100
    5 CONTINUE                                                          12200
      DO 6 M=1,MM                                                       12300
      DO 6 L=1,ML                                                       12400
      VVA(M,L)=0.0                                                      12500
      VHA(M,L)=0.0                                                      12600
    6 CONTINUE                                                          12700
      DO 8 M=1,MM                                                       12800
      JA(M)=0                                                           12900
      JB(M)=0                                                           13000
      NJ(M)=0                                                           13100
      NK(M)=0                                                           13200
      XSHIFT(M)=0.                                                      13300
      DO 8 K=1,MK                                                       13400
      GTC(K,M)=0.0                                                      13500
      GPT(K,M)=0.0                                                      13600
      DO 7 LR=1,2                                                       13700
      PG2(K,M,LR)=0.                                                    13800
      EG2(K,M,LR)=0.                                                    13900
    7 TG2(K,M,LR)=0.                                                    14000
      DO 8 L=1,ML1                                                      14100
      ERP(K,M,L)=0.0                                                    14200
      TRP(K,M,L)=0.0                                                    14300
    8 CONTINUE                                                          14400
      IXTRUE=0                                                          14500
      IREP=0                                                            14600
      DMY0=0.                                                           14700
      DMY1=0.                                                           14800
      DMY2=0.                                                           14900
      DMY3=0.                                                           15000
C                                                                       15100
C READ INPUT CARDS AND PRINT INPUT DATA                                 15200
C                                                                       15300
      READ(IN1,9) IDENT                                                 15400
    9 FORMAT (16A5)                                                     15500
      IF (IDENT(1).EQ.IEND) GO TO 9999                                  15600
      READ(IN1,11)NM,IEXIT,IPLOT,NL,NV,ESCALE,XSCALE,TSCALE,            15700
     1 EDAT1,XDAT1,EDAT2,XDAT2,SLOPE,A,BLIM,TLIM,ITRACE,JJOFF,IDIP      15800
   11 FORMAT (I1,I2,2I1,1X,I1,1X,3(F4.0,1X),4F7.1,F7.4,F7.1,F7.2,F4.1,1X 15900
     1,3I1)                                                             16000
C                                                                       16100
C SET DEFAULT VALUES FOR IPLOT                                          16200
C                                                                       16300
      IF(IPLOT.LE.0) IPLOT=IABS(IEXIT)+1                                16400
      IF(IPLOT.GT.4) IPLOT=4                                            16500
      IXIT=0                                                            16600
      IF (IABS(IEXIT).LE.6) IXIT=IEXIT                                  16700
      IF (NL.LE.1) NL=2                                                 16800
      IF (NM.EQ.0) NM=1                                                 16900
      IF (BLIM.EQ.0.0) BLIM=0.5                                         17000
      IF (ESCALE.EQ.0.) ESCALE=5.0                                      17100
      IF (XSCALE.EQ.0.) XSCALE=8.33333333                               17200
      IF (TSCALE.EQ.0.) TSCALE=1.0                                      17300
      IF (TLIM.EQ.0.0) TLIM=10.0                                        17400
      LN=NL-1                                                           17500
C                                                                       17600
      PRINT 13,IDENT,NM,IXIT,NL,IPLOT,NV,ESCALE,XSCALE,TSCALE           17700
     1,EDAT1,XDAT1,EDAT2,XDAT2,SLOPE,A,BLIM,TLIM,ITRACE,JJOFF,IDIP      17800
   13 FORMAT (1H1,50X,12H SIPB REV 20/1HO,16A5/1HO,17HCONTROL CARD DATA, 17900
```

```
     1 13X,20HP L O T  S C A L E S,5X,9HD A T U M,4X,15HO V E R R I D E,   18000
     2 4X,11HV A L U E S/1HO,30X,4HELEV,4X,5HHORIZ,                       18100
     3 2X,4HTIME,5X,29HP O I N T   1   P O I N T   2/1H ,5HSPRDS,1X,      18200
     4 'EXIT LAYERS PLOT VCARDS FT/COL FT/ROW MS/COL ',                   18300
     5 2(3X,4HELEV,4X,5HX POS),3X,28HSLOPE  INTCPT   BLIM    TLIM,3X,     18400
     6 13HTRACE OFF DIP/' ----- ---- ------ ----',4(' ------'),1X,        18500
     7 8(' ------'),2X,'----- --- ---'/1X,I3,4I6,2X,3F7.1,4F8.1,          18600
     8 F8.4,F7.1,F8.2,F8.1,I6,I5,I4)                                      18700
      NIXIT=0                                                             18800
      IF(IXIT.GE.0) GO TO 14                                              18900
      IXIT=IABS(IXIT)                                                     19000
      NIXIT=1                                                             19100
   14 IF (NV.EQ.0) GO TO 25                                               19200
      PRINT 15, (M,M=1,NM)                                                19300
   15 FORMAT (1HO,14HVELOCITY CARDS/4X,5(6X,'SPREAD',I2))                 19400
      PRINT 10014, (IBL,M=1,NM)                                           19500
10014 FORMAT(2X,'LAYER',5(A3,'VV      VH  '))                           19600
      PRINT 11014, (IBL,M=1,NM)                                           19700
11014 FORMAT(2X,'----- ',5(A1,'------ ------'))                           19800
      DO 20 I=1,NV                                                        19900
      READ(IN1,17) L,(VVA(M,L),VHA(M,L),M=1,NM)                           20000
   17 FORMAT (I1,10F6.0)                                                  20100
      PRINT 19,L,(VVA(M,L),VHA(M,L),M=1,NM)                               20200
   19 FORMAT (4X,I1,2X,10F7.0)                                            20300
      DO 20 M=1,NM                                                        20400
      VVA(M,L)=VVA(M,L)/1000.                                             20500
      VHA(M,L)=VHA(M,L)/1000.                                             20600
   20 CONTINUE                                                            20700
   25 DO 60 M=1,NM                                                        20800
      READ(IN1,27) IDSPR(M),NJ(M),NK(M),XSHIFT(M),IXTRUE                  20900
   27 FORMAT (A1,2I3,F11.1,1X,I1)                                         21000
      PRINT 29, IDSPR(M),NJ(M),NK(M),XSHIFT(M),IXTRUE                     21100
   29 FORMAT (/28H SHOTPOINT AND GEOPHONE DATA//2X,6HSPREAD,1X,A1,1H,,    21200
     1I2,1X,11HSHOTPOINTS,,I3,1X,19HGEOPHONES, XSHIFT =,F8.1,', XTRUE ='  21300
     2,I2//2X,55HSP    ELEV     X LOC     Y LOC     DEPTH  UPHOLE T  FUDGE T  21400
     3,2X,6HEND SP/2X,10H-- -------,6(1X,8H--------))                     21500
      XLAST=-BIG                                                          21600
      JN=NJ(M)                                                            21700
      DO 35 J=1,JN                                                        21800
      READ(IN1,31) IDTEST,IDSP(J,M),ESP(J,M),XSP(J,M)                     21900
     1,YSP(J,M),ZSP(J,M),TUH(J,M),TFUDGE(J,M),JC                          22000
   31 FORMAT (A1,2X,A1,3F7.1,3F5.1,1X,I1)                                 22100
      IF (IDTEST.NE.IDSPR(M).OR.XSP(J,M).LT.XLAST) GO TO 9990             22200
      PRINT 33, IDSP(J,M),ESP(J,M),XSP(J,M),YSP(J,M)                      22300
     1,ZSP(J,M),TUH(J,M),TFUDGE(J,M),JC                                   22400
   33 FORMAT (1H ,2X,A1,F8.1,5F9.1,I6)                                    22500
      ES(J,M)=ESP(J,M)-ZSP(J,M)                                           22600
      IF (JC.EQ.1) JA(M)=J                                                22700
      IF (JC.EQ.2) JB(M)=J                                                22800
      XLAST=XSP(J,M)                                                      22900
   35 CONTINUE                                                            23000
      PRINT 41, (IDSP(J,M),J=1,JN)                                        23100
   41 FORMAT (1HO,33X,46HARRIVAL TIMES + FUDGE T AND LAYERS REPRESENTED/  23200
     129H  GEO  ELEV     X LOC     Y LOC,2X,7(5X,'SP ',A1))              23300
      PRINT 42, (IBL,J=1,JN)                                              23400
   42 FORMAT('  --- ------',2(' --------'),2X,7(A2,'-------'))            23500
      XLAST=-BIG                                                          23600
      KN=NK(M)                                                            23700
      DO 55 K=1,KN                                                        23800
      READ(IN1,43)IDTEST,KTEST,EG(K,M),XG(K,M),YG(K,M)                    23900
```

```
     1,(TA(K,J,M),LG(K,J,M),J=1,JN)                                          24000
  43 FORMAT (A1,I3,3F7.1,7(F5.1,1X,I1))                                      24100
     IF (IDTEST.NE.IDSPR(M).OR.KTEST.NE.K.OR.XG(K,M).LT.XLAST)               24200
    1 GO TO 9990                                                             24300
     DO 44 J=1,JN                                                            24400
     IF (TA(K,J,M).NE.0.0) TA(K,J,M)=TA(K,J,M)+TFUDGE(J,M)                   24500
     IF (TA(K,J,M).LE.0.) LG(K,J,M)=0                                        24600
     TR(K,J,M)=TA(K,J,M)                                                     24700
  44 CONTINUE                                                                24800
     PRINT 45, K,EG(K,M),XG(K,M),YG(K,M),(TA(K,J,M),LG(K,J,M),J=1,JN)        24900
  45 FORMAT (2X,I2,F8.1,2F9.1,2X,7(F7.1,I2))                                 25000
     XLAST=XG(K,N)                                                           25100
  55 CONTINUE                                                                25200
     IF(M.NE.NM.OR.NIXIT.EQ.0)PRINT 57, IDENT                                25300
  57 FORMAT (1H1,16A5)                                                       25400
  60 CONTINUE                                                                25500
C                                                                            25600
C IF IXTRUE=0, CORRECT X-DISTANCES. IXTRUE=0 IMPLIES THAT X-DISTANCES        25700
C FOR SPS & GEOS ARE MEASURED ALONG GROUND SURFACE AND NO CORRECTION HAS     25800
C BEEN MADE FOR SLOPE.                                                       25900
C                                                                            26000
     IF(IXTRUE.NE.0) GO TO 95                                                26100
     DO 90 M=1,NM                                                            26200
     JN=NJ(M)                                                                26300
     KN=NK(M)                                                                26400
     XS(1)=XG(1,M)                                                           26500
     DO 62 K=2,KN                                                            26600
     XS(K)=XS(K-1)+SQRT((XG(K,M)-XG(K-1,M))**2-(EG(K,M)-EG(K-1,M))**2)       26700
  62 CONTINUE                                                                26800
     DO 64 J=1,JN                                                            26900
     IF(XSP(J,M).GT.XG(1,M)) GO TO 66                                        27000
  64 CONTINUE                                                                27100
     J=JN+1                                                                  27200
  66 J1=J-1                                                                  27300
     IF(J1.EQ.0) GO TO 70                                                    27400
     XTIE=XS(1)                                                              27500
     XREF=XG(1,M)                                                            27600
     EREF=EG(1,M)                                                            27700
     DO 68 J=1,J1                                                            27800
     JR=J1-J+1                                                               27900
     XTIE=XTIE-SQRT((XREF-XSP(JR,M))**2-(EREF-ESP(JR,M))**2)                 28000
     XREF=XSP(JR,M)                                                          28100
     EREF=ESP(JR,M)                                                          28200
     XSP(JR,M)=XTIE                                                          28300
  68 CONTINUE                                                                28400
  70 J1=J1+1                                                                 28500
     DO 72 J=J1,JN                                                           28600
     IF(XSP(J,M).GT.XG(KN,M)) GO TO 74                                       28700
     DO 71 K=2,KN                                                            28800
     IF(XG(K,M).LT.XSP(J,M)) GO TO 72                                        28900
     XSP(J,M)=XS(K-1)+(XS(K)-XS(K-1))*(XSP(J,M)-XG(K-1,M))/                  29000
    1(XG(K,M)-XG(K-1,M))                                                     29100
  71 CONTINUE                                                                29200
  72 CONTINUE                                                                29300
     GO TO 78                                                                29400
  74 J1=J                                                                    29500
     XTIE=XS(KN)                                                             29600
     XREF=XG(KN,M)                                                           29700
     EREF=EG(KN,M)                                                           29800
     DO 76 J=J1,JN                                                           29900
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```
      XTIE=XTIE+SQRT((XSP(J,M)-XREF)**2-(ESP(J,M)-EREF)**2)                30000
      XREF=XSP(J,M)                                                        30100
      EREF=ESP(J,M)                                                        30200
      XSP(J,M)=XTIE                                                        30300
   76 CONTINUE                                                             30400
   78 DO 80 K=1,KN                                                         30500
   80 XG(K,M)=XS(K)                                                        30600
   90 CONTINUE                                                             30700
C                                                                          30800
C COMPUTE V1 USING DIRECT DIST DD FROM SHOT TO GEOS FOR WHICH LG=1          30900
C                                                                          31000
   95 IF (NIXIT.EQ.0) PRINT 100                                            31100
  100 FORMAT (1H0,1X,42HV1 FOR DIRECT RAYS AND DIRECT DISTANCES DD)        31200
      SUM1=0.0                                                             31300
      PTS1=0.0                                                             31400
      DO 150 M=1,NM                                                        31500
      SUM2=0.0                                                             31600
      PTS2=0.0                                                             31700
      JN=NJ(M)                                                             31800
      DO 120 J=1,JN                                                        31900
      SUM3=0.0                                                             32000
      PTS3=0.0                                                             32100
      KN=NK(M)                                                             32200
      DO 110 K=1,KN                                                        32300
      IF (LG(K,J,M).NE.1) GO TO 110                                        32400
      D(K,J,M)=SQRT ((EG(K,M)-ES(J,M))**2+(XG(K,M)-XSP(J,M))**2+(YG(K,M)   32500
     1-YSP(J,M))**2)                                                       32600
      VDD(K,J,M)=D(K,J,M)/TA(K,J,M)                                        32700
      PTS3=PTS3+1.0                                                        32800
      SUM3=SUM3+VDD(K,J,M)                                                 32900
      PTS2=PTS2+1.0                                                        33000
      SUM2=SUM2+VDD(K,J,M)                                                 33100
      PTS1=PTS1+1.0                                                        33200
      SUM1=SUM1+VDD(K,J,M)                                                 33300
  110 CONTINUE                                                             33400
      IF (PTS3.EQ.0.) GO TO 115                                            33500
      AVVDD(J)=SUM3/PTS3                                                   33600
      GO TO 120                                                            33700
  115 AVVDD(J)=0.0                                                         33800
  120 CONTINUE                                                             33900
      IF (PTS2.EQ.0.) GO TO 126                                            34000
      SUM2=SUM2/PTS2                                                       34100
  126 IF (NIXIT.EQ.1) GO TO 150                                            34200
      PRINT 130,IDSPR(M)                                                   34300
  130 FORMAT(/2X,'SPREAD',1X,A1,5X,'SP  GEO     DD        V1    AVG V1'/   34400
     115X,'--  ---',3('  ------'))                                         34500
      DO 140 J=1,JN                                                        34600
      DO 134 K=1,KN                                                        34700
      IF(VDD(K,J,M).EQ.0.) GO TO 134                                       34800
      PRINT 132, IDSP(J,M),K,D(K,J,M),VDD(K,J,M)                           34900
  132 FORMAT(16X,A1,I5,F8.1,3PF8.0)                                        35000
  134 CONTINUE                                                             35100
      IF(AVVDD(J).NE.0.) PRINT 136, AVVDD(J)                               35200
  136 FORMAT(38X,3PF8.0)                                                   35300
  140 CONTINUE                                                             35400
  150 CONTINUE                                                             35500
      IF (PTS1.EQ.0.) GO TO 152                                            35600
      SUM1=SUM1/PTS1                                                       35700
  152 VREG(1)=SUM1                                                         35800
      IF (VREG(1).LE.0.0) VREG(1)=1.5                                      35900
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  156 IF (NIXIT.EQ.0) PRINT 157, SUM1                                    36000
  157 FORMAT (1H0,10HAVG OF ALL,3PF7.0)                                  36100
C                                                                        36200
C APPLY XSHIFT TO XSP AND XG ARRAYS                                      36300
C  ALSO COMPUTE DIR DIST BETWEEN (XSP,YSP,ESP) AND (XG,YG,EG) IF LG.NE.1 36400
C  AND COMPUTE PLOT POSITIONS P                                          36500
C                                                                        36600
      DO 180 M=1,NM                                                      36700
      JN=NJ(M)                                                           36800
      KN=NK(M)                                                           36900
      DO 165 K=1,KN                                                      37000
      XG(K,M)=XG(K,M)+XSHIFT(M)                                          37100
  165 CONTINUE                                                           37200
      DO 175 J=1,JN                                                      37300
      XSP(J,M)=XSP(J,M)+XSHIFT(M)                                        37400
      DO 170 K=1,KN                                                      37500
      IF (LG(K,J,M).NE.1) D(K,J,M)=SQRT((XG(K,M)-XSP(J,M))**2+(YG(K,M)-  37600
     1 YSP(J,M))**2+(EG(K,M)-ESP(J,M))**2)                               37700
      IF (XG(K,M)-XSP(J,M)) 168,166,167                                  37800
  166 IF (K.EQ.KN) GO TO 168                                             37900
  167 P(K,J,M)=XSP(J,M)+D(K,J,M)                                         38000
      GO TO 170                                                          38100
  168 P(K,J,M)=XSP(J,M)-D(K,J,M)                                         38200
  170 CONTINUE                                                           38300
  175 CONTINUE                                                           38400
  180 CONTINUE                                                           38500
C                                                                        38600
C FIND NUMBER OF GEO TO THE LEFT, KL(J,M), AND RIGHT, KR(J,M) OF EACH SP 38700
C     IF NONE, KL OR KR SET TO ZERO.                                     38800
C                                                                        38900
      DO 188 M=1,NM                                                      39000
      JN=NJ(M)                                                           39100
      KN=NK(M)                                                           39200
      DO 186 J=1,JN                                                      39300
      IF (XSP(J,M).LE.XG(1,M)) GO TO 183                                 39400
      IF (XSP(J,M).GE.XG(KN,M)) GO TO 184                                39500
      DO 181 K=2,KN                                                      39600
      IF (XG(K,M).GT.XSP(J,M)) GO TO 182                                 39700
  181 CONTINUE                                                           39800
  182 KL(J,M)=K-1                                                        39900
      KR(J,M)=K                                                          40000
      GO TO 186                                                          40100
  183 KL(J,M)=0                                                          40200
      KR(J,M)=1                                                          40300
      GO TO 186                                                          40400
  184 KL(J,M)=KN                                                         40500
      KR(J,M)=0                                                          40600
  186 CONTINUE                                                           40700
  188 CONTINUE                                                           40800
C                                                                        40900
C FIND END SPS FOR EACH SPREAD AND SET LIMITS OF X AXIS FOR T-D GRAPH     41000
C                                                                        41100
      XSC02=XSCALE/2.0                                                   41200
      DO 200 M=1,NM                                                      41300
      JN=NJ(M)                                                           41400
      KN=NK(M)                                                           41500
      IF (JA(M).NE.0) GO TO 192                                          41600
      DO 190 J=1,JN                                                      41700
      IF (XSP(J,M).LE.XG(1,M)) GO TO 190                                 41800
      JA(M)=J-1                                                          41900
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      IF (J.GT.1) GO TO 192                                              42000
      JA(M)=1                                                            42100
      IF (M.EQ.1) XLIM1=XG(1,1)                                          42200
      GO TO 194                                                          42300
  190 CONTINUE                                                           42400
      JA(M)=JN                                                           42500
  192 IF (M.NE.1) GO TO 195                                              42600
      J=JA(M)                                                            42700
      XLIM1=AMIN1(XSP(J,1),XG(1,1))                                      42800
  194 XLIM1=XLIM1+XSCO2                                                  42900
  195 IF (JB(M).NE.0) GO TO 197                                          43000
      DO 196 J=1,JN                                                      43100
      IF (XSP(J,M).LT.XG(KN,M)) GO TO 196                                43200
      JB(M)=J                                                            43300
      GO TO 197                                                          43400
  196 CONTINUE                                                           43500
      JB(M)=JN                                                           43600
      IF (M.NE.NM) GO TO 200                                             43700
      XLIM2=XG(KN,NM)                                                    43800
      GO TO 200                                                          43900
  197 IF (M.NE.NM) GO TO 200                                             44000
      J=JB(M)                                                            44100
      XLIM2=AMAX1(XSP(J,NM),XG(KN,NM))                                   44200
  200 CONTINUE                                                           44300
C                                                                        44400
C TEST FOR DOING RAW TIME T-D PLOT                                       44500
C                                                                        44600
      IF(IPLOT.EQ.1.AND.NIXIT.EQ.0) CALL PLOT(1)                         44700
      IF (IXIT.EQ.0) GO TO 1                                             44800
C                                                                        44900
C FIT STRAIGHT LINE THRU GEO ELEVATIONS                                  45000
C                                                                        45100
  205 IF (SLOPE.NE.0.0.OR.A.NE.0.0) GO TO 225                            45200
      IF (XDAT1.NE.0.0.OR.XDAT2.NE.0.0) GO TO 220                        45300
      SUM1=0.0                                                           45400
      SUM2=0.0                                                           45500
      PTS=0.0                                                            45600
      DO 212 M=1,NM                                                      45700
      KN=NK(M)                                                           45800
      DO 210 K=1,KN                                                      45900
      SUM1=SUM1+XG(K,M)                                                  46000
      SUM2=SUM2+EG(K,M)                                                  46100
      PTS=PTS+1.0                                                        46200
  210 CONTINUE                                                           46300
  212 CONTINUE                                                           46400
      XBAR=SUM1/PTS                                                      46500
      EBAR=SUM2/PTS                                                      46600
      SUM1=0.0                                                           46700
      SUM2=0.0                                                           46800
      DO 216 M=1,NM                                                      46900
      KN=NK(M)                                                           47000
      DO 214 K=1,KN                                                      47100
      DIFF=XG(K,M)-XBAR                                                  47200
      SUM1=SUM1+DIFF*EG(K,M)                                             47300
      SUM2=SUM2+DIFF**2                                                  47400
  214 CONTINUE                                                           47500
  216 CONTINUE                                                           47600
      SLOPE=SUM1/SUM2                                                    47700
      A=EBAR-SLOPE*XBAR                                                  47800
      GO TO 225                                                          47900
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  220 SLOPE=(EDAT2-EDAT1)/(XDAT2-XDAT1)                                  48000
      A=EDAT1-SLOPE*XDAT1                                                48100
  225 DO 230 M=1,NM                                                      48200
      KN=NK(M)                                                           48300
      DO 226 K=1,KN                                                      48400
      EDG(K,M)=A+SLOPE*XG(K,M)                                           48500
  226 CONTINUE                                                           48600
      JN=NJ(M)                                                           48700
      DO 227 J=1,JN                                                      48800
  227 EDSP(J,M)=ES(J,M)                                                  48900
      J1=JA(M)                                                           49000
      J2=JB(M)                                                           49100
      DO 228 J=J1,J2                                                     49200
      EDSP(J,M)=A+SLOPE*XSP(J,M)                                         49300
  228 CONTINUE                                                           49400
  230 CONTINUE                                                           49500
C                                                                        49600
C VELOCITY OVERRIDE CARD ANALYSIS -- SET ANY ZERO VH=VV IF VV NONZERO    49700
C                                                                        49800
      IOVER=0                                                            49900
      IF (VVA(1,1).NE.0.0) GO TO 242                                     50000
      DO 240 M=1,NM                                                      50100
      VVA(M,1)=VREG(1)                                                   50200
  240 CONTINUE                                                           50300
      GO TO 246                                                          50400
  242 IOVER=1                                                            50500
      IF (NM.LE.1) GO TO 246                                             50600
      DO 244 M=2,NM                                                      50700
      IF (VVA(M,1).EQ.0.0) VVA(M,1)=VVA(1,1)                             50800
  244 CONTINUE                                                           50900
  246 DO 250 L=2,NL                                                      51000
      IF (VVA(1,L).EQ.0.0) GO TO 250                                     51100
      IF (VHA(1,L).EQ.0.0) VHA(1,L)=VVA(1,L)                             51200
      IF (NM.LE.1) GO TO 250                                             51300
      DO 248 M=2,NM                                                      51400
      IF (VVA(M,L).EQ.0.0) VVA(M,L)=VVA(1,L)                             51500
      IF (VHA(M,L).EQ.0.0) VHA(M,L)=VHA(1,L)                             51600
  248 CONTINUE                                                           51700
  250 CONTINUE                                                           51800
C                                                                        51900
C COMPUTE AND APPLY VERTICAL TIME CORRECTIONS TO DATUM -- PRINT RESULTS   52000
C                                                                        52100
  300 IF(NIXIT.EQ.1) GO TO 303                                           52200
      PRINT 57, IDENT                                                    52300
      PRINT 302, A, SLOPE                                                52400
  302 FORMAT (1H0,46HARRIVAL TIMES CORRECTED TO DATUM (DATUM ELEV =,F8.1  52500
     1,4H + (,F8.4,25H)X), AND PLOT POSITIONS D)                         52600
  303 DO 400 M=1,NM                                                      52700
      VV=VVA(M,1)                                                        52800
      JN=NJ(M)                                                           52900
      KN=NK(M)                                                           53000
C FIRST PRECOMPUTE GEO TIME CORR                                         53100
      DO 304 K=1,KN                                                      53200
      TVG(K)=(EDG(K,M)-EG(K,M))/VV                                       53300
  304 CONTINUE                                                           53400
C THEN COMPUTE SP TIME CORR                                              53500
      DO 306 J=1,JN                                                      53600
      TVS(J)=0.                                                          53700
      IF (J.LT.JA(M).OR.J.GT.JB(M)) GO TO 306                            53800
      TVS(J)=(EDSP(J,M)-ES(J,M))/VV                                      53900
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      IF (TUH(J,M).NE.0.0) TVS(J)=TVS(J)*TUH(J,M)*VV/ZSP(J,M)
  306 CONTINUE
C APPLY DATUM CORRECTIONS
  312 DO 332 J=1,JN
      DO 330 K=1,KN
      IF (LG(K,J,M).NE.1.AND.TR(K,J,M).NE.0.0) TA(K,J,M)=TR(K,J,M) +
     1 TVS(J) + TVG(K)
  330 CONTINUE
  332 CONTINUE
C PRINT RESULTS
      IF (NIXIT.EQ.1) GO TO 400
      PRINT 383, IDSPR(M),(IDSP(J,M),J=1,JN)
  383 FORMAT (1H0,1X,7HSPREAD ,A1,7X,7(10X,'SP ',A1))
      PRINT 384, (EDSP(J,M),J=1,JN)
  384 FORMAT(/7X,'ELEV . . . . .',7(F10.1,4X))
      PRINT 385, (TVS(J),J=1,JN)
  385 FORMAT (9X,1H./9X,1H.,3X,6HCORR T,7(F12.1,2X))
      PRINT 387, (IBL,J=1,JN)
  387 FORMAT (' GEO      .',10X,7(A1,'---T-----D---'))
      DO 390 K=1,KN
      PRINT 389, K,EDG(K,M),TVG(K),(TA(K,J,M),P(K,J,M),J=1,JN)
  389 FORMAT (1X,I2,2F8.1,1X,14F7.1)
  390 CONTINUE
  400 CONTINUE
C
C EXIT POINT TEST AND BRANCH
C
C PLOT T-D GRAPH
C
  450 IF(IPLOT.EQ.2.AND.NIXIT.EQ.0) CALL PLOT(1)
C
      IF (IXIT.EQ.1) GO TO 1
C
C*****************************************************************
C PART 2
C*****************************************************************
C
C DO REGRESSION VELOCITY COMPUTATION FOR TOP OF LAYER 2
C
 1000 IF (NIXIT.EQ.0) PRINT 57, IDENT
      L1=1
      L2=2
      CALL REGV(L2,NIXIT)
      IF(PREG(2).GT.0.0) GO TO 1005
      IF (VVA(1,2).GT.0.0) GO TO 1020
 1001 IF (NIXIT.NE.0) GO TO 1
      PRINT 1002, L2
 1002 FORMAT (/1X,46HNOT ENOUGH POINTS TO DEFINE VELOCITY FOR LAYER,I2,
     118H USE OVERRIDE CARD)
      GO TO 1
C
C DO HOBSON-OVERTON VEL COMPUTATION FOR TOP OF LAYER 2
C
 1005 CALL HOBV(L2,NIXIT)
C
      IF (VVA(1,2).NE.0.0) GO TO 1020
      VV=(VREG(2)*PREG(2)+2.0*VHOB(2)*PHOB(2))/(PREG(2)+2.0*PHOB(2))
      DO 1008 M=1,NM
      VVA(M,2)=VV
      VHA(M,2)=VV
```

```
 1008 CONTINUE                                                          60000
C                                                                       60100
      IF(NIXIT.NE.0) GO TO 1094                                         60200
      PRINT 1011,L2,VV                                                  60300
 1011 FORMAT('0WTD AVG VELOCITY FOR LAYER',I2,' =',3PF7.0/' -'          60400
     1,6('------'))                                                     60500
      GO TO 1094                                                        60600
C                                                                       60700
 1020 IF(NIXIT.NE.0) GO TO 1094                                         60800
      PRINT 1021, L2,VVA(1,L2)                                          60900
 1021 FORMAT (1X,'OVERRIDE V',I1,' =',3PF8.0)                           61000
C                                                                       61100
C COMPUTE VELOCITIES FOR DEEPER LAYERS BY REGRESSION AND HOBSON METHOD  61200
C                                                                       61300
 1094 DO 1100 L=3,NL                                                    61400
      IF(NIXIT.EQ.0) PRINT 57, IDENT                                    61500
      LCALL=L                                                           61600
      CALL REGV(LCALL,NIXIT)                                            61700
      IF (PREG(L).GT.0.) GO TO 1096                                     61800
      IF(VVA(1,L),GT.0.) GO TO 1100                                     61900
      L2=L                                                              62000
      GO TO 1001                                                        62100
 1096 LCALL=L                                                           62200
      CALL HOBV(LCALL,NIXIT)                                            62300
      IF(VVA(1,L).NE.0.) GO TO 1098                                     62400
      VV=(VREG(L)*PREG(L)+2.*VHOB(L)*PHOB(L))/(PREG(L)+2.*PHOB(L))      62500
      DO 1097 M=1,NM                                                    62600
      VVA(M,L)=VV                                                       62700
      VHA(M,L)=VV                                                       62800
 1097 CONTINUE                                                          62900
      IF(NIXIT.NE.0) GO TO 1100                                         63000
      PRINT 1011, L,VV                                                  63100
      GO TO 1100                                                        63200
C                                                                       63300
 1098 IF(NIXIT.NE.0) GO TO 1100                                         63400
      PRINT 1021, L,VVA(1,L)                                            63500
 1100 CONTINUE                                                          63600
C                                                                       63700
C MAKE TIE CORRECTION IF JJOFF.EQ.0                                     63800
C                                                                       63900
      IF(JJOFF.NE.0) GO TO 1150                                         64000
      DO 1145 M=1,NM                                                    64100
      MCALL=M                                                           64200
      KN=NK(M)                                                          64300
      J=JA(M)                                                           64400
      IF(XG(1,M).GE.XSP(J,M)) GO TO 1120                                64500
C SET D NEGATIVE FOR GEOS LEFT OF LEFT END SP                           64600
      K2=KL(J,M)                                                        64700
      DO 1118 K=1,K2                                                    64800
      D(K,J,M)=-D(K,J,M)                                                64900
 1118 CONTINUE                                                          65000
 1120 JJ=J-1                                                            65100
      IF(JJ.LT.1) GO TO 1130                                            65200
      JJTIE=0                                                           65300
      DO 1125 L=2,NL                                                    65400
      LCALL=L                                                           65500
      CALL KENDS(LCALL,MCALL,JJ,KR(JJ,M),KN,K11,K22)                    65600
      IF(K11.EQ.0) GO TO 1125                                           65700
      KT1=KR(J,M)                                                       65800
      IF(KT1.EQ.0) GO TO 1125                                           65900
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      CALL TIE(LCALL,MCALL,J,JJ,K11,K22,KT1,KN,1,JJTIE)                 66000
 1125 CONTINUE                                                          66100
      J=J-1                                                             66200
      GO TO 1120                                                        66300
 1130 J=JB(M)                                                           66400
      JN=NJ(M)                                                          66500
      IF(XG(KN,M).LE.XSP(J,M)) GO TO 1135                               66600
C SET D NEGATIVE FOR GEOS RIGHT OF RIGHT END SP                         66700
      K1=KR(J,M)                                                        66800
      DO 1132 K=K1,KN                                                   66900
      D(K,J,M)=-D(K,J,M)                                                67000
 1132 CONTINUE                                                          67100
 1135 JJ=J+1                                                            67200
      IF(JJ.GT.JN) GO TO 1145                                           67300
      JJTIE=0                                                           67400
      DO 1140 L=2,NL                                                    67500
      LCALL=L                                                           67600
      CALL KENDS(LCALL,MCALL,JJ,1,KL(JJ,M),K11,K22)                     67700
      IF(K11.EQ.0) GO TO 1140                                           67800
      KT2=KL(J,M)                                                       67900
      IF(KT2.EQ.0) GO TO 1140                                           68000
      CALL TIE(LCALL,MCALL,J,JJ,K11,K22,1,KT2,KN,2,JJTIE)               68100
 1140 CONTINUE                                                          68200
      J=J+1                                                             68300
      GO TO 1135                                                        68400
 1145 CONTINUE                                                          68500
C                                                                       68600
C PLOT T-D GRAPH OF PRE-DEPTH TIME VALUES                               68700
C                                                                       68800
 1150 DO 1160 M=1,NM                                                    68900
      JN=NJ(M)                                                          69000.
      KN=NK(M)                                                          69100
      DO 1160 J=1,JN                                                    69200
      DO 1160 K=1,KN                                                    69300
 1160 TA(K,J,M)=TR(K,J,M)                                               69400
C                                                                       69500
      IF(IPLOT.EQ.3.AND.NIXIT.EQ.0) CALL PLOT(1)                        69600
C                                                                       69700
C COMPUTE DEPTH PTS AT BASE OF LAYER 1 (FOR IREP=1,IFLAG=0)             69800
C (IREP.GE.2 IS DONE IN PART 3)                                         69900
C                                                                       70000
C SPREAD LOOP STARTS HERE----------------------------LOOP ENDS AT 1060  70100
C                                                                       70200
 1025 IF (ITRACE.NE.0.AND.IXIT.GE.4) PRINT 1027, L2                     70300
 1027 FORMAT (1H1,45HINTERMEDIATE RESULTS OF RAY TRACING FOR LAYER,I2)   70400
      IFLAG=0                                                           70500
      RADS=SQRT(1.+SLOPE**2)                                            70600
      DO 1060 M=1,NM                                                    70700
      JN=NJ(M)                                                          70800
      KN=NK(M)                                                          70900
      VV=VVA(M,L1)                                                      71000
      HV=VHA(M,L2)                                                      71100
      IF (HV.LE.VV) GO TO 9992                                          71200
      RAD=SQRT(HV**2-VV**2)                                             71300
      TANSG=VV/RAD                                                      71400
      VOCOSG=TANSG*HV                                                   71500
      VVCOSG=VV*RAD/HV                                                  71600
      DENEX=HV*RADS                                                     71700
      IF (JJOFF.NE.0) GO TO 1029                                        71800
      J1=JA(M)                                                          71900
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      J2=JB(M)                                                          72000
      GO TO 1030                                                        72100
 1029 J1=1                                                              72200
      J2=NJ(M)                                                          72300
C                                                                       72400
C PRECOMPUTE DATUM ELEV CORR FOR ALL GEOS AND STORE V AND TRIG CONSTS   72500
 1030 DO 1034 K=1,KN                                                    72600
C I=1 FOR RIGHT-GOING RAYS, 2 FOR LEFT-GOING                            72700
      DO 1033 I=1,2                                                     72800
      ICALL=I                                                           72900
      CALL ELCOR(TANSG,VV,HV,XG(K,M),EG(K,M),A,SLOPE,ICALL,TCG(K,I),    73000
     1 XCG(K,I),XINTG(K,I),EINTG(K,I))                                  73100
 1033 CONTINUE                                                          73200
 1034 CONTINUE                                                          73300
C                                                                       73400
C SHOT POINT LOOP STARTS HERE----------------------LOOP ENDS AT 1049    73500
C                                                                       73600
      DO 1049 J=J1,J2                                                   73700
      JJ=J                                                              73800
C                                                                       73900
C INITIALIZE FOR RIGHT-GOING RAYS                                       74000
C                                                                       74100
      I=1                                                               74200
      II=2                                                              74300
      K1=KR(J,M)                                                        74400
      IF (K1.EQ.0) GO TO 1046                                           74500
      K2=KN                                                             74600
C                                                                       74700
C COMPUTE ELEV TIME CORR AND DIRECT DISTS                               74800
C                                                                       74900
 1036 MCALL=M                                                           75000
      JCALL=J                                                           75100
      CALL KENDS(2,MCALL,JCALL,K1,K2,K11,K22)                           75200
      IF (K11.EQ.0) GO TO (1046,1049),I                                 75300
      CALL ELCOR(TANSG,VV,HV,XSP(J,M),ES(J,M),A,SLOPE,II,TC,XC,XINT,EINT 75400
     1)                                                                 75500
C                                                                       75600
C RE-ENTRY POINT FOR OUTLYING SHOTPOINTS                                75700
C                                                                       75800
 1037 DO 1038 K=K11,K22                                                 75900
      IF (LG(K,JJ,M).NE.2) GO TO 1038                                   76000
      TA(K,JJ,M)=TR(K,JJ,M)+TC+TCG(K,I)                                 76100
      DSG(K)=D(K,J,M)+XC+XCG(K,I)                                       76200
 1038 CONTINUE                                                          76300
C                                                                       76400
C EXTRAP TIME AT SP AND COMPUTE COORD OF END PT OF RAY BENEATH SP       76500
C                                                                       76600
      MCALL=M                                                           76700
      CALL REGRES(K11,K22,JJ,MCALL,2,V,T,PT,0)                          76800
      IF (PT.EQ.0.) GO TO (1046,1049),I                                 76900
      Z=T*VOCOSG                                                        77000
      TS=Z/VVCOSG                                                       77100
      ZTAN=Z*TANSG                                                      77200
      RAY=SQRT(Z**2+ZTAN**2)                                            77300
      B=SLOPE                                                           77400
      IF(I.EQ.1) B=-B                                                   77500
      XTRU=RAY*(VV-B*RAD)/DENEX                                         77600
      ZTRU=RAY*(RAD+VV*B)/DENEX                                         77700
      IF(I.EQ.2) XTRU=-XTRU                                             77800
 1039 PRS2(JJ,M,1,I)=XINT+XTRU                                          77900
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      IF(I.EQ.2) ZTAN=-ZTAN                                              78000
      PRSH=XINT+ZTAN/RADS                                                78100
      ERS2(JJ,M,1,I)=EINT-ZTRU                                           78200
      TRS2(JJ,M,I)=TS                                                    78300
      PS2(JJ,M,I)=XSP(J,M)                                               78400
      ES2(JJ,M,I)=ES(J,M)                                                78500
      IF (TRS2(JJ,M,I).GE.0.) GO TO 1041                                 78600
      TS=0.                                                              78700
      Z=0.                                                               78800
      TRS2(JJ,M,I)=0.                                                    78900
      ERS2(JJ,M,1,I)=ES(J,M)                                             79000
      PRS2(JJ,M,1,I)=XSP(J,M)                                            79100
      PRSH=XSP(J,M)                                                      79200
C                                                                        79300
C COMPUTE COORD OF RAY END PTS AT GEOS                                   79400
C                                                                        79500
 1041 ZRSP(JJ)=Z                                                         79600
      DO 1043 K=K11,K22                                                  79700
      IF (LG(K,JJ,M).NE.2) GO TO 1043                                    79800
      EDIF=SLOPE*(XINTG(K,I)-PRSH)                                       79900
      KCALL=K                                                            80000
      JCALL=J                                                            80100
      MCALL=M                                                            80200
      CALL HTIME(KCALL,JCALL,MCALL,PRSH,0.,XINTG(K,I),EDIF,HV,TH)        80300
      PG2(K,M,I)=XG(K,M)                                                 80400
      EG2(K,M,I)=EG(K,M)                                                 80500
      Z=(TA(K,JJ,M)-TS-TH)*VOCOSG                                        80600
      ZTAN=Z*TANSG                                                       80700
      RAY=SQRT(Z**2+ZTAN**2)                                             80800
      B=SLOPE                                                            80900
      IF(I.EQ.2) B=-B                                                    81000
      XTRU=RAY*(VV-B*RAD)/DENEX                                          81100
      ZTRU=RAY*(RAD+VV*B)/DENEX                                          81200
      IF(I.EQ.1) XTRU=-XTRU                                              81300
      ERG(K,JJ,M)=EINTG(K,I)-ZTRU                                        81400
      IF (EG(K,M).GT.ERG(K,JJ,M)) GO TO 1042                             81500
      Z=0.                                                               81600
      ERG(K,JJ,M)=EG(K,M)                                                81700
      PRG(K,JJ,M)=XG(K,M)                                                81800
      TRG(K,JJ,M)=0.00001                                                81900
      GO TO 11043                                                        82000
 1042 TRG(K,JJ,M)=Z/VVCOSG                                               82100
      PRG(K,JJ,M)=XINTG(K,I)+XTRU                                        82200
11043 ZRG(K,JJ)=Z                                                        82300
 1043 CONTINUE                                                           82400
C                                                                        82500
C TEST FOR DOING OUTLYING SPS LEFT OF SPREAD, RIGHT-GOING RAYS           82600
C                                                                        82700
      IF (I.EQ.2) GO TO 1047                                             82800
      IF (JJOFF.NE.0.OR.JJ.GT.J1) GO TO 1046                             82900
 1044 JJ=JJ-1                                                            83000
      IF (JJ.GT.0) GO TO 1045                                            83100
      SUM1=0.                                                            83200
      SUM2=0.                                                            83300
      SUM3=0.                                                            83400
      PTS1=0.                                                            83500
      JJJ=0                                                              83600
      DO 2045 JJ=1,J1                                                    83700
      IF(ERS2(JJ,M,L1,1).EQ.0.) GO TO 2045                               83800
      SUM1=SUM1+TRS2(JJ,M,1)                                             83900
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      SUM2=SUM2+PRS2(JJ,M,L1,1)                                          84000
      SUM3=SUM3+ERS2(JJ,M,L1,1)                                          84100
      PTS1=PTS1+1.                                                       84200
      IF(JJJ.EQ.0) JJJ=JJ                                                84300
 2045 CONTINUE                                                           84400
      IF(PTS1.EQ.0.) GO TO 1046                                          84500
      TBAR=SUM1/PTS1                                                     84600
      PBAR=SUM2/PTS1                                                     84700
      EBAR=SUM3/PTS1                                                     84800
      DO 3045 JJ=JJJ,J1                                                  84900
      TRS2(JJ,M,1)=TBAR                                                  85000
      PRS2(JJ,M,L1,1)=PBAR                                               85100
      ERS2(JJ,M,L1,1)=EBAR                                               85200
      IF(JJ.LT.J1) KRS2(JJ,M,L1,1)=IAST                                  85300
 3045 CONTINUE                                                           85400
      GO TO 1046                                                         85500
 1045 MCALL=M                                                            85600
      CALL KENDS(2,MCALL,JJ,KR(JJ,M),KN,K11,K22)                         85700
      IF (K11.EQ.0) GO TO 1044                                           85800
      GO TO 1037                                                         85900
C                                                                        86000
C INITIALIZE FOR LEFT-GOING RAYS                                         86100
C                                                                        86200
 1046 I=2                                                                86300
      II=1                                                               86400
      K1=1                                                               86500
      K2=KL(J,M)                                                         86600
      IF (K2.NE.0) GO TO 1036                                            86700
C                                                                        86800
C TEST FOR DOING OUTLYING SPS RIGHT OF SPREAD, LEFT-GOING RAYS           86900
C                                                                        87000
 1047 IF (JJOFF.NE.0.OR.JJ.LT.J2) GO TO 1049                             87100
 1048 JJ=JJ+1                                                            87200
      IF (JJ.LE.JN) GO TO 4048                                           87300
      SUM1=0.                                                            87400
      SUM2=0.                                                            87500
      SUM3=0.                                                            87600
      PTS1=0.                                                            87700
      DO 2048 JJ=J2,JN                                                   87800
      IF(ERS2(JJ,M,L1,2).EQ.0.) GO TO 2048                               87900
      SUM1=SUM1+TRS2(JJ,M,2)                                             88000
      SUM2=SUM2+PRS2(JJ,M,L1,2)                                          88100
      SUM3=SUM3+ERS2(JJ,M,L1,2)                                          88200
      PTS1=PTS1+1.                                                       88300
      JJJ=JJ                                                             88400
 2048 CONTINUE                                                           88500
      IF(PTS1.EQ.0.) GO TO 1049                                          88600
      TBAR=SUM1/PTS1                                                     88700
      PBAR=SUM2/PTS1                                                     88800
      EBAR=SUM3/PTS1                                                     88900
      DO 3048 JJ=J2,JJJ                                                  89000
      TRS2(JJ,M,2)=TBAR                                                  89100
      PRS2(JJ,M,L1,2)=PBAR                                               89200
      ERS2(JJ,M,L1,2)=EBAR                                               89300
      IF(JJ.GT.J2) KRS2(JJ,M,L1,2)=IAST                                  89400
 3048 CONTINUE                                                           89500
      GO TO 1049                                                         89600
 4048 MCALL=M                                                            89700
      CALL KENDS(2,MCALL,JJ,1,KL(JJ,M),K11,K22)                          89800
      IF (K11.EQ.0) GO TO 1048                                           89900
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      GO TO 1037                                                        90000
 1049 CONTINUE                                                          90100
 1060 CONTINUE                                                          90200
C                                                                       90300
C COMPUTE AVG ELEV OF BASE OF LAYER 1 BENEATH EACH GEO                  90400
C                                                                       90500
C-----------------------------------ENTER AFTER RETURNING FROM PART 3   90600
C                                                                       90700
 1200 DO 1400 M=1,NM                                                    90800
      VV=VVA(M,1)                                                       90900
      TANSG=VV/SQRT(VHA(M,2)**2-VV**2)                                  91000
      MCALL=M                                                           91100
      IF (IFLAG.EQ.0) CALL ADMIG(L1,MCALL,BL(M))                        91200
      JN=NJ(M)                                                          91300
      KN=NK(M)                                                          91400
      DG2=(XG(KN,M)-XG(1,M))/FLOAT(KN+KN-2)                             91500
      DO 1255 K=1,KN                                                    91600
      ERX(K)=0.                                                         91700
      ERP(K,M,1)=0.                                                     91800
      TRP(K,M,1)=0.                                                     91900
      PRP(K)=0.                                                         92000
      ERX(K)=0.                                                         92100
      IF (K.EQ.1) GO TO 1235                                            92200
      X1=(XG(K,M)+XG(K-1,M))/2.                                         92300
      GO TO 1240                                                        92400
 1235 X1=XG(1,M)-DG2                                                    92500
 1240 IF (K.EQ.KN) GO TO 1245                                           92600
      X2=(XG(K+1,M)+XG(K,M))/2.                                         92700
      GO TO 1250                                                        92800
 1245 X2=XG(KN,M)+DG2                                                   92900
 1250 CALL AVG(X1,X2,2,PRP(K),ERX(K))                                   93000
 1255 CONTINUE                                                          93100
      DO 1285 K=1,KN                                                    93200
      IF(ERX(K).EQ.0.) GO TO 1285                                       93300
      KK=K                                                              93400
      IF (PRP(K).GT.XG(K,M)) GO TO 1270                                 93500
 1260 KK=KK+1                                                           93600
      IF (KK.GT.KN) GO TO 1278                                          93700
      IF(ERX(K).EQ.0.) GO TO 1260                                       93800
      GO TO 1275                                                        93900
 1270 KK=KK-1                                                           94000
      IF (KK.LT.1) GO TO 1278                                           94100
      IF(ERX(K).EQ.0.) GO TO 1270                                       94200
 1275 ERP(K,M,1)=TERP(PRP(K),ERX(K),PRP(KK),ERX(KK),XG(K,M))            94300
      GO TO 1285                                                        94400
 1278 ERP(K,M,1)=ERX(K)-(PRP(K)-XG(K,M))*SLOPE                          94500
 1285 CONTINUE                                                          94600
      DO 1290 K=1,KN                                                    94700
      IF(ERX(K).EQ.0.) GO TO 1290                                       94800
      PRP(K)=XG(K,M)                                                    94900
      TRP(K,M,1)=(EG(K,M)-ERP(K,M,1))/VV                                95000
      DEPTH=EG(K,M)-ERP(K,M,1)                                          95100
 1290 CONTINUE                                                          95200
      DO 1325 J=1,JN                                                    95300
      TRS(J,M,1)=0.                                                     95400
      ERS(J,M,1)=0.                                                     95500
 1325 CONTINUE                                                          95600
 1400 CONTINUE                                                          95700
C                                                                       95800
C FILL IN MISSING POINTS                                                95900
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C                                                                       96000
      CALL FILLIN(L1)                                                   96100
C L1 SET TO 0 IN FILLIN IF NO PTS ARE DEFINED FOR LAYER L1              96200
      IF(L1.EQ.0) GO TO 1                                               96300
      IF (IFLAG.EQ.2.OR.IXIT.LE.3.OR.(IFLAG.EQ.1.AND.IXIT.EQ.4))        96400
     1 GO TO 1061                                                       96500
      IFLAG=IFLAG+1                                                     96600
      L1=1                                                              96700
      L2=2                                                              96800
      IREP=IFLAG+1                                                      96900
      GO TO 2002                                                        97000
C                                                                       97100
C---------------------------------------------------------GO TO PART 3  97200
C                                                                       97300
 1061 IF (NIXIT.EQ.1) GO TO 1070                                        97400
C                                                                       97500
C PRINT HEADING FOR RESULTS                                             97600
C                                                                       97700
      PRINT 57, IDENT                                                   97800
      PRINT 1068                                                        97900
 1068 FORMAT (1HO,48HARRIVAL TIMES CORRECTED TO BASE OF LAYER 1, AND ,  98000
     1 23HELEV OF BASE OF LAYER 1)                                      98100
C                                                                       98200
C COMPUTE CORRECTED TA FOR T-D PLOT                                     98300
C                                                                       98400
 1070 DO 1092 M=1,NM                                                    98500
      JN=NJ(M)                                                          98600
      KN=NK(M)                                                          98700
      DO 1082 J=1,JN                                                    98800
      IF (J.GE.JA(M).OR.JJOFF.NE.0) GO TO 1075                          98900
      JJ=JA(1)                                                          99000
      GO TO 1076                                                        99100
 1075 IF (J.LE.JB(M).OR.JJOFF.NE.0) GO TO 1077                          99200
      JJ=JB(NM)                                                         99300
 1076 TRS(J,M,1)=TRS(JJ,M,1)                                            99400
 1077 DO 1080 K=1,KN                                                    99500
      IF (LG(K,J,M).EQ.1.OR.TR(K,J,M).EQ.0.0) GO TO 1078                99600
      TA(K,J,M)=TR(K,J,M)-TRP(K,M,1)-TRS(J,M,1)                         99700
      GO TO 1080                                                        99800
 1078 TA(K,J,M)=0.0                                                     99900
 1080 CONTINUE                                                         100000
 1082 CONTINUE                                                         100100
C                                                                      100200
C PRINT RESULTS                                                        100300
C                                                                      100400
      IF (NIXIT.EQ.1) GO TO 1092                                       100500
      PRINT 383, IDSPR(M),(IDSP(J,M),J=1,JN)                           100600
      PRINT 384, (ERS(J,M,1),J=1,JN)                                   100700
      PRINT 385, (TRS(J,M,1),J=1,JN)                                   100800
      PRINT 387, (IBL,J=1,JN)                                          100900
      DO 1090 K=1,KN                                                   101000
      PRINT 389, K,ERP(K,M,1),TRP(K,M,1),(TA(K,J,M),P(K,J,M),J=1,JN)   101100
 1090 CONTINUE                                                         101200
 1092 CONTINUE                                                         101300
C                                                                      101400
C PLOT T-D GRAPH (LAYER 1 REMOVED)                                     101500
C                                                                      101600
 1110 IF(IPLOT.EQ.4.AND.NIXIT.EQ.0) CALL PLOT(1)                       101700
      IF (IXIT.EQ.2) GO TO 1                                           101800
C                                                                      101900
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C*********************************************************************  102000
C PART 3                                                               102100
C*********************************************************************  102200
C                                                                      102300
C COMPUTE DEPTH POINTS AT BASE OF LAYER L, L.GT.2                      102400
C                                                                      102500
C LAYER LOOP -- REFR HORIZ IS BETWEEN L1 AND L2 -- LOOP ENDS AT 2190   102600
C                                                                      102700
 2000 IF (NL.LE.2) GO TO 2200                                          102800
      L2=3                                                             102900
 2001 L1=L2-1                                                          103000
      IF (ITRACE.NE.0) PRINT 1027, L2                                  103100
      LL=L1-1                                                          103200
      IFLAG=0                                                          103300
      IF (IREP.EQ.4) GO TO 2002                                        103400
      IREP=1                                                           103500
C                                                                      103600
C SPREAD LOOP STARTS HERE---------------------- LOOP ENDS AT 2090 + 3  103700
C                                                                      103800
C-----ENTRY POINT FROM PART 2  (FOR IREP.GE.2, IFLAG.NE.0, L1=1,L2=2)  103900
C                                                                      104000
 2002 M=1                                                              104100
      IXREP=IXIT-IREP                                                  104200
C                                                                      104300
 2003 JN=NJ(M)                                                         104400
      KN=NK(M)                                                         104500
      HV=VHA(M,L2)                                                     104600
      HV2=HV**2                                                        104700
      VV=VVA(M,L1)                                                     104800
      IF (HV.LE.VV) GO TO 9992                                         104900
      TANSG=VV/SQRT(HV2-VV**2)                                         105000
      VOCOSG=TANSG*HV                                                  105100
      IF(IREP.NE.2) BL(M)=0.                                           105200
      IF (JJOFF.EQ.0) GO TO 2004                                       105300
      J1=1                                                             105400
      J2=JN                                                            105500
      GO TO 2007                                                       105600
 2004 J1=JA(M)                                                         105700
      J2=JB(M)                                                         105800
C                                                                      105900
C PRECOMPUTE TIME AND MIGR CORR FOR ALL GEOS, SPREAD 4                 106000
C ALSO CLEAR WORKING STORAGE                                           106100
C                                                                      106200
 2007 DO 2011 K=1,KN                                                   106300
      DO 2008 LR=1,2                                                   106400
      PRG2(K,LR)=0.0                                                   106500
      ERG2(K,LR)=0.0                                                   106600
      TRG2(K,LR)=0.0                                                   106700
 2008 CONTINUE                                                         106800
      IF (IREP.GT.1) GO TO 2011                                        106900
      DO 2009 LR=1,2                                                   107000
      PG2(K,M,LR)=0.0                                                  107100
      EG2(K,M,LR)=0.0                                                  107200
      TG2(K,M,LR)=0.0                                                  107300
 2009 CONTINUE                                                         107400
      RAD=SQRT(HV2-VVA(M,1)**2)                                        107500
      TVG(K)=TRP(K,M,1)*HV/RAD                                         107600
      XVG(K)=(EG(K,M)-ERP(K,M,1))*VVA(M,1)/RAD                         107700
      IF (LL.LE.1) GO TO 2011                                          107800
      DO 2010 L=2,LL                                                   107900
```

```
      RAD=SQRT(HV2-VVA(M,L)**2)                                          108000
      TVG(K)=TVG(K)+TRP(K,M,L)*HV/RAD                                    108100
      XVG(K)=XVG(K)+(ERP(K,M,L-1)-ERP(K,M,L))*VVA(M,L)/RAD               108200
 2010 CONTINUE                                                           108300
 2011 CONTINUE                                                           108400
C                                                                        108500
C SHOT POINT LOOP STARTS HERE---------------------- LOOP ENDS AT 2090    108600
C                                                                        108700
      J=J1                                                               108800
 2012 JJ=J                                                               108900
C                                                                        109000
C COMPUTE TIME AND MIGR CORR AT SP J                                     109100
C                                                                        109200
      ISPLT=0                                                            109300
      IF (IFLAG.NE.0) GO TO 12018                                        109400
      IF (ES(J,M).LE.ERS(J,M,LL)) GO TO 2016                             109500
      TC=0.0                                                             109600
      XC=0.0                                                             109700
      NONE=0                                                             109800
      DO 2015 L=1,LL                                                     109900
      IF (ES(J,M).LT.ERS(J,M,L)) GO TO 2015                              110000
      IF (IREP.EQ.1) GO TO 2013                                          110100
      LS(J,M)=L                                                          110200
      GO TO 2018                                                         110300
 2013 V1=VVA(M,L)                                                        110400
      RAD=SQRT (HV2-V1**2)                                               110500
      IF (NONE.EQ.0) GO TO 2014                                          110600
      XC=XC+(ERS(J,M,L-1)-ERS(J,M,L))*V1/RAD                             110700
      TC=TC+TRS(J,M,L)*HV/RAD                                            110800
      GO TO 2015                                                         110900
 2014 XC=(ES(J,M)-ERS(J,M,L))*V1/RAD                                     111000
      TC=((ES(J,M)-ERS(J,M,L))*HV)/(V1*RAD)                              111100
      LS(J,M)=L                                                          111200
      NONE=1                                                             111300
 2015 CONTINUE                                                           111400
      GO TO 2017                                                         111500
 2016 LS(J,M)=L1                                                         111600
      IF(IREP.EQ.1) GO TO 12017                                          111700
      IF(ES(J,M).GE.ERS(J,M,L1)) GO TO 2018                              111800
      LS(J,M)=L2                                                         111900
      ISPLT=2                                                            112000
      GO TO 2018                                                         112100
12017 DZ=ERS(J,M,LL)-ES(J,M)                                             112200
      ISPLT=1                                                            112300
 2017 IF (ISPLT.EQ.0) GO TO 2018                                         112400
      TC=-DZ*VOCOSG/VV**2                                                112500
      ELLS=ERS(J,M,LL)                                                   112600
      DS=-DZ*TANSG                                                       112700
      XC=DS                                                              112800
      GO TO 2018                                                         112900
C                                                                        113000
C INITIALIZE FOR RIGHT-GOING RAYS                                        113100
C                                                                        113200
12018 IF(LS(J,M).EQ.2) ISPLT=1                                           113300
 2018 I=1                                                                113400
      II=2                                                               113500
      SGN=1.0                                                            113600
      IF(KR(J,M).EQ.0) GO TO 2040                                        113700
      CALL KENDS(L2,M,J,KR(J,M),KN,K11,K22)                              113800
C                                                                        113900
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C ENTRY POINT AFTER INITIALIZATION FOR RIGHT- OR LEFT-GOING RAYS          114000
C                                                                         114100
C--------------------TRACE SHOTPOINT RAYS, IREP=1-----                  114200
C                                                                         114300
 2019 IF (IREP.GT.1) GO TO 2021                                           114400
      XLLS=XSP(J,M)+XC*SGN                                                114500
      TLLS=TC                                                             114600
      IF(ISPLT.NE.0) GO TO 2023                                           114700
      IF(ITRACE.NE.0)PRINT 2020,IREP,IDSPR(M),IDSP(J,M)                   114800
     1,IZ,II,L2,L1,LS(J,M),XSP(J,M),ES(J,M),XLLS,ELLS,TLLS,DMY1,DMY2      114900
     2,DMY3,BL(M)                                                         115000
 2020 FORMAT(1HO,35HIREP SPR SP  G  I  L LL LO   XJ/XL1,7X,2HE0,6X,3HXLL  115100
     1,6X,3HELL,6X,3HTLL,7X,2HXL,7X,2HEL,7X,2HTL,3X,17H9LL/BL   EPS    N  115200
     2/1X,I3,2(3X,A1),5I3,8F9.1,F9.4)                                     115300
      CALL RAYUP(L2,L1,LS(J,M),J,M,II,XSP(J,M),ES(J,M),XLLS,              115400
     1 ELLS,TLLS,DMY1,DMY2,DMY3,BL(M))                                    115500
      DS=(XLLS-XSP(J,M))*SGN                                              115600
      GO TO 2023                                                          115700
C                                                                         115800
C--------------------TRACE SHOTPOINT RAYS, IREP.GT.1-----                115900
C                                                                         116000
 2021 IF((JJOFF.EQ.0.AND.J.EQ.J1.AND.I.EQ.1).OR.(JJOFF.EQ.0.AND.J.EQ.J2.  116100
     1AND.I.EQ.2)) GO TO 12021                                            116200
      IF(K11.EQ.0) GO TO 2031                                             116300
12021 IF (ISPLT.EQ.2) GO TO 2022                                          116400
      IF(ITRACE.NE.0)PRINT 2020,IREP,IDSPR(M),IDSP(J,M)                   116500
     1,IZ,II,L2,L2,LS(J,M),XSP(J,M),ES(J,M),PS2(J,M,I),ES2(J,M,I),DMY0    116600
     2,PRS2(J,M,L1,I),ERS2(J,M,L1,I),TRS2(J,M,I),BL(M)                    116700
      CALL RAYUP(L2,L2,LS(J,M),J,M,II,XSP(J,M),ES(J,M),                   116800
     1 PS2(J,M,I),ES2(J,M,I),DMY0,PRS2(J,M,L1,I),ERS2(J,M,L1,I),          116900
     2 TRS2(J,M,I),BL(M))                                                 117000
      GO TO 2023                                                          117100
 2022 PRS2(J,M,L1,I)=XSP(J,M)                                             117200
      ERS2(J,M,L1,I)=ERS(J,M,L1)                                          117300
C                                                                         117400
C RE-ENTRY PT FOR OUTLYING SHOTPOINTS                                     117500
C                                                                         117600
 2023 IF(K11.EQ.0) GO TO 2031                                             117700
      IF(KRS2(JJ,M,L1,I).EQ.IBEE) KRS2(JJ,M,L1,I)=IBL                     117800
      DO 2030 K=K11,K22                                                   117900
      IF (LG(K,JJ,M).NE.L2) GO TO 2030                                    118000
C                                                                         118100
C--------------------TRACE GEOPHONE RAYS, IREP=1-----                   118200
C                                                                         118300
      IF (IREP.GT.1) GO TO 2026                                           118400
      IF (TG2(K,M,I).NE.0.0) GO TO 2025                                   118500
      PG2(K,M,I)=XG(K,M)-XVG(K)*SGN                                       118600
      TG2(K,M,I)=TVG(K)                                                   118700
      IF(ITRACE.NE.0)PRINT 2020,IREP,IDSPR(M),IDSP(JJ,M)                  118800
     1,K,I,L2,L1,I1,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),TG2(K,M,I)      118900
     2,DMY1,DMY2,DMY3,BL(M)                                               119000
      CALL RAYUP(L2,L1,1,J,M,I,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),     119100
     1 TG2(K,M,I),DMY1,DMY2,DMY3,BL(M))                                   119200
 2025 DG=(XG(K,M)-PG2(K,M,I))*SGN                                         119300
      TA(K,JJ,M)=TR(K,JJ,M)-TLLS-TG2(K,M,I)                               119400
      DSG(K)=ABS(D(K,J,M))-DS-DG                                          119500
      GO TO 2030                                                          119600
C                                                                         119700
C--------------------TRACE GEOPHONE RAYS, IREP.GT.1-----                 119800
C                                                                         119900
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 2026 IF (TRG2(K,I).NE.0.0) GO TO 2028                                  120000
      PRG2(K,I)=PRG(K,JJ,M)                                             120100
      ERG2(K,I)=ERG(K,JJ,M)                                             120200
      TRG2(K,I)=TRG(K,JJ,M)                                             120300
      IF(ITRACE.NE.0)PRINT 2020,IREP,IDSPR(M),IDSP(JJ,M)                120400
     1,K,I,L2,L2,I1,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),DMY0,PRG2(K,I)120500
     2,ERG2(K,I),TRG2(K,I),BL(M)                                        120600
      CALL RAYUP(L2,L2,1,J,M,I,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),   120700
     1 DMY0,PRG2(K,I),ERG2(K,I),TRG2(K,I),BL(M))                        120800
      IF(ISPLT.NE.2) GO TO 2028                                         120900
      IF(ABS((PRG2(K,I)-XSP(J,M))/(ERG2(K,I)-ES(J,M))).GT.100.)         121000
     1 GO TO 2028                                                       121100
      DMY0=BIG                                                          121200
      PRG2(K,I)=(XSP(J,M)+2.*PRG2(K,I))/3.                              121300
      IF(ITRACE.NE.0) PRINT 2020,IREP,IDSPR(M),                         121400
     1IDSP(JJ,M),K,I,L2,L2,I1,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),    121500
     2DMY0,PRG2(K,I),ERG2(K,I),TRG2(K,I),BL(M)                          121600
      CALL RAYUP(L2,L2,1,J,M,I,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I)    121700
     1,DMY0,PRG2(K,I),ERG2(K,I),TRG2(K,I),BL(M))                        121800
 2028 PRG(K,JJ,M)=PRG2(K,I)                                             121900
      ERG(K,JJ,M)=ERG2(K,I)                                             122000
      TRG(K,JJ,M)=TRG2(K,I)                                             122100
 2030 CONTINUE                                                          122200
C                                                                       122300
C--------------------IREP=1  OR  IREP.GT.1----------                     122400
C                                                                       122500
 2031 IF(IREP.GT.1) GO TO 2035                                          122600
C                                                                       122700
C--------------------IREP=1----------                                   122800
C                                                                       122900
C REGRESSION OF END AND OUTLYING SP TIMES TO GET INTERCEPT T WHEN       123000
C IREP=1.  IF JJOFF=0 OUTLYING SP TIMES ARE TIED TO END SP TIMES.       123100
C                                                                       123200
      KT1=K11                                                           123300
      KT2=K22                                                           123400
      JT=JJ                                                             123500
      S1=0.                                                             123600
      S2=0.                                                             123700
      PT=0.                                                             123800
      T=0.                                                              123900
12033 IF(KT1.EQ.0) GO TO 12037                                          124000
      DO 12036 K=KT1,KT2                                                124100
      IF(LG(K,JT,M).NE.L2) GO TO 12036                                  124200
      IF(JT.EQ.JJ) GO TO 12035                                          124300
      IF(TG2(K,M,I).NE.0.) GO TO 12034                                  124400
      PG2(K,M,I)=XG(K,M)-XVG(K)*SGN                                     124500
      TG2(K,M,I)=TVG(K)                                                 124600
      IF(ITRACE.NE.0)PRINT 2020,IREP,IDSPR(M),IDSP(JT,M)                124700
     1,K,I,L2,L1,I1,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),TG2(K,M,I)    124800
     2,DMY1,DMY2,DMY3,BL(M)                                             124900
      CALL RAYUP(L2,L1,1,JT,M,I,XG(K,M),EG(K,M),PG2(K,M,I),EG2(K,M,I),  125000
     1 TG2(K,M,I),DMY1,DMY2,DMY3,BL(M))                                 125100
12034 DG=(XG(K,M)-PG2(K,M,I))*SGN                                       125200
      DSG(K)=ABS(D(K,J,M))-DS-DG                                        125300
      TA(K,JT,M)=TR(K,JT,M)-TLLS-TG2(K,M,I)                             125400
12035 S1=S1+DSG(K)                                                      125500
      S2=S2+TA(K,JT,M)                                                  125600
      PT=PT+1.                                                          125700
12036 CONTINUE                                                          125800
12037 IF(JJOFF.NE.0) GO TO 2032                                         125900
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      IF(I.EQ.2) GO TO 12040                                            126000
      IF(JJ.NE.J1) GO TO 2032                                           126100
      JT=JT-1                                                           126200
      IF(JT.LT.1) GO TO 12042                                           126300
      KRS2(JT,M,L1,1)=IAST                                              126400
      CALL KENDS(L2,M,JT,KR(JT,M),KN,KT1,KT2)                           126500
      GO TO 12033                                                       126600
12040 IF(JJ.NE.J2) GO TO 2032                                           126700
      JT=JT+1                                                           126800
      IF(JT.GT.JN) GO TO 12042                                          126900
      KRS2(JT,M,L1,2)=IAST                                              127000
      CALL KENDS(L2,M,JT,1,KL(JT,M),KT1,KT2)                            127100
      GO TO 12033                                                       127200
C                                                                       127300
12042 IF(PT.EQ.0.) GO TO 2040                                           127400
      IF(PT.EQ.1.) GO TO 12055                                          127500
      XBAR=S1/PT                                                        127600
      TBAR=S2/PT                                                        127700
      S1=0.                                                             127800
      S2=0.                                                             127900
      KT1=K11                                                           128000
      KT2=K22                                                           128100
      JT=JJ                                                             128200
12043 IF(KT1.EQ.0) GO TO 12046                                          128300
      DO 12045 K=KT1,KT2                                                128400
      IF(LG(K,JT,M).NE.L2) GO TO 12045                                  128500
      XD=DSG(K)-XBAR                                                    128600
      S1=S1+XD*TA(K,JT,M)                                               128700
      S2=S2+XD**2                                                       128800
12045 CONTINUE                                                          128900
12046 IF(I.EQ.2) GO TO 12050                                            129000
      JT=JT-1                                                           129100
      IF(JT.LT.1) GO TO 12052                                           129200
      CALL KENDS(L2,M,JT,KR(JT,M),KN,KT1,KT2)                           129300
      GO TO 12043                                                       129400
12050 JT=JT+1                                                           129500
      IF(JT.GT.JN) GO TO 12052                                          129600
      CALL KENDS(L2,M,JT,1,KL(JT,M),KT1,KT2)                            129700
      GO TO 12043                                                       129800
C                                                                       129900
12052 T=(TBAR-XBAR*S1/S2)/2.                                            130000
      GO TO 12060                                                       130100
C                                                                       130200
12055 T=(S2-S1/VHA(M,L2))/2.                                            130300
      GO TO 12060                                                       130400
C                                                                       130500
C--------------------IREP=1----------                                  130600
C                                                                       130700
C COMPUTE HORIZ TIME AND FIRST APPROX DEPTHS                            130800
C                                                                       130900
 2032 IF(K11.EQ.0) GO TO 2040                                           131000
      CALL REGRES(K11,K22,JJ,M,L2,V,T,PT,0)                             131100
      IF(PT.EQ.0.) GO TO 2040                                           131200
12060 Z=T*VOCOSG                                                        131300
      TS=Z*VOCOSG/VV**2                                                 131400
      TRS2(JJ,M,I)=TLLS+TS                                              131500
      ERS2(JJ,M,L1,I)=ELLS-Z                                            131600
      PRS2(JJ,M,L1,I)=XLLS+Z*TANSG*SGN                                  131700
 2033 ZRSP(JJ)=Z                                                        131800
      DO 2034 K=K11,K22                                                 131900
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      IF (LG(K,JJ,M).NE.L2) GO TO 2034                                  132000
      EDIF=SLOPE*(PG2(K,M,I)-PRS2(JJ,M,L1,I))                           132100
      KCALL=K                                                           132200
      CALL HTIME(KCALL,J,M,PRS2(JJ,M,L1,I),0.,PG2(K,M,I),EDIF,HV,TH)    132300
      Z=(TA(K,JJ,M)-TS-TH)*VOCOSG                                       132400
      IF (Z.LT.0.0) Z=0.0                                               132500
      ZRG(K,JJ)=Z                                                       132600
      TG=Z*VOCOSG/VV**2                                                 132700
      TRG(K,JJ,M)=TG2(K,M,I)+TG                                         132800
      ERG(K,JJ,M)=EG2(K,M,I)-Z                                          132900
      PRG(K,JJ,M)=PG2(K,M,I)-Z*TANSG*SGN                                133000
 2034 CONTINUE                                                          133100
      GO TO 2040                                                        133200
C                                                                       133300
C--------------------IREP.GT.1----------                                133400
C                                                                       133500
C COMPUTE HORIZ TIME, COMPUTE TOTAL RAY TIME, AND ADJUST DEPTHS         133600
C TO MAKE COMPUTED TIME AGREE WITH MEASURED TIME                        133700
C                                                                       133800
 2035 IF(K11.EQ.0) GO TO 2040                                           133900
      SUM1=0.                                                           134000
      PTS1=0.                                                           134100
      IF(ISPLT.EQ.2) GO TO 3035                                         134200
      P1=PRS2(J,M,L1,I)                                                 134300
      E1=ERS2(J,M,L1,I)                                                 134400
      GO TO 3135                                                        134500
 3035 P1=XSP(J,M)                                                       134600
      E1=ES(J,M)                                                        134700
      KRS2(JJ,M,L1,I)=IBEE                                              134800
 3135 DO 2037 K=K11,K22                                                 134900
      IF (LG(K,JJ,M).NE.L2) GO TO 2037                                  135000
      KRG(K,JJ,M)=IBL                                                   135100
      P2=PRG2(K,I)                                                      135200
      E2=ERG2(K,I)                                                      135300
 3036 KCALL=K                                                           135400
      CALL HTIME(KCALL,J,M,P1,E1,P2,E2,HV,TH)                           135500
      TCOR=TR(K,JJ,M)-TRS2(JJ,M,I)-TH-TRG2(K,I)                         135600
      IF(ISPLT.EQ.0) TCOR=TCOR/2.                                       135700
      TCALL=TCOR                                                        135800
      IF(ABS(TCOR).LE.TLIM) GO TO 2036                                  135900
      TCALL=SIGN(TLIM,TCOR)                                             136000
      KRG(K,JJ,M)=IQUES                                                 136100
 2036 CALL RAYCOR(PG2(K,M,I),P2,EG2(K,M,I),E2,VV,HV,TCALL)              136200
      PRG(K,JJ,M)=P2                                                    136300
      ERG(K,JJ,M)=E2                                                    136400
      TRG(K,JJ,M)=TRG2(K,I)+TCALL                                       136500
      PTS1=PTS1+1.0                                                     136600
      SUM1=SUM1+TCOR                                                    136700
      IF (IXREP.GT.2.OR.L2.EQ.2) GO TO 2037                             136800
      GTC(K,M)=GTC(K,M)+TCOR                                            136900
      GPT(K,M)=GPT(K,M)+1.0                                             137000
 2037 CONTINUE                                                          137100
      IF (PTS1.EQ.0..OR.ISPLT.EQ.2) GO TO 2040                          137200
      IF (IXREP.GT.2.OR.L2.EQ.2) GO TO 2038                             137300
      SPTC(JJ,M)=SPTC(JJ,M)+SUM1                                        137400
      SPPT(JJ,M)=SPPT(JJ,M)+PTS1                                        137500
 2038 TCOR=SUM1/PTS1                                                    137600
      IF(KRS2(JJ,M,L1,I).EQ.IQUES) KRS2(JJ,M,L1,I)=IBL                  137700
      IF(ABS(TCOR).LE.TLIM) GO TO 2039                                  137800
      IF(KRS2(JJ,M,L1,I).EQ.IBL) KRS2(JJ,M,L1,I)=IQUES                  137900
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      TCOR=SIGN(TLIM,TCOR)                                                  138000
 2039 CALL RAYCOR(PS2(J,M,I),P1,ES2(J,M,I),E1,VV,HV,TCOR)                   138100
      TRS2(JJ,M,I)=TRS2(JJ,M,I)+TCOR                                        138200
      PRS2(JJ,M,L1,I)=P1                                                    138300
      ERS2(JJ,M,L1,I)=E1                                                    138400
C                                                                           138500
C TEST FOR DOING OUTLYING SPS LEFT OF SPREADS, RIGHT-GOING RAYS             138600
C                                                                           138700
 2040 IF (I.NE.1) GO TO 2070                                                138800
      IF (JJOFF.NE.0.OR.JJ.GT.J1) GO TO 2046                                138900
 2041 JJ=JJ-1                                                               139000
      IF (JJ.GT.0) GO TO 2042                                               139100
      IF(IREP.EQ.1.OR.J1.EQ.1) GO TO 2046                                   139200
      SUM1=0.                                                               139300
      SUM2=0.                                                               139400
      SUM3=0.                                                               139500
      PTS1=0.                                                               139600
      JJJ=0                                                                 139700
      DO 3041 JJ=1,J1                                                       139800
      IF(ERS2(JJ,M,L1,I).EQ.0..OR.KRS2(JJ,M,L1,I).EQ.IQUES) GO TO 3041      139900
      SUM1=SUM1+TRS2(JJ,M,I)                                                140000
      SUM2=SUM2+PRS2(JJ,M,L1,I)                                             140100
      SUM3=SUM3+ERS2(JJ,M,L1,I)                                             140200
      PTS1=PTS1+1.                                                          140300
      IF(JJJ.EQ.0) JJJ=JJ                                                   140400
 3041 CONTINUE                                                              140500
      IF(PTS1.EQ.0.) GO TO 2046                                             140600
      TBAR=SUM1/PTS1                                                        140700
      PBAR=SUM2/PTS1                                                        140800
      EBAR=SUM3/PTS1                                                        140900
      DO 4041 JJ=JJJ,J1                                                     141000
      TRS2(JJ,M,I)=TBAR                                                     141100
      PRS2(JJ,M,L1,I)=PBAR                                                  141200
      ERS2(JJ,M,L1,I)=EBAR                                                  141300
 4041 CONTINUE                                                              141400
      GO TO 2046                                                            141500
 2042 CALL KENDS(L2,M,JJ,KR(JJ,M),KN,K11,K22)                               141600
      IF (K11.EQ.0) GO TO 2041                                              141700
 2043 TRS2(JJ,M,I)=TRS2(J,M,I)                                              141800
      PRS2(JJ,M,L1,I)=PRS2(J,M,L1,I)                                        141900
      ERS2(JJ,M,L1,I)=ERS2(J,M,L1,I)                                        142000
      GO TO 2023                                                            142100
C                                                                           142200
C INITIALIZE FOR LEFT-GOING RAYS                                            142300
C                                                                           142400
 2046 I=2                                                                   142500
      II=1                                                                  142600
      SGN=-1.0                                                              142700
      IF(KL(J,M).EQ.0) GO TO 2090                                           142800
      CALL KENDS(L2,M,J,1,KL(J,M),K11,K22)                                  142900
      GO TO 2019                                                            143000
C                                                                           143100
C TEST FOR DOING OUTLYING SPS RIGHT OF SPREADS, LEFT-GOING RAYS             143200
C                                                                           143300
 2070 IF (JJOFF.NE.0.OR.JJ.LT.J2) GO TO 2090                                143400
 2072 JJ=JJ+1                                                               143500
      IF (JJ.LE.JN) GO TO 2074                                              143600
      IF(IREP.EQ.1.OR.J2.EQ.JN) GO TO 2090                                  143700
      SUM1=0.                                                               143800
      SUM2=0.                                                               143900
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      SUM3=0.                                                          144000
      PTS1=0.                                                          144100
      DO 2073 JJ=J2,JN                                                 144200
      IF(ERS2(JJ,M,L1,I).EQ.0..OR.KRS2(JJ,M,L1,I).EQ.IQUES) GO TO 2073 144300
      SUM1=SUM1+TRS2(JJ,M,I)                                           144400
      SUM2=SUM2+PRS2(JJ,M,L1,I)                                        144500
      SUM3=SUM3+ERS2(JJ,M,L1,I)                                        144600
      PTS1=PTS1+1.                                                     144700
      JJJ=JJ                                                           144800
 2073 CONTINUE                                                         144900
      IF(PTS1.EQ.0.) GO TO 2090                                        145000
      TBAR=SUM1/PTS1                                                   145100
      PBAR=SUM2/PTS1                                                   145200
      EBAR=SUM3/PTS1                                                   145300
      DO 3073 JJ=J2,JJJ                                                145400
      TRS2(JJ,M,I)=TBAR                                                145500
      PRS2(JJ,M,L1,I)=PBAR                                             145600
      ERS2(JJ,M,L1,I)=EBAR                                             145700
 3073 CONTINUE                                                         145800
      GO TO 2090                                                       145900
 2074 CALL KENDS(L2,M,JJ,1,KL(JJ,M),K11,K22)                           146000
      IF (K11.EQ.0) GO TO 2072                                         146100
      GO TO 2043                                                       146200
C                                                                      146300
 2090 J=J+1                                                            146400
      IF (J.LE.J2) GO TO 2012                                          146500
      IF (IREP.EQ.1)CALL ADMIG(L1,M,BL(M))                             146600
      M=M+1                                                            146700
      IF (M.LE.NM) GO TO 2003                                          146800
      IF (IFLAG.NE.0) GO TO 1200                                       146900
C                                                                      147000
C-------------------------------------FOR FLAG.NE.0  RETURN TO PART 2  147100
C                                                                      147200
C END OF SP LOOP AT 2090, END OF SPREAD LOOP AT 2090 + 3.              147300
C                                                                      147400
C COMPUTE AVG COORDS(P1,E1),(P2,E2) IN ADJACENT INTERVALS BETWEEN GEOS, 147500
C  AND THEN INTERPOLATE TO FIND SMOOTHED ELEV PTS (ERP) AT GEO POS (XG) 147600
C  BETWEEN THE TWO INTERVALS.  THEN COMPUTE LAYER VERT TRAVEL TIME (TRP) 147700
C                                                                      147800
      DO 2096 M=1,NM                                                   147900
      JN=NJ(M)                                                         148000
      KN=NK(M)                                                         148100
      DO 2094 J=1,JN                                                   148200
      TRS(J,M,L1)=0.0                                                  148300
      ERS(J,M,L1)=0.0                                                  148400
 2094 CONTINUE                                                         148500
      DO 2095 K=1,KN                                                   148600
      TRP(K,M,L1)=0.0                                                  148700
      ERP(K,M,L1)=0.0                                                  148800
 2095 CONTINUE                                                         148900
 2096 CONTINUE                                                         149000
C                                                                      149100
      M=0                                                              149200
      X1=2.*XG(1,1)-XG(2,1)                                            149300
 2100 M=M+1                                                            149400
      IF (M.GT.NM) GO TO 2114                                          149500
      M1=M                                                             149600
      KN=NK(M)                                                         149700
      K=1                                                              149800
 2102 KK=K                                                             149900
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      X2=XG(K,M)                                                        150000
      IF (X2.LE.X1) GO TO 2104                                          150100
      CALL AVG(X1,X2,L2,P1,E1)                                          150200
      IF (E1.NE.0.0) GO TO 2105                                         150300
C                                                                       150400
C CONDITION IN WHICH (P1,E1) IS NOT YET DEFINED                         150500
C                                                                       150600
      X1=X2                                                             150700
 2104 K=K+1                                                             150800
      IF (K.GT.KN) GO TO 2100                                           150900
      GO TO 2102                                                        151000
C                                                                       151100
C CONDITION IN WHICH (P1,E1) IS DEFINED AND (P2,E2) IS SOUGHT           151200
C                                                                       151300
 2105 ERP(KK,M1,L1)=E1                                                  151400
      TRP(KK,M1,L1)=(ERP(KK,M1,LL)-ERP(KK,M1,L1))/VVA(M1,L1)            151500
 2106 X1=X2                                                             151600
 2108 K=K+1                                                             151700
      IF (K.LE.KN) GO TO 2109                                           151800
      M=M+1                                                             151900
      IF (M.GT.NM) GO TO 2113                                           152000
      KN=NK(M)                                                          152100
      K=1                                                               152200
 2109 X2=XG(K,M)                                                        152300
      IF (X2.LE.X1) GO TO 2108                                          152400
      CALL AVG(X1,X2,L2,P2,E2)                                          152500
      IF (E2.EQ.0.0) GO TO 2106                                         152600
 2110 ERP(KK,M1,L1)=TERP(P1,E1,P2,E2,XG(KK,M1))                         152700
      TRP(KK,M1,L1)=(ERP(KK,M1,LL)-ERP(KK,M1,L1))/VVA(M1,L1)            152800
      KK=KK+1                                                           152900
      IF (M.NE.M1) GO TO 2111                                           153000
      IF (KK.EQ.K) GO TO 2112                                           153100
      GO TO 2110                                                        153200
 2111 IF (KK.LE.NK(M1)) GO TO 2110                                      153300
      M1=M                                                              153400
      KK=K                                                              153500
      ERP(KK,M1,L1)=TERP(P1,E1,P2,E2,XG(KK,M1))                         153600
      TRP(KK,M1,L1)=(ERP(KK,M1,LL)-ERP(KK,M1,L1))/VVA(M1,L1)            153700
 2112 P1=P2                                                             153800
      E1=E2                                                             153900
      GO TO 2106                                                        154000
 2113 X2=2.*XG(KN,NM)-XG(KN-1,NM)                                       154100
      CALL AVG(X1,X2,L2,P2,E2)                                          154200
      IF (E2.EQ.0.0) GO TO 2114                                         154300
      ERP(KN,NM,L1)=TERP(P1,E1,P2,E2,XG(KN,NM))                         154400
      TRP(KN,NM,L1)=(ERP(KN,M1,LL)-ERP(KN,M1,L1))/VVA(M1,L1)            154500
 2114 CALL FILLIN(L1)                                                   154600
C L1 SET TO 0 IN FILLIN IF NO PTS ARE DEFINED FOR LAYER L1              154700
      IF(L1.EQ.0) GO TO 1                                               154800
C                                                                       154900
C REPEAT IF IREP=1 OR IREP=2                                            155000
C                                                                       155100
      IF (IXREP.LE.3) GO TO 2190                                        155200
      IREP=IREP+1                                                       155300
      GO TO 2002                                                        155400
C                                                                       155500
 2190 L2=L2+1                                                           155600
      IF (L2.LE.NL) GO TO 2001                                          155700
C                                                                       155800
C END OF LAYER LOOP AT 2190                                             155900
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C                                                                       156000
C FINAL FILTER -- TRIM-UP TIME ADJUST AT BASE OF LAYER 1                156100
C                                                                       156200
      IF (IREP.EQ.4.OR.IXIT.LE.3) GO TO 2200                            156300
      IREP=4                                                            156400
C                                                                       156500
      DO 2196 M=1,NM                                                    156600
      JN=NJ(M)                                                          156700
      KN=NK(M)                                                          156800
      DO 2192 J=1,JN                                                    156900
      IF (SPPT(J,M).EQ.0.0) GO TO 2192                                  157000
      TCOR=SPTC(J,M)/SPPT(J,M)                                          157100
      ERS(J,M,1)=ERS(J,M,1)-TCOR*VVA(M,1)                               157200
      IF (ERS(J,M,1).GT.ESP(J,M)) ERS(J,M,1)=ESP(J,M)                   157300
 2192 CONTINUE                                                          157400
      DO 2194 K=1,KN                                                    157500
      IF (GPT(K,M).EQ.0.0) GO TO 2194                                   157600
      TCOR=GTC(K,M)/GPT(K,M)                                            157700
      ERP(K,M,1)=ERP(K,M,1)-TCOR*VVA(M,1)                               157800
      IF (ERP(K,M,1).GT.EG(K,M)) ERP(K,M,1)=EG(K,M)                     157900
 2194 CONTINUE                                                          158000
 2196 CONTINUE                                                          158100
      GO TO 2000                                                        158200
C                                                                       158300
C PRINT RESULTS -- DEPTHS COMPUTED FROM REFRACTION ARRIVALS             158400
C                                                                       158500
 2200 DO 2222 M=1,NM                                                    158600
      PRINT 57, IDENT                                                   158700
      JN=NJ(M)                                                          158800
      PRINT 2201, IDSPR(M),(IDSP(J,M),J=1,JN)                           158900
 2201 FORMAT (1H0,8H SPREAD ,A1,3X,32HRAY END POINTS BENEATH GEOPHONES/ 159000
     1 '  GEO',14X,7(8X,'SP ',A1))                                     159100
      PRINT 2202, (IBL,J=1,JN)                                          159200
 2202 FORMAT('  ---',17X,7(A2,'--------L-'))                            159300
C                                                                       159400
      KN=NK(M)                                                          159500
C                                                                       159600
      DO 2210 K=1,KN                                                    159700
      PRINT 2203, K, (PRG(K,J,M),LG(K,J,M),J=1,JN)                      159800
 2203 FORMAT (1H ,I3,15X,3HPOS,7(F9.1,I2,1X))                           159900
      PRINT 2205, (ERG(K,J,M),KRG(K,J,M),J=1,JN)                        160000
 2205 FORMAT (1H ,17X,4HELEV,7(F9.1,1X,A1,1X))                          160100
      PRINT 2207                                                        160200
 2207 FORMAT (1X)                                                       160300
 2210 CONTINUE                                                          160400
C                                                                       160500
      PRINT 2211                                                        160600
 2211 FORMAT (' RAY END POINTS BENEATH SHOTPOINTS')                     160700
C                                                                       160800
      DO 2220 L2=2,NL                                                   160900
      L=L2-1                                                            161000
      PRINT 2213, L2,(PRS2(J,M,L,1),J=1,JN)                             161100
 2213 FORMAT (1H0,2HL=,I1,4X,5HRIGHT,6X,3HPOS,F9.1,6F12.1)              161200
      PRINT 2205, (ERS2(J,M,L,1),KRS2(J,M,L,1),J=1,JN)                  161300
      PRINT 2217, L2,(PRS2(J,M,L,2),J=1,JN)                             161400
 2217 FORMAT (1H0,2HL=,I1,4X,4HLEFT,7X,3HPOS,F9.1,5F12.1)               161500
      PRINT 2205, (ERS2(J,M,L,2),KRS2(J,M,L,2),J=1,JN)                  161600
 2220 CONTINUE                                                          161700
 2222 CONTINUE                                                          161800
C                                                                       161900
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C PRINT RESULTS -- INTERP-EXTRAP PTS AT SPS AND GEOS                    162000
C                                                                       162100
      DO 2260 M=1,NM                                                    162200
      IF (JJOFF.EQ.0) GO TO 2225                                        162300
      J1=1                                                              162400
      GO TO 2226                                                        162500
 2225 J1=JA(M)                                                          162600
 2226 IF (JJOFF.EQ.0) GO TO 2227                                        162700
      J2=NJ(M)                                                          162800
      GO TO 2228                                                        162900
 2227 J2=JB(M)                                                          163000
 2228 PRINT 57, IDENT                                                   163100
      PRINT 2231, IDSPR(M),(L,L=2,NL)                                   163200
 2231 FORMAT (1H0,8H SPREAD ,A1,3X,28HSMOOTHED POSITION OF LAYERS ,     163300
     1 32HBENEATH SHOTPOINTS AND GEOPHONES/1H0,24X,4(11X,'LAYER',I2))   163400
C                                                                       163500
      PRINT 2233, (IBL,L=2,NL)                                          163600
 2233 FORMAT('0 SP   POSITION  SURF ELEV ',4(A1,5X,')EPTH  ELEV '))     163700
      PRINT 2234, (IBL,L=2,NL)                                          163800
 2234 FORMAT('  ---  --------  ---------',4(A4,'--------------'))       163900
C                                                                       164000
      DO 2246 J=J1,J2                                                   164100
      DO 2240 L=1,LN                                                    164200
      ZSG(L)=0.0                                                        164300
      IF (ERS(J,M,L).NE.0.0) ZSG(L)=ESP(J,M)-ERS(J,M,L)                 164400
 2240 CONTINUE                                                          164500
      PRINT 2243, IDSP(J,M),XSP(J,M),ESP(J,M),(ZSG(L),ERS(J,M,L),L=1,LN) 164600
 2243 FORMAT(3X,A1,2F11.1,4(2X,2F8.1))                                  164700
 2246 CONTINUE                                                          164800
C                                                                       164900
      PRINT 2249                                                        165000
 2249 FORMAT('0 GEO'/'  ---')                                           165100
      KN=NK(M)                                                          165200
      DO 2256 K=1,KN                                                    165300
      DO 2252 L=1,LN                                                    165400
      IF (ERP(K,M,L).NE.0.0) ZSG(L)=EG(K,M)-ERP(K,M,L)                  165500
 2252 CONTINUE                                                          165600
      PRINT 2255, K,XG(K,M),EG(K,M),(ZSG(L),ERP(K,M,L),L=1,LN)          165700
 2255 FORMAT (1X,I3,2F11.1,4(2X,2F8.1))                                 165800
 2256 CONTINUE                                                          165900
      PRINT 2257,(L,L=1,NL)                                             166000
 2257 FORMAT(/' VELOCITIES USED:'/7X,5(11X,'LAYER',I2))                 166100
      PRINT 2258,(VVA(M,L),L=1,LN)                                      166200
      PRINT 2259,(VHA(M,L),L=2,NL)                                      166300
 2258 FORMAT(/8X,'VERTICAL',3PF9.0,4F18.0)                              166400
 2259 FORMAT(6X,'HORIZONTAL',9X,3P4F18.0)                               166500
 2260 CONTINUE                                                          166600
C                                                                       166700
C PLOT DEPTH GRAPH                                                      166800
C                                                                       166900
      CALL PLOT(2)                                                      167000
      GO TO 1                                                           167100
C                                                                       167200
 9990 PRINT 9991                                                        167300
 9991 FORMAT (/1X,41H ERROR ON INPUT CARDS, COMPUTATION HALTED)         167400
      GO TO 9999                                                        167500
C                                                                       167600
 9992 PRINT 9993, L1,L2                                                 167700
 9993 FORMAT (/1X,25HVELOCITY INVERSION, LAYER,I2,10H AND LAYER,I2,     167800
     1 19H COMPUTATION HALTED)                                          167900
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 9999 STOP                                                              168000
      END                                                               168100
C                                                                       168200
C-----------------------------------------------------------------------168300
C                                                                       168400
      SUBROUTINE RAYUP(L,LL,LO,J,M,I,XO,EO,XLL,ELL,TLL,XL,EL,TL,BLL)    168500
      COMMON IBL                                                        168600
      COMMON/BLK1/NM,NJ,NK                                              168700
     2       /BLK2/XG,ERP,SLOPE,IDIP                                    168800
     4       /BLK4/VVA,VHA                                              168900
     6       /BLK6/TRP,JJOFF                                            169000
     7       /BLK7/JA,JB,TRS,ERS,XSP,ESP,LS                             169100
     9       /BLK9/EG,ES                                                169200
     9       /BLK10/BLIM,ITRACE,TANSG                                   169300
C  IN PROGRAM SIPB                                                      169400
C TRACES RAY FROM STARTING POINT ON TOP OF LAYER L OR LL TO ENDING POINT 169500
C (XO,EO) WITHIN OR ON THE UPPER BOUNDARY OF LAYER LO.  REFRACTING HORIZ 169600
C IS THE TOP OF LAYER L.  COMPUTES AND RETURNS CORRECTED COORD OF START  169700
C POINT AND TOTAL TRAVEL TIME. FOR IREP=1, LL=L-1, AND RAY START POINT   169800
C IS TAKEN AS (XLL,ELL) ON TOP OF LAYER LL,  FOR IREP=2 OR 3, LL=L, AND  169900
C START POINT IS TAKEN AS (XL,EL) ON TOP OF LAYER L. ALSO FOR IREP=2 OR  170000
C 3, RAY INTERSECTION WITH TOP OF LAYER L-1 IS OUTPUTTED AS (XLL,ELL)    170100
C AND TIME FROM THIS POINT AS TLL. INPUT PARAMETER BLL IS PRECOMPUTED    170200
C AS AVG DIP OF REFRACTOR OVER ENTIRE SPREAD. IF BLL IS NONZERO ON INPUT 170300
C IT IS USED IN PLACE OF INTERVAL DIP BETWEEN  GEO PAIRS WHICH IS        170400
C OTHERWISE COMPUTED INTERNALLY. INPUT PARAMETER I IS PRESET TO 1 FOR    170500
C RAYS GOING UP AND RIGHT, 2 FOR RAYS GOING UP AND LEFT.                170600
C                                                                       170700
C FOR THE CASE WHERE SHOT IS BELOW REFRACTOR (ES(J,M).LT.ERS(J,M,L1)),  170800
C TLL=BIG ON INPUT AND RAY IS TRACED FROM SHOT TO GEO.                  170900
C                                                                       171000
      DIMENSION NK(5),XG(25,5),ERP(25,5,4),VVA(5,5),VHA(5,5),NJ(5),JA(5) 171100
     1,JB(5),TRS(7,5,4),ERS(7,5,4),XSP(7,5),ESP(7,5),LS(7,5),ES(7,5)    171200
     2,EG(25,5),TRP(25,5,4)                                             171300
C                                                                       171400
      DATA BIG,SMALL/999999.,0.000001/                                  171500
C                                                                       171600
C INITIALIZE                                                            171700
C                                                                       171800
      NONE=0                                                            171900
      XLLS=XLL                                                          172000
      TLLS=TLL                                                          172100
      XLS=XL                                                            172200
      TLS=TL                                                            172300
      IF (L.EQ.LL) XLL=XL                                               172400
    2 IBLSW=0                                                           172500
    3 XREFL=XLL                                                         172600
      XREFLL=XLL                                                        172700
      TLL=0.0                                                           172800
      TL=0.0                                                            172900
      M1=M                                                              173000
      L2=LL                                                             173100
      L1=L2-1                                                           173200
C COMPUTE SLOPE OF RAY FROM STARTING POINT                              173300
      INVAL=0                                                           173400
      MFLAG=0                                                           173500
      IF(BLL.NE.0.) BL=BLL                                              173600
C FIRST FIND K OF GEOS BOUNDING XLL                                     173700
    4 KN=NK(M1)                                                         173800
      K3=KN-1                                                           173900
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      K1=1                                                              174000
      K2=2                                                              174100
      IF (XLL.LT.XG(1,M1)) GO TO 8                                      174200
      K1=KN-1                                                           174300
      K2=KN                                                             174400
      IF (XLL.GT.XG(KN,M1)) GO TO 11                                    174500
      DO 6 K1=1,K3                                                      174600
      K2=K1+1                                                           174700
      IF (XLL.LE.XG(K2,M1)) GO TO 15                                    174800
    6 CONTINUE                                                          174900
      GO TO 14                                                          175000
C CASE OF XLL LEFT OF SPREAD M1                                         175100
    8 IF (M1.EQ.1) GO TO 9                                              175200
      IF (INVAL.GT.0) GO TO 15                                          175300
      INVAL=-1                                                          175400
      M1=M1-1                                                           175500
      GO TO 4                                                           175600
C CASE OF XLL LEFT OF SPREAD 1                                          175700
    9 IF(BLL.NE.0..OR.IDIP.NE.0) GO TO 10                               175800
      KMID=KN/2                                                         175900
      K1=1                                                              176000
      K2=2                                                              176100
      IF(KMID-K1.LT.5) KMID=K1+5                                        176200
      IF(KMID.GT.KN) KMID=KN                                            176300
      CALL DIP(L1,M1,K1,KMID,K1,A,BL)                                   176400
   10 IF(JJOFF.EQ.0) GO TO 310                                          176500
      J2=JA(1)                                                          176600
      IF(XLL.GE.XSP(J2,1).OR.J2.LE.1) GO TO 310                         176700
  110 J1=J2-1                                                           176800
      IF(XLL.GE.XSP(J1,1).OR.J1.EQ.1) GO TO 210                         176900
      J2=J2-1                                                           177000
      GO TO 110                                                         177100
  210 ELL=TERP(XSP(J1,1),ERS(J1,1,L1),XSP(J2,1),ERS(J2,1,L1),XLL)       177200
      GO TO 410                                                         177300
  310 IF(IDIP.NE.0.AND.BLL.EQ.0.) BL=SLOPE                              177400
      IF(BL.GT.BLIM) BL=BLIM                                            177500
      IF(BL.LT.-BLIM) BL=-BLIM                                          177600
      ELL=ERP(K1,M1,L1)+BL*(XLL-XG(K1,M1))                              177700
  410 MFLAG=1                                                           177800
      GO TO 16                                                          177900
C CASE OF XLL RIGHT OF SPREAD M1                                        178000
   11 IF (M1.EQ.NM) GO TO 12                                            178100
      IF (INVAL.LT.0) GO TO 15                                          178200
      INVAL=1                                                           178300
      M1=M1+1                                                           178400
      GO TO 4                                                           178500
C CASE OF XLL RIGHT OF SPREAD NM                                        178600
   12 IF(BLL.NE.0..OR.IDIP.NE.0) GO TO 13                               178700
      KMID=KN/2+1                                                       178800
      K1=KN-1                                                           178900
      K2=KN                                                             179000
      IF(K2-KMID.LT.5) KMID=K2-5                                        179100
      IF(KMID.LT.1) KMID=1                                              179200
      CALL DIP(L1,M1,KMID,K2,K2,A,BL)                                   179300
   13 IF(JJOFF.EQ.0) GO TO 313                                          179400
      JN=NJ(NM)                                                         179500
      J1=JB(NM)                                                         179600
      IF(XLL.LE.XSP(J1,NM).OR.J1.GE.JN) GO TO 313                       179700
  113 J2=J1+1                                                           179800
      IF(XLL.LE.XSP(J2,NM).OR.J2.EQ.JN) GO TO 213                       179900
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      J1=J1+1                                                          180000
      GO TO 113                                                        180100
  213 ELL=TERP(XSP(J1,NM),ERS(J1,NM,L1),XSP(J2,NM),ERS(J2,NM,L1),XLL)  180200
      GO TO 413                                                        180300
  313 IF(IDIP.NE.0.AND.BLL.EQ.0.) BL=SLOPE                             180400
      IF(BL.GT.BLIM) BL=BLIM                                           180500
      IF(BL.LT.-BLIM) BL=-BLIM                                         180600
      ELL=ERP(K2,M1,L1)+BL*(XLL-XG(K2,M1))                             180700
  413 MFLAG=2                                                          180800
      GO TO 16                                                         180900
   14 K1=KN-1                                                          181000
      K2=KN                                                            181100
C K1, K2, AND M1 NOW KNOWN. COMPUTE ELL AND BL FOR LAYER L1 AT XLL.    181200
   15 ELL=TERP(XG(K1,M1),ERP(K1,M1,L1),XG(K2,M1),ERP(K2,M1,L1),XLL)    181300
   16 EL=ELL                                                           181400
      EREFL=ELL                                                        181500
      EREFLL=ELL                                                       181600
      IF (NONE.NE.0) GO TO 17                                          181700
      ELLS=ELL                                                         181800
      ELS=ELL                                                          181900
   17 IF (BLL.EQ.0.0) GO TO 18                                         182000
      BL=BLL                                                           182100
      GO TO 19                                                         182200
   18 IF (IBLSW.NE.0) GO TO 19                                         182300
      DENOM=XG(K2,M1)-XG(K1,M1)                                        182400
      IF (DENOM.GT.0.1) GO TO 118                                      182500
      BL=SLOPE                                                         182600
      GO TO 19                                                         182700
  118 IF(MFLAG.NE.0) GO TO 119                                         182800
      BL=(ERP(K2,M1,L1)-ERP(K1,M1,L1))/DENOM                           182900
  119 IF (BL.GT.BLIM) BL=BLIM                                          183000
      IF (BL.LT.-BLIM) BL=-BLIM                                        183100
   19 BLREF=BL                                                         183200
      IF(TLLS.LT.BIG) GO TO 219                                        183300
C                                                                      183400
C RAY TRACED FROM ES WHEN ES IS BELOW REFRACTOR.                       183500
C                                                                      183600
      DENOM=SQRT(((XLL-XSP(J,M))**2+(ELL-ES(J,M))**2)*(1.+BL**2))      183700
      IF(DENOM.LT.0.001) GO TO 219                                     183800
      SINR=(ELL-ES(J,M)-BL*(XLL-XSP(J,M)))/DENOM                       183900
      IF(ABS(SINR).GT.0.999) GO TO 219                                 184000
      SINI=SINR*VVA(M1,L1)/VHA(M1,L)                                   184100
      TANI=SINI/SQRT(1.-SINI**2)                                       184200
      GO TO 120                                                        184300
  219 TANI=VVA(M1,L1)/SQRT(VHA(M1,L)**2-VVA(M1,L1)**2)                 184400
C COMPUTE SLOPE OF RAY EMERGING FROM L2                                184500
  120 IF (I.EQ.2) TANI=-TANI                                           184600
C ENTRY PT FOR RAYS AFTER 1ST ONE                                      184700
   20 DENOM=TANI-BL                                                    184800
C DECREMENT L1 IN PREPARATION FOR FINDING INTERSECTION W/ HORIZON ABOVE 184900
      L1=L1-1                                                          185000
      L2=L2-1                                                          185100
C VERTICAL RAY TEST                                                    185200
      IF (ABS(DENOM).LT.SMALL) GO TO 39                                185300
C NONVERTICAL RAY                                                      185400
      BRAY=(TANI*BL+1.0)/DENOM                                         185500
      ARAY=ELL-BRAY*XLL                                                185600
C TEST FOR UPPERMOST RAY -- IF SO COMPUTE XL1, TLL, TL, AND THEN EXIT  185700
      IF (L2.GT.L0) GO TO 23                                           185800
      XL1=(E0-ARAY)/BRAY                                               185900
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      T=SQRT ((XL1-XLL)**2+(EO-ELL)**2)/VVA(M1,L2)                          186000
      IF (EO.GT.ELL) GO TO 22                                              186100
  121 T=0.00001                                                            186200
   21 L3=L2+1                                                              186300
      T=T*VVA(M1,L2)/VVA(M1,L3)                                            186400
   22 TLL=TLL+T                                                            186500
      TL=TL+T                                                              186600
      GO TO 46                                                             186700
C NOT UPPERMOST RAY -- COMPUTE TENTATIVE INTERSECTION W/ HORIZON ABOVE     186800
   23 INVAL=0                                                              186900
   24 IF(BLL.NE.0.) GO TO 25                                               187000
      DENOM=XG(K2,M1)-XG(K1,M1)                                            187100
      IF(DENOM.GT.0.1) GO TO 124                                           187200
      BL=SLOPE                                                             187300
      GO TO 25                                                             187400
  124 IF(MFLAG.EQ.0) GO TO 125                                             187500
      IF(IDIP.EQ.0) GO TO 224                                              187600
      BL=SLOPE                                                             187700
      GO TO 25                                                             187800
  224 IF(MFLAG.EQ.2) GO TO 225                                             187900
C MFLAG=1 (XLL OR XL1 LEFT OF SPREAD M1)                                   188000
  324 KMID=KN/2                                                            188100
      K1=1                                                                 188200
      K2=1                                                                 188300
      IF(KMID-K1.LT.5) KMID=K1+5                                           188400
      IF(KMID.GT.KN) KMID=KN                                               188500
      CALL DIP(L1,M1,K1,KMID,K1,A,BL)                                      188600
      IF(JJOFF.EQ.0.OR.INVAL.EQ.0) GO TO 25                                188700
      J2=JA(1)                                                             188800
      IF(XL1.GE.XSP(J2,1).OR.J2.LE.1) GO TO 25                             188900
  424 J1=J2-1                                                              189000
      IF(XL1.GE.XSP(J1,1).OR.J1.EQ.1) GO TO 524                            189100
      J2=J1                                                                189200
      GO TO 424                                                            189300
  524 BL=(ERS(J2,M1,L1)-ERS(J1,M1,L1))/(XSP(J2,M1)-XSP(J1,M1))             189400
      GO TO 25                                                             189500
C MFLAG=2 (XLL OR XL1 RIGHT OF SPREAD M1)                                  189600
  225 KMID=KN/2+1                                                          189700
      K1=KN                                                                189800
      K2=KN                                                                189900
      IF(K2-KMID.LT.5) KMID=K2-5                                           190000
      IF(KMID.LT.1) KMID=1                                                 190100
      CALL DIP(L1,M1,KMID,K2,K2,A,BL)                                      190200
      IF(JJOFF.EQ.0.OR.INVAL.EQ.0) GO TO 25                                190300
      JN=NJ(NM)                                                            190400
      J1=JB(NM)                                                            190500
      IF(XL1.LE.XSP(J1,NM).OR.J1.GE.JN) GO TO 25                           190600
  625 J2=J1+1                                                              190700
      IF(XL1.LE.XSP(J2,NM).OR.J2.EQ.JN) GO TO 524                          190800
      J1=J2                                                                190900
      GO TO 625                                                            191000
  125 BL=(ERP(K2,M1,L1)-ERP(K1,M1,L1))/DENOM                               191100
   25 IF(BL.GT.BLIM) BL=BLIM                                               191200
      IF(BL.LT.-BLIM) BL=-BLIM                                             191300
      AL=ERP(K1,M1,L1)-BL*XG(K1,M1)                                        191400
C TEST FOR RAY PARALLEL WITH HORIZON ABOVE                                 191500
      DENOM=BRAY-BL                                                        191600
      IF (ABS (DENOM).GE.SMALL) GO TO 28                                   191700
      IF (BRAY) 32,26,36                                                   191800
   26 GO TO (36,32), I                                                     191900
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C TEST FOR VALID INTERSECTION                                          192000
   28 XL1=(AL-ARAY)/DENOM                                              192100
      IF(K1.EQ.K2) GO TO 30                                            192200
      IF (XL1.LT.XG(K1,M1)) GO TO 32                                   192300
      IF (XL1.GT.XG(K2,M1)) GO TO 36                                   192400
C VALID INTERSECTION FOUND                                             192500
   30 EL1=AL+BL*XL1                                                    192600
      IF (ABS (BRAY).LT.SMALL) BRAY=SIGN(SMALL,BRAY)                   192700
      IF (BL.GT.BLIM) BL=BLIM                                          192800
      IF (BL.LT.-BLIM) BL=-BLIM                                        192900
      DENOM=1.-BL/BRAY                                                 193000
      IF(ABS(DENOM).LT.SMALL) GO TO 52                                 193100
      TANR=(BL+1.0/BRAY)/DENOM                                         193200
      T=SQRT ((XL1-XLL)**2+(EL1-ELL)**2)/VVA(M1,L2)                    193300
   31 TL=TL+T                                                          193400
C TEST FOR CASE WHERE TLL STARTS ACCUMULATING AT L-1, NOT L            193500
      IF (LL.EQ.L.AND.L2.EQ.(L-1)) GO TO 43                            193600
      TLL=TLL+T                                                        193700
      GO TO 44                                                         193800
C INTERSECTION NOT VALID -- SEARCH TO LEFT                             193900
   32 IF (INVAL.GT.0) GO TO 30                                         194000
      IF (K1.EQ.1) GO TO 34                                            194100
      K2=K1                                                            194200
      K1=K2-1                                                          194300
   33 INVAL=-1                                                         194400
      GO TO 24                                                         194500
   34 IF (M1.EQ.1) GO TO 35                                            194600
      M1=M1-1                                                          194700
      KN=NK(M1)                                                        194800
      K2=KN                                                            194900
      K1=K2-1                                                          195000
      INVAL=-1                                                         195100
      GO TO 24                                                         195200
C CASE OF XL1 LEFT OF SPREAD 1                                         195300
   35 INVAL=1                                                          195400
      MFLAG=1                                                          195500
      GO TO 324                                                        195600
C INTERSECTION NOT VALID -- SEARCH TO RIGHT                            195700
   36 IF (INVAL.LT.0) GO TO 30                                         195800
      IF (K2.EQ.KN) GO TO 38                                           195900
      K1=K2                                                            196000
      K2=K1+1                                                          196100
   37 INVAL=1                                                          196200
      GO TO 24                                                         196300
   38 IF (M1.EQ.NM) GO TO 138                                          196400
      M1=M1+1                                                          196500
      KN=NK(M1)                                                        196600
      K1=1                                                             196700
      K2=2                                                             196800
      INVAL=1                                                          196900
      GO TO 24                                                         197000
C CASE OF XL1 RIGHT OF SPREAD NM                                       197100
  138 INVAL=-1                                                         197200
      MFLAG=2                                                          197300
      GO TO 225                                                        197400
C VERTICAL RAY -- TEST IF UPPERMOST -- IF SO COMPUTE TL, TLL AND EXIT. 197500
   39 XL1=XLL                                                          197600
      IF (L2.GT.L0) GO TO 40                                           197700
      T=(E0-ELL)/VVA(M1,L2)                                            197800
      IF(T.LE.0.) GO TO 121                                            197900
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      GO TO 22                                                          198000
C VERTICAL RAY -- NOT UPPERMOST ONE                                     198100
   40 IF(BLL.NE.0.) GO TO 141                                           198200
      DENOM=XG(K2,M1)-XG(K1,M1)                                         198300
      IF(DENOM.GT.0.1) GO TO 41                                         198400
      BL=SLOPE                                                          198500
      GO TO 141                                                         198600
   41 BL=(ERP(K2,M1,L1)-ERP(K1,M1,L1))/DENOM                            198700
      IF (BL.GT.BLIM) BL=BLIM                                           198800
      IF (BL.LT.-BLIM) BL=-BLIM                                         198900
  141 AL=ERP(K1,M1,L1)-BL*XG(K1,M1)                                     199000
   42 EL1=AL+BL*XL1                                                     199100
      TANR=BL                                                           199200
      T=(EL1-ELL)/VVA(M1,L2)                                            199300
      GO TO 31                                                          199400
C                                                                       199500
   43 XREFLL=XL1                                                        199600
      EREFLL=EL1                                                        199700
      ELLS=EL1                                                          199800
C PREPARE TO CONTINUE TRACING RAY UPWARD                                199900
   44 XLL=XL1                                                           200000
      ELL=EL1                                                           200100
      SINI=VVA(M1,L1)*TANR/(SQRT(1.0+TANR**2)*VVA(M1,L2))               200200
      TANI=SINI/SQRT (1.0-SINI**2)                                      200300
      GO TO 20                                                          200400
C EXIT FROM RAY-TRACE ROUTINE -- PREPARE TO TRACE MORE RAYS IF NECESSARY 200500
   46 IF (NONE.GT.0) GO TO 50                                           200600
C FIRST RAY TRACED -- STORE RESULTS                                     200700
      NONE=NONE+1                                                       200800
      XS1=XO-XL1                                                        200900
      XRLL1=XREFLL                                                      201000
      XRL1=XREFL                                                        201100
      ERL1=EREFL                                                        201200
      ERLL1=EREFLL                                                      201300
      TL1=TL                                                            201400
      TLL1=TLL                                                          201500
      BLREF1=BLREF                                                      201600
      EPSS=ABS(XS1)                                                     201700
      IF (ITRACE.NE.0) PRINT 47, XL1,XREFLL,EREFLL,TLL                  201800
     1,XREFL,EREFL,TL,XS1,NONE                                          201900
   47 FORMAT (1H ,25X,F10.1,9X,6F9.1,F15.1,I5)                          202000
      IF (ABS (XS1).LT.0.5) GO TO 67                                    202100
   49 XLL=XREFL+XS1                                                     202200
      GO TO 2                                                           202300
C SECOND RAY TRACED -- STORE RESULTS                                    202400
   50 NONE=NONE+1                                                       202500
      XS2=XO-XL1                                                        202600
      XRL2=XREFL                                                        202700
      XRLL2=XREFLL                                                      202800
      ERL2=EREFL                                                        202900
      ERLL2=EREFLL                                                      203000
      TL2=TL                                                            203100
      TLL2=TLL                                                          203200
      BLREF2=BLREF                                                      203300
      IF (ABS(XS2).GE.EPSS) GO TO 51                                    203400
      EPSS=ABS(XS2)                                                     203500
      XLLS=XREFLL                                                       203600
      ELLS=EREFLL                                                       203700
      TLLS=TLL                                                          203800
      XLS=XREFL                                                         203900
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      ELS=EREFL                                                          204000
      TLS=TL                                                             204100
   51 IF (ITRACE.NE.0) PRINT 47, XL1,XREFLL,EREFLL,TLL                   204200
     1,XREFL,EREFL,TL,XS2,NONE                                           204300
C MAKE TESTS FOR ACCEPTING FIRST TWO RAYS TRACED                         204400
      IF (XS1*XS2.LT.0.0) GO TO 53                                       204500
C THE TWO RAYS ARE ON SAME SIDE OF SP OR GEO                             204600
      IF (ABS (XS2).LT.ABS (XS1)) GO TO 54                               204700
C THE 2ND RAY IS NOT CLOSER TO SP OR GEO THAN 1ST RAY                    204800
      IF (NONE.GT.4) GO TO 52                                            204900
      XLL=XREFL+XS1                                                      205000
      GO TO 56                                                           205100
C GIVE UP AND RESORT TO USING SAVED INPUT VALUES, THEN RETURN            205200
   52 XLL=XLLS                                                           205300
      ELL=ELLS                                                           205400
      TLL=TLLS                                                           205500
      XL=XLS                                                             205600
      EL=ELS                                                             205700
      TL=TLS                                                             205800
      GO TO 63                                                           205900
C TEST IF 2ND RAY COMES WITHIN 10 FT OF OBJECTIVE                        206000
   53 IF (ABS(XS2).LE.10.0) GO TO 58                                     206100
C NOT WITHIN 10 FT. IF 4 OR LESS RAYS TRACED TRY ONCE MORE AFTER         206200
C INTERPOLATING BL. IF MORE THAN 4 RAYS TRACED, ACCEPT LAST PAIR.        206300
      IF (NONE.GT.4) GO TO 58                                            206400
      IBLSW=1                                                            206500
      XLL=(XRL1*XS2-XRL2*XS1)/(XS2-XS1)                                  206600
      BL=TERP(XRL1,BLREF1,XRL2,BLREF2,XLL)                               206700
      XRL1=XRL2                                                          206800
      XRLL1=XRLL2                                                        206900
      ERL1=ERL2                                                          207000
      ERLL1=ERLL2                                                        207100
      TL1=TL2                                                            207200
      TLL1=TLL2                                                          207300
      XS1=XS2                                                            207400
      GO TO 3                                                            207500
C TEST IF EXTRAPOLATION IS PERMISSIBLE                                   207600
   54 IF (ABS (XS2).LE.ABS (XS1-XS2)) GO TO 57                           207700
      IF (NONE.GT.4) GO TO 52                                            207800
C READJUST STARTING POINT AND THEN RETRACE 2ND RAY                       207900
   55 XLL=TERP(XS1,XRL1,XS2,XRL2,0.0)                                    208000
   56 XRL1=XRL2                                                          208100
      XRLL1=XRLL2                                                        208200
      ERL1=ERL2                                                          208300
      ERLL1=ERLL2                                                        208400
      TL1=TL2                                                            208500
      TLL1=TLL2                                                          208600
      XS1=XS2                                                            208700
      BLREF1=BLREF2                                                      208800
      GO TO 2                                                            208900
C TEST IF 2ND RAY WITHIN 10 FT OF OBJECTIVE                              209000
   57 IF (ABS(XS2).LE.10.0) GO TO 58                                     209100
C NOT WITHIN 10 FT. IF 4 OR LESS RAYS TRACED TRY ONCE MORE, OTHERWISE    209200
C ACCEPT THE LAST PAIR TRACED.                                           209300
      IF (NONE.GT.4) GO TO 58                                            209400
      GO TO 55                                                           209500
C INTERPOLATE OR EXTRAPOLATE TO OBTAIN XLL,ELL,TLL,XL,EL,TL, THEN RETURN 209600
   58 XL=TERP(XS1,XRL1,XS2,XRL2,0.0)                                     209700
      XLL=TERP(XS1,XRLL1,XS2,XRLL2,0.0)                                  209800
      ELL=TERP(XRLL1,ERLL1,XRLL2,ERLL2,XLL)                              209900
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      EL=TERP(XRL1,ERL1,XRL2,ERL2,XL)                                   210000
      TLL=TERP(XRLL1,TLL1,XRLL2,TLL2,XLL)                               210100
      TL=TERP(XRL1,TL1,XRL2,TL2,XL)                                     210200
      IF (TL.LT.TLL) GO TO 52                                           210300
   63 IF (ITRACE.NE.0) PRINT 65, XLL,ELL,TLL,XL,EL,TL,BL                210400
   65 FORMAT (45X,6F9.1,F9.4)                                           210500
      IF(TLLS.GE.BIG) TLL=0.                                            210600
      RETURN                                                            210700
C VERY CLOSE APPROXIMATION (.LT.0.5 FT). NO FURTHER RAY TRACING NEEDED  210800
   67 XLL=XREFLL                                                        210900
      XL=XREFL                                                          211000
      ELL=EREFLL                                                        211100
      EL=EREFL                                                          211200
      GO TO 63                                                          211300
      END                                                               211400
C                                                                       211500
C-----------------------------------------------------------------------211600
C                                                                       211700
      FUNCTION TERP(X1,Y1,X2,Y2,X)                                      211800
C  IN PROGRAM SIPB                                                      211900
C COMPUTES INTERPOLATED VALUE OF Y CORRESPONDING TO X, GIVEN THE 2 PTS  212000
C (X1,Y1) AND (X2,Y2)                                                   212100
C                                                                       212200
      IF (ABS (X2-X1).LT.0.1) GO TO 2                                   212300
      TERP=((X-X1)*(Y2-Y1))/(X2-X1)+Y1                                  212400
    1 RETURN                                                            212500
    2 TERP=(Y1+Y2)/2.0                                                  212600
      GO TO 1                                                           212700
      END                                                               212800
C                                                                       212900
C-----------------------------------------------------------------------213000
C                                                                       213100
      SUBROUTINE KENDS(L,M,J,K1,K2,K11,K22)                             213200
      COMMON/BLK0/LG                                                    213300
C  IN PROGRAM SIPB                                                      213400
C FINDS INDEX OF LEFTMOST (K11) AND RIGHTMOST (K22) GEO REPRESENTING    213500
C LAYER L FOR SP J, SPREAD M. K1 AND K2 ARE END PTS OF RANGE TO BE      213600
C TESTED, AND ARE INPUT VALUES.K11 AND K22 ARE END PTS FOUND (OUTPUT).  213700
C BOTH K11 AND K22 SET TO ZERO IF NO PTS FOUND                          213800
C                                                                       213900
      DIMENSION LG(25,7,5)                                              214000
      K11=0                                                             214100
      K22=0                                                             214200
      IF (K1.EQ.0.OR.K2.EQ.0) GO TO 12                                  214300
      DO 1 K=K1,K2                                                      214400
      IF (LG(K,J,M).NE.L) GO TO 1                                       214500
      K11=K                                                             214600
      GO TO 3                                                           214700
    1 CONTINUE                                                          214800
      GO TO 12                                                          214900
    3 DO 5 K=K11,K2                                                     215000
      IF(LG(K,J,M).EQ.L) K22=K                                          215100
    5 CONTINUE                                                          215200
   12 RETURN                                                            215300
      END                                                               215400
C                                                                       215500
C-----------------------------------------------------------------------215600
C                                                                       215700
      SUBROUTINE REGRES(K1,K2,J,M,L,V,T,PT,IT)                          215800
      COMMON/BLK0/LG                                                    215900
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     3       /BLK3/TA,TR,D                                                    216000
     4       /BLK4/VVA,VHA                                                    216100
C  IN PROGRAM SIPB                                                           216200
C COMPUTES VELOCITY V BY REGRESSION OF TIME PTS (TA) AT DISTANCES D FROM     216300
C SP J TO GEOS BETWEEN INDICES K1 AND K2 FOR LAYER L, SPREAD M.              216400
C ONLY NONZERO TA FOR WHICH LG=L ARE USED IN REGRESSION.                     216500
C HALF INTERCEPT TIME AT SP J IS GIVEN BY T, NUM OF REGRESSE) PTS IS PT.     216600
C                                                                            216700
      DIMENSION D(25),TA(25,7,5),TR(25,7,5),LG(25,7,5),VHA(5,5),VVA(5,5)     216800
     1,TAR(25)                                                               216900
C                                                                            217000
      IF(IT.EQ.1) GO TO 2                                                    217100
      DO 1 K=K1,K2                                                           217200
    1 TAR(K)=TA(K,J,M)                                                       217300
      GO TO 4                                                                217400
    2 DO 3 K=K1,K2                                                           217500
    3 TAR(K)=TR(K,J,M)                                                       217600
    4 S1=0.0                                                                 217700
      S2=0.0                                                                 217800
      PT=0.0                                                                 217900
      T=0.0                                                                  218000
      V=0.0                                                                  218100
      DO 5 K=K1,K2                                                           218200
      IF (LG(K,J,M).NE.L) GO TO 5                                            218300
      S1=S1+D(K)                                                             218400
      S2=S2+TAR(K)                                                           218500
      PT=PT+1.0                                                              218600
    5 CONTINUE                                                               218700
C                                                                            218800
      IF (PT.LE.1.0) GO TO 15                                                218900
      XBAR=S1/PT                                                             219000
      TBAR=S2/PT                                                             219100
      S1=0.0                                                                 219200
      S2=0.0                                                                 219300
      DO 10 K=K1,K2                                                          219400
      IF (LG(K,J,M).NE.L) GO TO 10                                           219500
      XD=D(K)-XBAR                                                           219600
      S1=S1+XD*TAR(K)                                                        219700
      S2=S2+XD**2                                                            219800
   10 CONTINUE                                                               219900
      V=ABS (S2/S1)                                                          220000
      T=(TBAR-XBAR*S1/S2)/2.0                                                220100
   12 RETURN                                                                 220200
C                                                                            220300
   15 IF (PT.EQ.0.0) GO TO 12                                                220400
      V=VHA(M,L)                                                             220500
      IF (V.LE.0.0) GO TO 12                                                 220600
      T=(S2-S1/V)/2.0                                                        220700
      GO TO 12                                                               220800
      END                                                                    220900
C                                                                            221000
C--------------------------------------------------------------------------- 221100
C                                                                            221200
      SUBROUTINE REGV(L,NIXIT)                                               221300
      COMMON IBL                                                             221400
      COMMON/BLK0/LG                                                         221500
     1       /BLK1/NM,NJ,NK                                                  221600
     3       /BLK3/TA,TR,DSG                                                 221700
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                        221800
     9       /BLK11/VREG,PREG                                                221900
```

```
C  IN PROGRAM SIPB                                                        222000
C COMPUTES AND PRINTS REGRESSION VELOCITIES AND INTERCEPT T FOR LAYER L   222100
C                                                                        222200
      DIMENSION NJ(5),NK( 5),KL(7,5),KR(7,5),D(25,7,5),IDSPR(5),         222300
     1IDSP(7,5),VREG(5),PREG(5),LG(25,7,5),TA(25,7,5),TR(25,7,5),DSG(25) 222400
C                                                                        222500
      IF (NIXIT.EQ.0) PRINT 1, L                                         222600
    1 FORMAT (' LAYER',I2,' VELOCITY AND TIME INTERCEPTS COMPUTED BY',    222700
     1' REGRESSION')                                                     222800
      SUM1=0.0                                                           222900
      PTS1=0.0                                                           223000
      DO 50 M=1,NM                                                       223100
      MCALL=M                                                            223200
      NONE=0                                                             223300
      JN=NJ(M)                                                           223400
      KN=NK(M)                                                           223500
      SUM2=0.0                                                           223600
      PTS2=0.0                                                           223700
      DO 40 J=1,JN                                                       223800
      JCALL=J                                                            223900
      CALL KENDS(L,MCALL,JCALL,1,KL(J,M),KL1,KL2)                        224000
      IF (KL1.EQ.0) GO TO 10                                             224100
      DO 5 K=KL1,KL2                                                     224200
      DSG(K)=D(K,J,M)                                                    224300
    5 CONTINUE                                                           224400
      CALL REGRES(KL1,KL2,JCALL,MCALL,L,VL,TLF,PT,3)                     224500
      IF (PT.LE.1.0) GO TO 10                                            224600
      TLF=TLF+TLF                                                        224700
      SUM3=PT/VL                                                         224800
      PTS3=PT                                                            224900
      GO TO 15                                                           225000
   10 VL=0.0                                                             225100
      TLF=0.0                                                            225200
      SUM3=0.0                                                           225300
      PTS3=0.0                                                           225400
C                                                                        225500
   15 CALL KENDS(L,MCALL,JCALL,KR(J,M),KN,KR1,KR2)                       225600
      IF (KR1.EQ.0) GO TO 23                                             225700
      DO 20 K=KR1,KR2                                                    225800
      DSG(K)=D(K,J,M)                                                    225900
   20 CONTINUE                                                           226000
      CALL REGRES(KR1,KR2,JCALL,MCALL,L,VR,TRT,PT,3)                     226100
      IF (PT.LE.1.0) GO TO 23                                            226200
      TRT=TRT+TRT                                                        226300
      PTS3=PTS3+PT                                                       226400
      SUM3=SUM3+PT/VR                                                    226500
      GO TO 24                                                           226600
   23 VR=0.0                                                             226700
      TRT=0.0                                                            226800
      AVGT=TLF                                                           226900
   24 SUM2=SUM2+SUM3                                                     227000
      PTS2=PTS2+PTS3                                                     227100
      SUM1=SUM1+SUM3                                                     227200
      PTS1=PTS1+PTS3                                                     227300
      IF (PTS3.EQ.0.0) GO TO 40                                          227400
      IF (TLF.EQ.0.0) AVGT=TRT                                           227500
      IF (TLF.NE.0.0.AND.TRT.NE.0.0) AVGT=(TLF+TRT)/2.0                  227600
      IF (NONE.NE.0) GO TO 27                                            227700
      NONE=1                                                             227800
      IF (NIXIT.EQ.0) PRINT 25, IDSPR(M)                                 227900
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```
   25 FORMAT (1HO,8H SPREAD ,A1,3X,22HVEL    TIME    GEOS    SP,5X,          228000
     1 17HGEOS   TIME     VEL,8X,19HAVG V    AVG T    PTS/1H ,10X,6H------,   228100
     2 2X,4H----,2X,5H-----,3X,3H---,3X,5H-----,2X,4H----,2X,6H------,       228200
     3 6X,6H------,3X,5H-----,3X,3H---)                                      228300
   27 SUM3=PTS3/SUM3                                                         228400
      IF (NIXIT.EQ.1) GO TO 40                                               228500
      PRINT 31, VL,TLF,KL1,KL2,IDSP(J,M),KR1,KR2,TRT,VR,SUM3,AVGT,PTS3       228600
   31 FORMAT (1H ,3PF16.0,0PF6.1,1X,2I3,4X,A1,3X,2I3,F6.1,3PF8.0,F12.0,      228700
     1 0PF8.1,F6.0)                                                          228800
   40 CONTINUE                                                               228900
C                                                                            229000
      IF (NONE.EQ.0) GO TO 50                                                229100
      SUM2=PTS2/SUM2                                                         229200
      IF (NIXIT.EQ.1) GO TO 50                                               229300
      PRINT 41, SUM2,PTS2                                                    229400
   41 FORMAT (1HO,59X,3HAVG,3PF7.0,0PF14.0)                                  229500
   42 FORMAT (1HO,52X,10HAVG OF ALL,3PF7.0,0PF14.0)                          229600
C                                                                            229700
   50 CONTINUE                                                               229800
C                                                                            229900
      IF (PTS1.EQ.0.0) GO TO 56                                              230000
      VREG(L)=PTS1/SUM1                                                      230100
      PREG(L)=PTS1                                                           230200
      IF (NM.EQ.1.OR.NIXIT.EQ.1) GO TO 60                                    230300
      PRINT 55                                                               230400
   55 FORMAT (1HO,63X,7H-------,10X,3H---)                                   230500
      PRINT 42, VREG(L),PTS1                                                 230600
      GO TO 60                                                               230700
   56 VREG(L)=0.0                                                            230800
      PREG(L)=0.0                                                            230900
C                                                                            231000
      IF (NIXIT.EQ.0) PRINT 57                                               231100
   57 FORMAT(/////1HO,8H--NONE--)                                            231200
C                                                                            231300
   60 RETURN                                                                 231400
      END                                                                    231500
C                                                                            231600
C-------------------------------------------------------------------------   231700
C                                                                            231800
      SUBROUTINE HOBV(L,NIXIT)                                               231900
      COMMON IBL                                                             232000
      COMMON/BLK0/LG                                                         232100
     1       /BLK1/NM,NJ,NK                                                  232200
     3       /BLK3/TA,TR,DSG                                                 232300
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                        232400
     9       /BLK12/VHOB,PHOB                                                232500
C  IN PROGRAM SIPB                                                           232600
C COMPUTES HORIZ VEL OF LAYER L BY HOBSON-OVERTON METHOD                     232700
C                                                                            232800
      DIMENSION EP(25),DX(25),DT(25),NJ(5),NK(5),IDSPR(5),LG(25,7,5),        232900
     1 TA(25,7,5),KR(7,5),KL(7,5),IDSP(7,5),VHOB(5),PHOB(5),D(25,7,5) ,      233000
     2 DSG(25),KI(5),PE(5),TR(25,7,5)                                        233100
C                                                                            233200
      IF (NIXIT.EQ.0) PRINT 2, L                                             233300
    2 FORMAT (1HO,'LAYER',I2,' VELOCITY COMPUTED BY HOBSON-OVERTON ',        233400
     1'METHOD')                                                              233500
      SUM2=0.0                                                               233600
      PTS2=0.0                                                               233700
C                                                                            233800
      DO 22 M=1,NM                                                           233900
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      MCALL=M                                                          234000
      NONE=0                                                           234100
      JN=NJ(M)                                                         234200
      KN=NK(M)                                                         234300
      SUM3=0.0                                                         234400
      PTS3=0.0                                                         234500
      J2=JN-1                                                          234600
C                                                                      234700
      DO 18 J=1,J2                                                     234800
      JCALL=J                                                          234900
      CALL KENDS(L,MCALL,JCALL,KR(J,M),KN,KR1,KR2)                     235000
      IF (KR1.EQ.0) GO TO 18                                           235100
      J1=J+1                                                           235200
C                                                                      235300
      DO 16 JJ=J1,JN                                                   235400
      JJCALL=JJ                                                        235500
      CALL KENDS(L,MCALL,JJCALL,1,KL(JJ,M),KL1,KL2)                    235600
      K1=MAXO(KR1,KL1)                                                 235700
      K2=MINO(KR2,KL2)                                                 235800
      IF (KL1.EQ.0.OR.(K2-K1).LE.0) GO TO 16                           235900
C                                                                      236000
C BEGIN HOBSON-OVERTON ROUTINE                                         236100
C                                                                      236200
      SDX=0.0                                                          236300
      SDX2=0.0                                                         236400
      SDT=0.0                                                          236500
      SDTDX=0.0                                                        236600
      SEEP=0.0                                                         236700
      PT=0.0                                                           236800
      DO 3 K=1,12                                                      236900
      EP(K)=0.0                                                        237000
    3 CONTINUE                                                         237100
      DO 4 K=K1,K2                                                     237200
      IF (LG(K,J,M).NE.L.OR.LG(K,JJ,M).NE.L) GO TO 4                   237300
      DX(K)=ABS(D(K,J,M))-ABS(D(K,JJ,M))                               237400
      SDX=SDX+DX(K)                                                    237500
      SDX2=SDX2+DX(K)**2                                               237600
      DT(K)=TA(K,J,M)-TA(K,JJ,M)                                       237700
      SDT=SDT+DT(K)                                                    237800
      SDTDX=SDTDX+DX(K)*DT(K)                                          237900
      PT=PT+1.0                                                        238000
    4 CONTINUE                                                         238100
      IF (PT.LE.1.0) GO TO 9                                           238200
      V=(SDX2-SDX**2/PT)/(SDTDX-(SDX*SDT)/PT)                          238300
      TDSP=(SDT-SDX/V)/PT                                              238400
      DO 6 K=K1,K2                                                     238500
      IF (LG(K,J,M).NE.L.OR.LG(K,JJ,M).NE.L) GO TO 6                   238600
      EP(K)=DT(K)-DX(K)/V-TDSP                                         238700
      SEEP=SEEP+EP(K)**2                                               238800
    6 CONTINUE                                                         238900
      SEEP=SQRT (SEEP/PT)                                              239000
      DO 8 IK=1,5                                                      239100
      KI(IK)=0                                                         239200
      PE(IK)=0.                                                        239300
      DO 7 K=K1,K2                                                     239400
      IF(ABS(EP(K)).LE.ABS(PE(IK))) GO TO 7                            239500
      PE(IK)=EP(K)                                                     239600
      KI(IK)=K                                                         239700
    7 CONTINUE                                                         239800
      IF(KI(IK).EQ.0) GO TO 8                                          239900
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```
      K=KI(IK)                                                          240000
      EP(K)=0.                                                          240100
    8 CONTINUE                                                          240200
      GO TO 10                                                          240300
    9 V=0.0                                                             240400
      PT=0.0                                                            240500
C                                                                       240600
C END HOBSON-OVERTON ROUTINE                                            240700
C                                                                       240800
   10 IF (PT.EQ.0.0) GO TO 16                                           240900
      SUM3=SUM3+V*PT                                                    241000
      PTS3=PTS3+PT                                                      241100
      IF (NIXIT.EQ.1) GO TO 16                                          241200
      IF (NONE.NE.0) GO TO 12                                           241300
      NONE=1                                                            241400
      PRINT 11, IDSPR(M)                                                241500
   11 FORMAT('0 SPREAD ',A1,40X,'5 HIGHEST EPS'/7X,'VEL   SPS   GEOS',  241600
     1' TDSP  SE EP',5(4X,'EP   GEO')/5X,'------',2X,'---  -----  ----'  241700
     2,2X,'-----',5(3X,'---------'))                                    241800
   12 PRINT 13, V,IDSP(J,M),IDSP(JJ,M),K1,K2,TDSP,SEEP,                 241900
     1(PE(K),KI(K),K=1,5)                                               242000
   13 FORMAT (1H ,3PF10.0,2X,A1,1X,A1,1X,2I3,0PF6.1,F7.3,5(F8.3,I4))    242100
   16 CONTINUE                                                          242200
   18 CONTINUE                                                          242300
C                                                                       242400
      SUM2=SUM2+SUM3                                                    242500
      PTS2=PTS2+PTS3                                                    242600
      IF (PTS3.EQ.0.0) GO TO 22                                         242700
      SUM3=SUM3/PTS3                                                    242800
      IF (NIXIT.EQ.0) PRINT 20, SUM3,PTS3                               242900
   20 FORMAT (1HO,5X,4HAVG=,3PF7.0,4H FOR,0PF5.0,7H POINTS)             243000
   22 CONTINUE                                                          243100
C                                                                       243200
      IF (PTS2.EQ.0.0) GO TO 26                                         243300
      SUM2=SUM2/PTS2                                                    243400
      IF (NH.EQ.1.OR.NIXIT.EQ.1) GO TO 28                               243500
      PRINT 25, SUM2,PTS2                                               243600
   25 FORMAT('0  AVG OF ALL',3PF7.0,4H FOR,0PF5.0,7H POINTS)            243700
      GO TO 28                                                          243800
   26 IF(NIXIT.EQ.0) PRINT 27                                           243900
   27 FORMAT(1HO,2X,17HNOT ENOUGH POINTS)                               244000
C                                                                       244100
   28 VHOB(L)=SUM2                                                      244200
      PHOB(L)=PTS2                                                      244300
C                                                                       244400
      RETURN                                                            244500
      END                                                               244600
C                                                                       244700
C-----------------------------------------------------------------------244800
C                                                                       244900
      SUBROUTINE EXTRP(L,M,K1,K2,A,B,VV)                                245000
      COMMON/BLK2/XG,ERP,SLOPE,IDIP                                     245100
     6       /BLK6/TRP,JJOFF                                            245200
     9       /BLK9/EG,ES                                                245300
C  IN PROGRAM SIPB                                                      245400
C COMPUTES ERP AND TRP BETWEEN GEOS K1 AND K2 USING EQUATION CONSTS A,B 245500
C                                                                       245600
      DIMENSION XG(25,5),ERP(25,5,4),TRP(25,5,4),EG(25,5),ES(7,5)       245700
C                                                                       245800
      DO 2 K=K1,K2                                                      245900
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      ERP(K,M,L)=A+B*XG(K,M)                                              246000
      IF (L.EQ.1) GO TO 1                                                 246100
      TRP(K,M,L)=(ERP(K,M,L-1)-ERP(K,M,L))/VV                             246200
      GO TO 2                                                             246300
    1 TRP(K,M,L)=(EG(K,M)-ERP(K,M,L))/VV                                  246400
    2 CONTINUE                                                            246500
      RETURN                                                              246600
      END                                                                 246700
C                                                                         246800
C-------------------------------------------------------------------------246900
C                                                                         247000
      SUBROUTINE ELCOR(TANI,VV,HV,XSG,ESG,AD,BD,I,TC,XC,XINT,EINT)        247100
      COMMON/BLK1/NM,NJ,NK                                                247200
C  IN PROGRAM SIPB                                                        247300
C COMPUTES TIME CORR (TC) AND X CORR (XC) FOR SURF-TO-DATUM SLANT RAYS    247400
C FOR LAYER 1, GIVEN X POS OF SHOT OR GEO (XSG), ELEV OF SHOT OR GEO      247500
C (ESG), INTCPT AND SLOPE OF DATUM (AD AND BD), AND SIGN OF BOA=COT I     247600
C (I=1 FOR PLUS, 2 FOR MINUS). XINT,EINT IS COORD OF INTERSECTION OF      247700
C RAY AND DATUM.                                                          247800
C                                                                         247900
      DIMENSION NJ(5),NK(5)                                               248000
      BI=TANI                                                             248100
      IF(I.EQ.2) BI=-BI                                                   248200
      BOA=(1.-BI*BD)/(BI-BD)                                              248300
      AOA=ESG-BOA*XSG                                                     248400
      XINT=(AD-AOA)/(BOA-BD)                                              248500
      EINT=AD+BD*XINT                                                     248600
      OA=SQRT ((XSG-XINT)**2+(ESG-EINT)**2)                               248700
      TC=OA/VV                                                            248800
      XC=OA*VV/HV                                                         248900
      IF (ESG.LE.EINT) GO TO 4                                            249000
    3 TC=-TC                                                              249100
      XC=-XC                                                              249200
    4 RETURN                                                              249300
      END                                                                 249400
C                                                                         249500
C-------------------------------------------------------------------------249600
C                                                                         249700
      SUBROUTINE DIP(L,M,K1,K2,KK,A,B)                                    249800
      COMMON/BLK2/XG,ERP,SLOPE,IDIP                                       249900
C  IN PROGRAM SIPB                                                        250000
C COMPUTES EQUATION CONSTANTS A AND B (Y=A+BX) FOR REGRESSION LINE        250100
C FITTED TO ERP OVER GEOS K1 TO K2 WITH LINE PASSING THROUGH POINT        250200
C XG(KK,M),ERP(KK,M,L)                                                    250300
C                                                                         250400
      DIMENSION XG(25,5),ERP(25,5,4)                                      250500
C                                                                         250600
      IF (IDIP.EQ.0.AND.XG(K1,M).LT.XG(K2,M)) GO TO 1                     250700
      A=ERP(KK,M,L)                                                       250800
      B=SLOPE                                                             250900
      GO TO 4                                                             251000
    1 SUM1=0.0                                                            251100
      SUM2=0.0                                                            251200
      DO 2 K=K1,K2                                                        251300
      SUM1=SUM1+XG(K,M)                                                   251400
      SUM2=SUM2+1.0                                                       251500
    2 CONTINUE                                                            251600
      XBAR=SUM1/SUM2                                                      251700
      SUM1=0.0                                                            251800
      SUM2=0.0                                                            251900
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```
      DO 3 K=K1,K2                                                      252000
      XD=XG(K,M)-XBAR                                                   252100
      SUM1=SUM1+XD*ERP(K,M,L)                                           252200
      SUM2=SUM2+XD**2                                                   252300
    3 CONTINUE                                                          252400
      B=SUM1/SUM2                                                       252500
      A=ERP(KK,M,L)-B*XG(KK,M)                                          252600
    4 RETURN                                                            252700
      END                                                               252800
C                                                                       252900
C-----------------------------------------------------------------------253000
C                                                                       253100
      SUBROUTINE AVG(X1,X2,L2,PA,EA)                                    253200
      COMMON IBL                                                        253300
      COMMON/BLK0/LG                                                    253400
     1       /BLK1/NM,NJ,NK                                             253500
     8       /BLK8/PRG,ERG,KRG,PRS2,ERS2,KRS2,ZRSP,ZRG                  253600
C  IN PROGRAM SIPB                                                      253700
C COMPUTES AVG COORD (PA,EA) OF ALL PTS IN ARRAYS (PRG,ERG) AND         253800
C (PRS2,ERS2) WHOSE X POSITION IS GE X1 .AND. LT X2. AND WHOSE REFRACTOR 253900
C IS LAYER L2. IF PTS.LE.2.AND.L2.GT.2 INTERVAL IS EXPANDED BY          254000
C DX=X2-X1 ON EACH SIDE.                                                254100
C                                                                       254200
      DIMENSION LG(25,7,5),NJ(5),NK(5),PRG(25,7,5),ERG(25,7,5),         254300
     1 KRG(25,7,5),PRS2(7,5,4,2),ERS2(7,5,4,2),KRS2(7,5,4,2),ZRSP(7),   254400
     2 ZRG(25,7)                                                        254500
C                                                                       254600
      SUM1=0.0                                                          254700
      SUM2=0.0                                                          254800
      PTS=0.0                                                           254900
      L1=L2-1                                                           255000
      X11=X1                                                            255100
      X22=X2                                                            255200
      DX=0.0                                                            255300
C                                                                       255400
    1 DO 14 M=1,NM                                                      255500
      JN=NJ(M)                                                          255600
      KN=NK(M)                                                          255700
      DO 12 J=1,JN                                                      255800
      I=1                                                               255900
    2 IF (ERS2(J,M,L1,I).EQ.0..OR.KRS2(J,M,L1,I).NE.IBL) GO TO 3        256000
      E1=ERS2(J,M,L1,I)                                                 256100
      P1=PRS2(J,M,L1,I)                                                 256200
      GO TO 10                                                          256300
    3 IF (I.EQ.2) GO TO 5                                               256400
    4 I=2                                                               256500
      GO TO 2                                                           256600
    5 K=1                                                               256700
    6 IF (LG(K,J,M).NE.L2.OR.ERG(K,J,M).EQ.0.0.OR.KRS(K,J,M).NE.IBL) GO 256800
     1 TO 8                                                             256900
      E1=ERG(K,J,M)                                                     257000
      P1=PRG(K,J,M)                                                     257100
      I=3                                                               257200
      GO TO 10                                                          257300
    8 K=K+1                                                             257400
      IF (K.GT.KN) GO TO 12                                             257500
      GO TO 6                                                           257600
   10 IF (P1.LT.X11.OR.P1.GE.X22) GO TO 11                              257700
      SUM1=SUM1+P1                                                      257800
      SUM2=SUM2+E1                                                      257900
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      PTS=PTS+1.0                                                       258000
   11 GO TO (4,5,8),I                                                   258100
   12 CONTINUE                                                          258200
   14 CONTINUE                                                          258300
      IF (PTS.EQ.0.0) GO TO 18                                          258400
      IF (PTS.LE.2..AND.L2.GT.2) GO TO 19                               258500
      PA=SUM1/PTS                                                       258600
      EA=SUM2/PTS                                                       258700
   16 RETURN                                                            258800
   18 PA=0.0                                                            258900
      EA=0.0                                                            259000
      GO TO 16                                                          259100
   19 DX=X22-X11                                                        259200
      X11=X11-DX                                                        259300
      X22=X22+DX                                                        259400
      GO TO 1                                                           259500
      END                                                               259600
C                                                                       259700
C-----------------------------------------------------------------------259800
C                                                                       259900
      SUBROUTINE ADMIG(L1,M,B)                                          260000
      COMMON IBL                                                        260100
      COMMON/BLK0/LG                                                    260200
     1       /BLK1/NM,NJ,NK                                             260300
     2       /BLK2/XG,ERP,SLOPE,IDIP                                    260400
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                   260500
     6       /BLK6/TRP,JJOFF                                            260600
     7       /BLK7/JA,JB,TRS,ERS,XSP,ESP,LS                             260700
     8       /BLK8/PRG,ERG,KRG,PRS2,ERS2,KRS2,ZRSP,ZRG                  260800
     9       /BLK9/EG,ES                                                260900
     9       /BLK10/BLIM,ITRACE,TANSG                                   261000
C IN PROGRAM SIPB                                                       261100
C COMPUTES TAN OF AVG ANGLE OF DIP (B) OF BOTTOM OF L1 FOR SPREAD M     261200
C BY REGRESSION OF POINTS (PRS2,ERS2) AND (PRG,ERG).                    261300
C                                                                       261400
      DIMENSION NJ(5),NK(5),KL(7,5),KR(7,5),LG(25,7,5),LS(7,5),         261500
     1 PRS2(7,5,4,2),ERS2(7,5,4,2),KRS2(7,5,4,2),PRG(25,7,5),           261600
     2 ERG(25,7,5),IDSPR(5),IDSP(7,5),ERS(7,5,4),XSP(7,5),ESP(7,5),     261700
     3 D(25,7,5),KRG(25,7,5),TRP(25,5,4),JA(5),JB(5),TRS(7,5,4),XG(25,5) 261800
     4,EG(25,5),ES(7,5),ERP(25,5,4),ZRSP(7),ZRG(25,7)                   261900
C                                                                       262000
      B=0.                                                              262100
      JN=NJ(M)                                                          262200
      KN=NK(M)                                                          262300
      L0=L1-1                                                           262400
      L2=L1+1                                                           262500
C                                                                       262600
C COMPUTE AVERAGE PRG AND PRS2 (XBAR)                                   262700
C                                                                       262800
      S1=0.                                                             262900
      S2=0.                                                             263000
      P1=0.                                                             263100
      P2=0.                                                             263200
C                                                                       263300
      DO 22 J=1,JN                                                      263400
      JCALL=J                                                           263500
C                                                                       263600
C UP-RIGHT AND DOWN-LEFT RAYS                                           263700
C                                                                       263800
      IF(KR(J,M).EQ.0) GO TO 18                                         263900
```

```
      CALL KENDS(L2,M,JCALL,KR(J,M),KN,K11,K22)                          264000
      IF(K11.EQ.0) GO TO 18                                              264100
      DO 17 K=K11,K22                                                    264200
      IF(LG(K,J,M).NE.L2) GO TO 17                                       264300
      S1=S1+PRG(K,J,M)                                                   264400
      P1=P1+1.                                                           264500
   17 CONTINUE                                                           264600
      IF((JJOFF.EQ.0.AND.J.LT.JA(M)).OR.KRS2(J,M,L1,1).NE.IBL) GO TO 18  264700
      S2=S2+PRS2(J,M,L1,1)                                               264800
      P2=P2+1.                                                           264900
C                                                                        265000
C UP-LEFT AND DOWN-RIGHT RAYS                                            265100
C                                                                        265200
   18 IF(KL(J,M).EQ.0) GO TO 22                                          265300
      CALL KENDS(L2,M,JCALL,1,KL(J,M),K11,K22)                           265400
      IF(K11.EQ.0) GO TO 22                                              265500
      DO 20 K=K11,K22                                                    265600
      IF(LG(K,J,M).NE.L2) GO TO 20                                       265700
      S2=S2+PRG(K,J,M)                                                   265800
      P2=P2+1.                                                           265900
   20 CONTINUE                                                           266000
      IF((JJOFF.EQ.0.AND.J.GT.JB(M)).OR.KRS2(J,M,L1,2).NE.IBL) GO TO 22  266100
      S1=S1+PRS2(J,M,L1,2)                                               266200
      P1=P1+1.                                                           266300
   22 CONTINUE                                                           266400
C                                                                        266500
      IF((P1+P2).LT.2.) GO TO 99                                         266600
      XBAR1=0.                                                           266700
      XBAR2=0.                                                           266800
      IF(P1.NE.0.) XBAR1=S1/P1                                           266900
      IF(P2.NE.0.) XBAR2=S2/P2                                           267000
C                                                                        267100
C COMPUTE AVERAGE DIP (B)                                                267200
C                                                                        267300
      S1=0.                                                              267400
      S2=0.                                                              267500
      SS1=0.                                                             267600
      SS2=0.                                                             267700
      P1=0.                                                              267800
      P2=0.                                                              267900
      DO 52 J=1,JN                                                       268000
      JCALL=J                                                            268100
C                                                                        268200
C UP-RIGHT AND DOWN-LEFT RAYS                                            268300
C                                                                        268400
      IF (KR(J,M).EQ.0) GO TO 48                                         268500
      CALL KENDS(L2,M,JCALL,KR(J,M),KN,K11,K22)                          268600
      IF (K11.EQ.0) GO TO 48                                             268700
      DO 47 K=K11,K22                                                    268800
      IF(LG(K,J,M).NE.L2.OR.XBAR1.EQ.0.) GO TO 47                        268900
      X=PRG(K,J,M)-XBAR1                                                 269000
      S1=S1+X*ERG(K,J,M)                                                 269100
      SS1=SS1+X**2                                                       269200
      P1=P1+1.                                                           269300
   47 CONTINUE                                                           269400
      IF((JJOFF.EQ.0.AND.J.LT.JA(M)).OR.KRS2(J,M,L1,1).NE.IBL.OR.        269500
     1 XBAR2.EQ.0.) GO TO 48                                             269600
      X=PRS2(J,M,L1,1)-XBAR2                                             269700
      S2=S2+X*ERS2(J,M,L1,1)                                             269800
      SS2=SS2+X**2                                                       269900
```

```
      P2=P2+1.                                                          270000
C                                                                       270100
C  UP-LEFT AND DOWN-RIGHT RAYS                                         270200
C                                                                       270300
   48 IF(KL(J,M).EQ.0) GO TO 52                                         270400
      CALL KENDS(L2,M,JCALL,1,KL(J,M),K11,K22)                          270500
      IF(K11.EQ.0) GO TO 52                                             270600
      DO 50 K=K11,K22                                                   270700
      IF(LG(K,J,M).NE.L2.OR.XBAR2.EQ.0.) GO TO 50                       270800
      X=PRG(K,J,M)-XBAR2                                                270900
      S2=S2+X*ERG(K,J,M)                                                271000
      SS2=SS2+X**2                                                      271100
      P2=P2+1.                                                          271200
   50 CONTINUE                                                          271300
      IF((JJOFF.EQ.0.AND.J.GT.JB(M)).OR.KRS2(J,M,L1,2).NE.IBL.OR.       271400
     1 XBAR1.EQ.0.) GO TO 52                                            271500
      X=PRS2(J,M,L1,2)-XBAR1                                            271600
      S1=S1+X*ERS2(J,M,L1,2)                                            271700
      SS1=SS1+X**2                                                      271800
      P1=P1+1.                                                          271900
   52 CONTINUE                                                          272000
C                                                                       272100
      R1=0.                                                             272200
      R2=0.                                                             272300
      IF(SS1.NE.0.) R1=S1/SS1                                           272400
      IF(SS2.NE.0.) R2=S2/SS2                                           272500
      B=(P1*R1+P2*R2)/(P1+P2)                                           272600
      IF(IDIP.NE.0) B=SLOPE                                             272700
      IF(B.GT.BLIM) B=BLIM                                              272800
      IF(B.LT.-BLIM) B=-BLIM                                            272900
C                                                                       273000
C  MIGRATE RAY END POINTS                                               273100
C                                                                       273200
      B1=B                                                              273300
      IF(L1.EQ.1) B1=(B-SLOPE)/(1.+B*SLOPE)                             273400
      COSA=1./SQRT(1.+B1**2)                                            273500
      ZRK=(1.+B1*TANSG)*COSA-1.                                         273600
      XRK=TANSG-COSA*(TANSG-B1)                                         273700
      ZLK=(1.-B1*TANSG)*COSA-1.                                         273800
      XLK=TANSG-COSA*(TANSG+B1)                                         273900
C                                                                       274000
      DO 72 J=1,JN                                                      274100
C                                                                       274200
C  UP-RIGHT AND DOWN-LEFT RAYS                                          274300
C                                                                       274400
      JCALL=J                                                           274500
      IF(KR(J,M).EQ.0) GO TO 68                                         274600
      CALL KENDS(L2,M,JCALL,KR(J,M),KN,K11,K22)                         274700
      IF(K11.EQ.0) GO TO 68                                             274800
      DO 67 K=K11,K22                                                   274900
      IF(LG(K,J,M).NE.L2.OR.XBAR1.EQ.0.) GO TO 67                       275000
      ERG(K,J,M)=ERG(K,J,M)-ZRG(K,J)*ZRK                                275100
      PRG(K,J,M)=PRG(K,J,M)+ZRG(K,J)*XRK                                275200
   67 CONTINUE                                                          275300
      IF(XBAR2.EQ.0..OR.KRS2(J,M,L1,1).NE.IBL) GO TO 68                 275400
      ERS2(J,M,L1,1)=ERS2(J,M,L1,1)-ZRSP(J)*ZLK                         275500
      PRS2(J,M,L1,1)=PRS2(J,M,L1,1)-ZRSP(J)*XLK                         275600
C                                                                       275700
C  UP-LEFT AND DOWN-RIGHT RAYS                                          275800
C                                                                       275900
```

```
   68 IF(KL(J,M).EQ.0) GO TO 72                                          276000
      CALL KENDS(L2,M,JCALL,1,KL(J,M),K11,K22)                           276100
      IF(K11.EQ.0) GO TO 72                                              276200
      DO 70 K=K11,K22                                                    276300
      IF(LG(K,J,M).NE.L2.OR.XBAR2.EQ.0) GO TO 70                         276400
      ERG(K,J,M)=ERG(K,J,M)-ZRG(K,J)*ZLK                                 276500
      PRG(K,J,M)=PRG(K,J,M)-ZRG(K,J)*XLK                                 276600
   70 CONTINUE                                                           276700
      IF(XBAR1.EQ.0..OR.KRS2(J,M,L1,2).NE.IBL) GO TO 72                  276800
      ERS2(J,M,L1,2)=ERS2(J,M,L1,2)-ZRSP(J)*ZRK                          276900
      PRS2(J,M,L1,2)=PRS2(J,M,L1,2)+ZRSP(J)*XRK                          277000
   72 CONTINUE                                                           277100
C                                                                        277200
   99 RETURN                                                             277300
      END                                                                277400
C                                                                        277500
C-----------------------------------------------------------------------277600
C                                                                        277700
      SUBROUTINE RAYCOR(X1,X2,E1,E2,VV,HV,TCOR)                          277800
C  IN PROGRAM  SIPB                                                      277900
C ADJUSTS COORDINATES OF BOTTOM END POINT OF RAY ENTERING OR LEAVING THE 278000
C REFRACTING HORIZON SO THAT TOTAL TIME OF COMPUTER-TRACED RAY AGREES    278100
C WITH TOTAL OBSERVED TIME.                                              278200
C                                                                        278300
      DX=X1-X2                                                           278400
      DE=E1-E2                                                           278500
      DENOM=SQRT (DX**2+DE**2)/VV-ABS (DX)/HV                            278600
      IF (DENOM.LT.0.1) DENOM=0.1                                        278700
      FCTR=TCOR/DENOM                                                    278800
      X2=X2-DX*FCTR                                                      278900
      E2=E2-DE*FCTR                                                      279000
    5 RETURN                                                             279100
      END                                                                279200
C                                                                        279300
C-----------------------------------------------------------------------279400
C                                                                        279500
      SUBROUTINE FILLIN(L)                                               279600
      COMMON IBL                                                         279700
      COMMON/BLK1/NM,NJ,NK                                               279800
     2       /BLK2/XG,ERP,SLOPE,IDIP                                     279900
     4       /BLK4/VVA,VHA                                               280000
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                    280100
     6       /BLK6/TRP,JJOFF                                             280200
     7       /BLK7/JA,JB,TRS,ERS,XSP,ESP,LS                              280300
     8       /BLK8/PRG,EPG,KRG,PRS2,ERS2,KRS2,ZRSP,ZRG                   280400
     9       /BLK9/EG,ES                                                 280500
     9       /BLK10/BLIM,ITRACE,TANSG                                    280600
C  IN PROGRAM SIPB                                                       280700
C COMPUTES MISSING (ZERO) ELEV AND TIMES AT GEOS (ERP AND TRP) AND AT    280800
C SPS (ERS AND TRS) BY INTERP OR EXTRAP OF NONZERO VALUES OF ERP AND TRP 280900
C                                                                        281000
      DIMENSION KA(5),KB(5),NJ(5),NK(5),XG(25,5),EG(25,5),TRP(25,5,4),   281100
     1 ERP(25,5,4),TRS(7,5,4),ERS(7,5,4),XSP(7,5),ESP(7,5),JA(5),JB(5),  281200
     2 ES(7,5),VVA(5,5),VHA(5,5),LS(7,5),PRG(25,7,5),ERG(25,7,5),        281300
     3 KRG(25,7,5),PRS2(7,5,4,2),ERS2(7,5,4,2),KRS2(7,5,4,2),IDSPR(5),   281400
     4 IDSP(7,5),KL(7,5),KR(7,5),D(25,7,5),ZRSP(7),ZRG(25,7)             281500
C                                                                        281600
C                                                                        281700
C FIRST INTERP TO FILL IN GAPS WITHIN EACH SPREAD                        281800
C                                                                        281900
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```
      DO 20 M=1,NM                                                      282000
      KN=NK(M)                                                          282100
C SEARCH FOR 1ST NONZERO VALUE                                          282200
      DO 4 K=1,KN                                                       282300
      IF (TRP(K,M,L).NE.0.0) GO TO 6                                    282400
    4 CONTINUE                                                          282500
      KA(M)=0                                                           282600
      KB(M)=0                                                           282700
      GO TO 20                                                          282800
C NONZERO VALUE FOUND -- SEARCH FOR ZERO VALUE                          282900
    6 KA(M)=K                                                           283000
      KB(M)=K                                                           283100
      K1=K+1                                                            283200
    8 IF (K1.GT.KN) GO TO 20                                            283300
      DO 10 K=K1,KN                                                     283400
      IF (TRP(K,M,L).EQ.0.0) GO TO 12                                   283500
      KB(M)=K                                                           283600
   10 CONTINUE                                                          283700
      GO TO 20                                                          283800
C ZERO VALUE FOUND -- STORE INDEX OF PRECEDING NONZERO VALUE AND SEARCH 283900
C FOR NEXT NONZERO VALUE                                                284000
   12 K11=K-1                                                           284100
      K1=K+1                                                            284200
      IF (K1.GT.KN) GO TO 20                                            284300
      DO 14 K=K1,KN                                                     284400
      IF (TRP(K,M,L).NE.0.0) GO TO 16                                   284500
   14 CONTINUE                                                          284600
      GO TO 20                                                          284700
   16 K22=K                                                             284800
      KB(M)=K                                                           284900
      K1=K11+1                                                          285000
      K2=K22-1                                                          285100
      DO 18 K=K1,K2                                                     285200
      ERP(K,M,L)=TERP(XG(K11,M),ERP(K11,M,L),XG(K22,M),ERP(K22,M,L),    285300
     1 XG(K,M))                                                         285400
      TRP(K,M,L)=TERP(XG(K11,M),TRP(K11,M,L),XG(K22,M),TRP(K22,M,L),    285500
     1 XG(K,M))                                                         285600
   18 CONTINUE                                                          285700
      K1=K22+1                                                          285800
      GO TO 8                                                           285900
   20 CONTINUE                                                          286000
C                                                                       286100
C CONNECT PTS BETWEEN SPREADS                                           286200
C                                                                       286300
      IF (NM.NE.1) GO TO 21                                             286400
      M111=1                                                            286500
      M222=1                                                            286600
      GO TO 100                                                         286700
   21 M=NM-1                                                            286800
      DO 52 M1=1,M                                                      286900
      KN1=NK(M1)                                                        287000
      M2=M1+1                                                           287100
      KN2=NK(M2)                                                        287200
      K1=KB(M1)                                                         287300
      K2=KA(M2)                                                         287400
      IF (K1.EQ.0.OR.K2.EQ.0) GO TO 52                                  287500
      IF (XG(1,M2).GE.XG(KN1,M1)) GO TO 44                              287600
C END GEOS OF THE TWO SPREADS OVERLAP                                   287700
      IF (XG(K2,M2).LT.XG(K1,M1)) GO TO 30                              287800
C END PTS WHERE ERP IS DEFINED DONT OVERLAP -- INTERPOLATE IN THIS INTVL 287900
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      K11=K1+1                                                          288000
      KK1=K1                                                            288100
      IF (K11.GT.KN1) GO TO 24                                          288200
      DO 22 K=K11,KN1                                                   288300
      IF (XG(K,M1).GT.XG(K2,M2)) GO TO 24                               288400
      ERP(K,M1,L)=TERP(XG(K1,M1),ERP(K1,M1,L),XG(K2,M2),ERP(K2,M2,L),   288500
     1 XG(K,M1))                                                        288600
      TRP(K,M1,L)=TERP(XG(K1,M1),TRP(K1,M1,L),XG(K2,M2),TRP(K2,M2,L),   288700
     1 XG(K,M1))                                                        288800
      KK1=K                                                             288900
   22 CONTINUE                                                          289000
   24 K22=K2-1                                                          289100
      KK2=K2                                                            289200
      IF (K22.LT.1) GO TO 28                                            289300
      NONE=0                                                            289400
      DO 26 K=1,K22                                                     289500
      IF (XG(K,M2).LT.XG(K1,M1)) GO TO 26                               289600
      ERP(K,M2,L)=TERP(XG(K1,M1),ERP(K1,M1,L),XG(K2,M2),ERP(K2,M2,L),   289700
     1 XG(K,M2))                                                        289800
      TRP(K,M2,L)=TERP(XG(K1,M1),TRP(K1,M1,L),XG(K2,M2),TRP(K2,M2,L),   289900
     1 XG(K,M2))                                                        290000
      IF (NONE.EQ.1) GO TO 26                                           290100
      NONE=1                                                            290200
      KK2=K                                                             290300
   26 CONTINUE                                                          290400
   28 K1=KK1                                                            290500
      KB(M1)=K1                                                         290600
      K2=KK2                                                            290700
      KA(M2)=K2                                                         290800
C NOW THE END PTS DO OVERLAP                                            290900
C FIRST FILL IN SPREAD M1 GOING TO THE RIGHT                            291000
      K22=KB(M2)-1                                                      291100
   30 K11=K1+1                                                          291200
      IF (K11.GT.KN1.OR.K22.LT.1) GO TO 37                              291300
      DO 36 K=K11,KN1                                                   291400
      DO 32 KK=K2,K22                                                   291500
      IF (XG(K,M1).GE.XG(KK,M2).AND.XG(K,M1).LE.XG(KK+1,M2)) GO TO 34   291600
   32 CONTINUE                                                          291700
      GO TO 36                                                          291800
   34 IF (TRP(KK,M2,L).EQ.0.0.OR.TRP(KK+1,M2,L).EQ.0.0) GO TO 36        291900
      ERP(K,M1,L)=TERP(XG(KK,M2),ERP(KK,M2,L),XG(KK+1,M2),ERP(KK+1,M2,L) 292000
     1,XG(K,M1))                                                        292100
      TRP(K,M1,L)=TERP(XG(KK,M2),TRP(KK,M2,L),XG(KK+1,M2),TRP(KK+1,M2,L) 292200
     1,XG(K,M1))                                                        292300
      KB(M1)=K                                                          292400
   36 CONTINUE                                                          292500
C THEN FILL IN SPREAD M2 GOING TO THE LEFT                              292600
   37 K11=KA(M1)+1                                                      292700
      K22=K2-1                                                          292800
      IF (K11.GT.KN1) GO TO 52                                          292900
      IF (K22.LT.1) GO TO 52                                            293000
      NONE=0                                                            293100
      DO 42 K=1,K22                                                     293200
      DO 38 KK=K11,K1                                                   293300
      IF (XG(K,M2).GE.XG(KK-1,M1).AND.XG(K,M2).LE.XG(KK,M1)) GO TO 40   293400
   38 CONTINUE                                                          293500
      GO TO 42                                                          293600
   40 IF (TRP(KK-1,M1,L).EQ.0.0.OR.TRP(KK,M1,L).EQ.0.0) GO TO 42        293700
      ERP(K,M2,L)=TERP(XG(KK-1,M1),ERP(KK-1,M1,L),XG(KK,M1),ERP(KK,M1,L) 293800
     1,XG(K,M2))                                                        293900
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      TRP(K,M2,L)=TERP(XG(KK-1,M1),TRP(KK-1,M1,L),XG(KK,M1),TRP(KK,M1,L)  294000
     1,XG(K,M2))                                                          294100
      IF (NONE.NE.0) GO TO 42                                             294200
      NONE=1                                                              294300
      KA(M2)=K                                                            294400
   42 CONTINUE                                                            294500
      GO TO 52                                                            294600
C                                                                         294700
C END GEOS DONT OVERLAP -- INTERPOLATE BETWEEN NONZERO END PTS            294800
C FIRST GO RIGHT ON SPREAD M1                                             294900
   44 K11=K1+1                                                            295000
      IF (K11.GT.KN1) GO TO 48                                            295100
      DO 46 K=K11,KN1                                                     295200
      ERP(K,M1,L)=TERP(XG(K1,M1),ERP(K1,M1,L),XG(K2,M2),ERP(K2,M2,L),     295300
     1 XG(K,M1))                                                          295400
      TRP(K,M1,L)=TERP(XG(K1,M1),TRP(K1,M1,L),XG(K2,M2),TRP(K2,M2,L),     295500
     1 XG(K,M1))                                                          295600
   46 CONTINUE                                                            295700
      KB(M1)=KN1                                                          295800
C THEN GO LEFT ON SPREAD M2                                               295900
   48 K22=K2-1                                                            296000
      IF (K22.LT.1) GO TO 52                                              296100
      DO 50 K=1,K22                                                       296200
      ERP(K,M2,L)=TERP(XG(K1,M1),ERP(K1,M1,L),XG(K2,M2),ERP(K2,M2,L),     296300
     1 XG(K,M2))                                                          296400
      TRP(K,M2,L)=TERP(XG(K1,M1),TRP(K1,M1,L),XG(K2,M2),TRP(K2,M2,L),     296500
     1 XG(K,M2))                                                          296600
   50 CONTINUE                                                            296700
      KA(M2)=1                                                            296800
   52 CONTINUE                                                            296900
C                                                                         297000
C FILL IN INTERMEDIATE SPREADS WITH NO DEPTH PTS DEFINED                  297100
C                                                                         297200
      DO 54 M1=1,NM                                                       297300
      IF (KA(M1).NE.0) GO TO 58                                           297400
   54 CONTINUE                                                            297500
      PRINT 56, L                                                         297600
   56 FORMAT (/1X,30HNO DEPTH PTS DEFINED FOR LAYER,I2,                   297700
     1 17H.  QUIT IN FILLIN)                                              297800
      L=0                                                                 297900
      GO TO 200                                                           298000
   58 M111=M1                                                             298100
   60 M11=M1+1                                                            298200
      IF (M11.GE.NM) GO TO 80                                             298300
      DO 62 MM=M11,NM                                                     298400
      IF (KA(MM).EQ.0) GO TO 64                                           298500
      M1=MM                                                               298600
   62 CONTINUE                                                            298700
C NO SUCH SPREADS OCCUR                                                   298800
      GO TO 80                                                            298900
   64 MM=MM+1                                                             299000
      DO 66 M2=MM,NM                                                      299100
      IF (KA(M2).NE.0) GO TO 68                                           299200
   66 CONTINUE                                                            299300
      GO TO 80                                                            299400
C SUCH A SPREAD DOES OCCUR                                                299500
   68 K1=KB(M1)                                                           299600
      K2=KA(M2)                                                           299700
      M11=M1+1                                                            299800
      M22=M2-1                                                            299900
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      DO 72 MM=M11,M22                                                  300000
      KN=NK(MM)                                                         300100
      DO 70 K=1,KN                                                      300200
      ERP(K,MM,L)=TERP(XG(K1,M1),ERP(K1,M1,L),XG(K2,M2),ERP(K2,M2,L),   300300
     1 XG(K,MM))                                                        300400
      TRP(K,MM,L)=TERP(XG(K1,M1),TRP(K1,M1,L),XG(K2,M2),TRP(K2,M2,L),   300500
     1 XG(K,MM))                                                        300600
   70 CONTINUE                                                          300700
      KA(MM)=1                                                          300800
      KB(MM)=KN                                                         300900
   72 CONTINUE                                                          301000
      M1=M2                                                             301100
      GO TO 60                                                          301200
C                                                                       301300
C FILL IN INTERMEDIATE SPREADS WITH ONLY ONE DEPTH PT DEFINED           301400
C                                                                       301500
   80 DO 88 M=M111,NM                                                   301600
      KN=NK(M)                                                          301700
      IF (KA(M).EQ.0) GO TO 90                                          301800
      KK=KA(M)                                                          301900
      IF (KK.NE.KB(M)) GO TO 88                                         302000
      IF (M.EQ.M111) GO TO 84                                           302100
C DO TO THE LEFT OF PT                                                  302200
      M1=M-1                                                            302300
      K1=KB(M1)                                                         302400
      K2=KK-1                                                           302500
      IF (K2.LT.1) GO TO 84                                             302600
      DO 82 K=1,K2                                                      302700
      ERP(K,M,L)=TERP(XG(K1,M1),ERP(K1,M1,L),XG(KK,M),ERP(KK,M,L),      302800
     1 XG(K,M))                                                         302900
      TRP(K,M,L)=TERP(XG(K1,M1),TRP(K1,M1,L),XG(KK,M),TRP(KK,M,L),      303000
     1 XG(K,M))                                                         303100
   82 CONTINUE                                                          303200
      KA(M)=1                                                           303300
C DO TO THE RIGHT OF PT                                                 303400
   84 M2=M+1                                                            303500
      IF (M2.GT.NM) GO TO 88                                            303600
      IF (KA(M2).EQ.0) GO TO 92                                         303700
      K1=KK+1                                                           303800
      IF (K1.GT.KN) GO TO 88                                            303900
      K2=KA(M2)                                                         304000
      DO 86 K=K1,KN                                                     304100
      ERP(K,M,L)=TERP(XG(KK,M),ERP(KK,M,L),XG(K2,M2),ERP(K2,M2,L),      304200
     1 XG(K,M))                                                         304300
      TRP(K,M,L)=TERP(XG(KK,M),TRP(KK,M,L),XG(K2,M2),TRP(K2,M2,L),      304400
     1 XG(K,M))                                                         304500
   86 CONTINUE                                                          304600
      KB(M)=KN                                                          304700
   88 CONTINUE                                                          304800
      M222=NM                                                           304900
      GO TO 100                                                         305000
   90 M=M-1                                                             305100
   92 M222=M                                                            305200
C                                                                       305300
C EXTRAPOLATE END GEOS AND END SPREADS                                  305400
C                                                                       305500
C  LEFT OF SPREAD                                                       305600
C                                                                       305700
  100 KMID=(KB(M111)-KA(M111))/2                                        305800
      IF(KMID-KA(M111).LT.5) KMID=KA(M111)+5                            305900
```

```
      IF(KMID.GT.KB(M111)) KMID=KB(M111)                                306000
      CALL DIP(L,M111,KA(M111),KMID,KA(M111),A1,B1)                     306100
      K1=KA(M111)-1                                                     306200
      IF (K1.LT.1) GO TO 102                                            306300
      CALL EXTRP(L,M111,1,K1,A1,B1,VVA(M111,L))                         306400
  102 IF (M111.EQ.1) GO TO 106                                          306500
      M11=M111-1                                                        306600
      DO 104 M=1,M11                                                    306700
      MCALL=M                                                           306800
      CALL EXTRP(L,MCALL,1,NK(M),A1,B1,VVA(M,L))                        306900
  104 CONTINUE                                                          307000
C                                                                       307100
C RIGHT OF SPREAD                                                       307200
C                                                                       307300
  106 KMID=(KB(M222)-KA(M222))/2+1                                      307400
      IF(KB(M222)-KMID.LT.5) KMID=KB(M222)-5                            307500
      IF(KMID.LT.KA(M222)) KMID=KA(M222)                                307600
      CALL DIP(L,M222,KMID,KB(M222),KB(M222),A2,B2)                     307700
      KN=NK(M222)                                                       307800
      K2=KB(M222)+1                                                     307900
      IF (K2.GT.KN) GO TO 108                                           308000
      CALL EXTRP(L,M222,K2,KN,A2,B2,VVA(M222,L))                        308100
  108 IF (M222.EQ.NM) GO TO 112                                         308200
      M22=M222+1                                                        308300
      DO 110 M=M22,NM                                                   308400
      MCALL=M                                                           308500
      CALL EXTRP(L,MCALL,1,NK(M),A2,B2,VVA(M,L))                        308600
  110 CONTINUE                                                          308700
C                                                                       308800
C INTERP-EXTRAP ELEV AND TIME AT SPS AND PREVENT CRISS-CROSS OF LAYERS  308900
C                                                                       309000
  112 DO 160 M=1,NM                                                     309100
      IF (JJOFF.EQ.0) GO TO 113                                         309200
      J1=1                                                              309300
      J2=NJ(M)                                                          309400
      GO TO 116                                                         309500
  113 J1=JA(M)                                                          309600
      J2=JB(M)                                                          309700
  116 KN=NK(M)                                                          309800
      DO 146 J=J1,J2                                                    309900
      MM=M                                                              310000
      KNM=NK(M)                                                         310100
      IF (TRS(J,M,L).NE.0.0) GO TO 142                                  310200
      IF (XSP(J,M).GE.XG(1,MM)) GO TO 118                               310300
  117 IF (MM.EQ.1) GO TO 136                                            310400
      MM=MM-1                                                           310500
      KNM=NK(MM)                                                        310600
      IF (XSP(J,M).LT.XG(1,MM)) GO TO 117                               310700
      GO TO 122                                                         310800
  118 IF (XSP(J,M).LE.XG(KNM,MM)) GO TO 122                             310900
  119 IF (MM.EQ.NM) GO TO 138                                           311000
      MM=MM+1                                                           311100
      KNM=NK(MM)                                                        311200
      IF (XSP(J,M).GT.XG(KNM,MM)) GO TO 119                             311300
C                                                                       311400
  122 IF (XG(2,MM).GE.XSP(J,M)) GO TO 128                               311500
      IF (XG(KNM-1,MM).LE.XSP(J,M)) GO TO 126                           311600
      DO 124 K=2,KNM                                                    311700
      IF (XG(K,MM).GE.XSP(J,M)) GO TO 134                               311800
  124 CONTINUE                                                          311900
```

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C                                                                       312000
  126 K1=KNM-1                                                          312100
      X1=XG(K1,MM)                                                      312200
      E1=ERP(K1,MM,L)                                                   312300
      X2=XG(KNM,MM)                                                     312400
      E2=ERP(KNM,MM,L)                                                  312500
      GO TO 140                                                         312600
C                                                                       312700
  128 X1=XG(1,MM)                                                       312800
      E1=ERP(1,MM,L)                                                    312900
      X2=XG(2,MM)                                                       313000
      E2=ERP(2,MM,L)                                                    313100
      GO TO 140                                                         313200
C                                                                       313300
  134 K1=K-1                                                            313400
      X1=XG(K1,MM)                                                      313500
      E1=ERP(K1,MM,L)                                                   313600
      X2=XG(K,MM)                                                       313700
      E2=ERP(K,MM,L)                                                    313800
      GO TO 140                                                         313900
C                                                                       314000
C CASE WHERE MM=1                                                       314100
C                                                                       314200
  136 KMID=KNM/2                                                        314300
      IF(KMID.LT.6) KMID=6                                              314400
      IF(KMID.GT.KNM) KMID=KNM                                          314500
      CALL DIP(L,1,1,KMID,1,A1,B1)                                      314600
      IF(JJOFF.EQ.0.OR.J.GE.JA(1)) GO TO 7136                           314700
      E1=0.                                                             314800
      JJ2=J-1                                                           314900
      IF(JJ2.LT.1) GO TO 2136                                           315000
      DO 1136 JJ=1,JJ2                                                  315100
      JR=JJ2-JJ+1                                                       315200
      IF(ERS2(JR,1,L,1).EQ.0) GO TO 1136                                315300
      X1=PRS2(JR,1,L,1)                                                 315400
      E1=ERS2(JR,1,L,1)                                                 315500
      GO TO 2136                                                        315600
 1136 CONTINUE                                                          315700
 2136 JJ1=J                                                             315800
      JJ2=JA(1)-1                                                       315900
 3136 DO 4136 JJ=JJ1,JJ2                                                316000
      IF(ERS2(JJ,1,L,1).EQ.0.) GO TO 4136                               316100
      X2=PRS2(JJ,1,L,1)                                                 316200
      E2=ERS2(JJ,1,L,1)                                                 316300
      JLAST=JJ                                                          316400
      GO TO 6136                                                        316500
 4136 CONTINUE                                                          316600
      IF(E1.EQ.0.) GO TO 7136                                           316700
 5136 X2=XG(1,1)                                                        316800
      E2=ERP(1,1,L)                                                     316900
      GO TO 140                                                         317000
 6136 IF(E1.NE.0) GO TO 140                                             317100
      X1=X2                                                             317200
      E1=E2                                                             317300
      JJ1=JLAST+1                                                       317400
      IF(JJ1.LE.JJ2) GO TO 3136                                         317500
      GO TO 5136                                                        317600
 7136 ERS(J,M,L)=ERP(1,MM,L)-B1*(XG(1,MM)-XSP(J,M))                     317700
      GO TO 142                                                         317800
C                                                                       317900
```

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C CASE WHERE MM=NM                                                      318000
C                                                                       318100
  138 KMID=KNM/2+1                                                      318200
      IF(KNM-KMID.LT.5) KMID=KNM-5                                      318300
      IF(KMID.LT.1) KMID=1                                              318400
      CALL DIP(L,NM,KMID,KNM,KNM,A2,B2)                                 318500
      IF(JJOFF.EQ.0.OR.J.LE.JB(NM)) GO TO 7138                          318600
      E2=0.                                                             318700
      JN=NJ(NM)                                                         318800
      JJ1=J+1                                                           318900
      IF(JJ1.GT.JN) GO TO 2138                                          319000
      DO 1138 JJ=JJ1,JN                                                 319100
      IF(ERS2(JJ,NM,L,2).EQ.0.) GO TO 1138                              319200
      X2=PRS2(JJ,NM,L,2)                                                319300
      E2=ERS2(JJ,NM,L,2)                                                319400
      GO TO 2138                                                        319500
 1138 CONTINUE                                                          319600
 2138 JJ2=J                                                             319700
      JJ1=JB(NM)+1                                                      319800
 3138 DO 4138 JJ=JJ1,JJ2                                                319900
      JR=JJ2-JJ+JJ1                                                     320000
      IF(ERS2(JR,NM,L,2).EQ.0.) GO TO 4138                              320100
      X1=PRS2(JR,NM,L,2)                                                320200
      E1=ERS2(JR,NM,L,2)                                                320300
      JLAST=JR                                                          320400
      GO TO 6138                                                        320500
 4138 CONTINUE                                                          320600
      IF(E2.EQ.0.) GO TO 7138                                           320700
 5138 X1=XG(KNM,NM)                                                     320800
      E1=ERP(KNM,NM,L)                                                  320900
      GO TO 140                                                         321000
 6138 IF(E2.NE.0.) GO TO 140                                            321100
      X2=X1                                                             321200
      E2=E1                                                             321300
      JJ2=JLAST-1                                                       321400
      IF(JJ1.LE.JJ2) GO TO 3138                                         321500
      GO TO 5138                                                        321600
 7138 ERS(J,M,L)=ERP(KNM,MM,L)+B2*(XSP(J,M)-XG(KNM,MM))                 321700
      GO TO 142                                                         321800
C                                                                       321900
  140 ERS(J,M,L)=TERP(X1,E1,X2,E2,XSP(J,M))                             322000
C                                                                       322100
  142 IF (L.EQ.1) GO TO 144                                             322200
      IF (ERS(J,M,L).LE.ERS(J,M,L-1)) GO TO 143                         322300
      ERS(J,M,L)=ERS(J,M,L-1)-.00001                                    322400
      TRS(J,M,L)=0.00001                                                322500
      GO TO 146                                                         322600
  143 TRS(J,M,L)=(ERS(J,M,L-1)-ERS(J,M,L))/VVA(M,L)                     322700
      GO TO 146                                                         322800
  144 IF (ERS(J,M,L).LE.ES(J,M)) GO TO 145                              322900
      LS(J,M)=2                                                         323000
      TRS(J,M,L)=0.00001                                                323100
      IF (ERS(J,M,L).GT.ESP(J,M)) ERS(J,M,L)=ESP(J,M)-.00001            323200
      GO TO 146                                                         323300
  145 TRS(J,M,L)=(ES(J,M)-ERS(J,M,1))/VVA(M,L)                          323400
C                                                                       323500
  146 CONTINUE                                                          323600
C                                                                       323700
      IF (L.EQ.1) GO TO 150                                             323800
      DO 148 K=1,KN                                                     323900
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      IF (ERP(K,M,L-1)-ERP(K,M,L).GE.0.00001) GO TO 148                 324000
      ERP(K,M,L)=ERP(K,M,L-1)-0.00001                                   324100
      TRP(K,M,L)=0.00001                                                324200
  148 CONTINUE                                                          324300
      GO TO 160                                                         324400
C                                                                       324500
  150 DO 152 K=1,KN                                                     324600
      IF (EG(K,M)-ERP(K,M,L).GE.0.00001) GO TO 152                      324700
      TRP(K,M,L)=0.00001                                                324800
      ERP(K,M,L)=EG(K,M)-0.00001                                        324900
  152 CONTINUE                                                          325000
C                                                                       325100
  160 CONTINUE                                                          325200
C                                                                       325300
  200 IF(ITRACE.EQ.0) GO TO 300                                         325400
      DO 260 M=1,NM                                                     325500
      KN=NK(M)                                                          325600
      L2=L+1                                                            325700
      IF(JJOFF.NE.0) GO TO 206                                          325800
      J1=JA(M)                                                          325900
      J2=JB(M)                                                          326000
      GO TO 208                                                         326100
  206 J1=1                                                              326200
      J2=NJ(M)                                                          326300
  208 PRINT 210, L2,IDSPR(M)                                            326400
  210 FORMAT(/' OUTPUT OF SUBR FILLIN FOR LAYER',I2,'  SPREAD ',A1)     326500
      DO 230 J=J1,J2                                                    326600
      PRINT 220, IDSP(J,M),XSP(J,M),ESP(J,M),ERS(J,M,L),TRS(J,M,L)      326700
  220 FORMAT('  SP=',1X,A1,'  XSP=',F8.1,'  ESP=',F8.1,'  ERS=',F12.4,  326800
     1'  TRS=',F12.4)                                                   326900
  230 CONTINUE                                                          327000
      DO 250 K=1,KN                                                     327100
      PRINT 240, K,XG(K,M),EG(K,M),ERP(K,M,L),TRP(K,M,L)                327200
  240 FORMAT('  K=',I2,'   XG=',F8.1,'   EG=',F8.1,'  ERP=',F12.4,      327300
     1'  TRP=',F12.4)                                                   327400
  250 CONTINUE                                                          327500
  260 CONTINUE                                                          327600
  300 RETURN                                                            327700
      END                                                               327800
C                                                                       327900
C-----------------------------------------------------------------------328000
C                                                                       328100
      SUBROUTINE PLOT(IGOTO)                                            328200
C  IN PROGRAM  SIPB                                                     328300
C PLOTS T-D GRAPH (IGOTO=1) OR DEPTH GRAPH (IGOTO=2)                    328400
C                                                                       328500
      COMMON IBL,IQUES,IP,IT,ICOLN,IPLUS,ISQ,IDASH,IS,IAST,IDEE,IL,NL,  328600
     1LN,P,TSCALE,XSCALE,XSCO2,ESCALE,XLIM1,XLIM2,IPLOT,IDENT           328700
      COMMON/BLK0/LG                                                    328800
     1       /BLK1/NM,NJ,NK                                             328900
     2       /BLK2/XG,ERP,SLOPE,IDIP                                    329000
     3       /BLK3/TA,TR,DSG                                            329100
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                   329200
     6       /BLK6/TRP,JJOFF                                            329300
     7       /BLK7/JA,JB,TRS,ERS,XSP,ESP,LS                             329400
     8       /BLK8/PRG,ERG,KRG,PRS2,ERS2,KRS2,ZRSP,ZRG                  329500
     9       /BLK9/EG,ES                                                329600
C                                                                       329700
C COMMON ARRAYS                                                         329800
C                                                                       329900
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      DIMENSION IDENT(16),IL(5),IDSPR(5),JA(5),JB(5),NJ(5),NK(5),          330000
     1 XSP(7,5),ESP(7,5),ES(7,5),IDSP(7,5),KL(7,5),KR(7,5),IP(103),        330100
     2 IT(53),ERS(7,5,4),PRS2(7,5,4,2),ERS2(7,5,4,2),KRS2(7,5,4,2),        330200
     3 XG(25,5),EG(25,5),P(25,7,5),TA(25,7,5),LG(25,7,5), DSG(25),         330300
     4 PRG(25,7,5),ERG(25,7,5),KRG(25,7,5),ERP(25,5,4),D(25,7,5),          330400
     5 TRS(7,5,4),TRP(25,5,4),LS(7,5),TR(25,7,5),ZRSP(7),ZRG(25,7)         330500
C                                                                         330600
C INTERNAL ARRAYS                                                         330700
C                                                                         330800
      DIMENSION LB(11),PRGALL(875),ERGALL(875),ISYMBL(875),               330900
     1 PRSALL(280),ERSALL(280),JSYMBL(280) ,                              331000
     1 ENEXT(4),ELAST(4),ERITE(4),                                        331100
     2 JPTR(5),KPTR(5),                                                   331200
     4 KJPT(7,5)                                                          331300
       DATA BIG/9999999./                                                 331400
C                                                                         331500
C                                                                         331600
      GO TO (500,3000),IGOTO                                              331700
C                                                                         331800
C T-D PLOT ROUTINE                                                        331900
C                                                                         332000
  500 LBINC=IFIX (10.0*TSCALE)                                            332100
C                                                                         332200
C MAIN T-D GRAPH PLOT LOOP                                                332300
C                                                                         332400
      LB(1)=0                                                             332500
      DO 510 I=2,11                                                       332600
      LB(I)=LB(I-1)+LBINC                                                 332700
  510 CONTINUE                                                            332800
      PRINT 57, IDENT                                                     332900
   57 FORMAT (1H1,16A5)                                                   333000
      GO TO (515,520,525,530),IPLOT                                       333100
  515 PRINT 516                                                           333200
  516 FORMAT (1H0,' S',20X,'TIME-DISTANCE PLOT  --  RAW DATA WITH NO'     333300
     1,' CORRECTIONS APPLIED')                                            333400
      GO TO 540                                                           333500
  520 PRINT 521                                                           333600
  521 FORMAT (1H0,' S',20X,'TIME-DISTANCE PLOT  --  TIMES CORRECTED TO'   333700
     1,' DATUM ELEVATION')                                                333800
      GO TO 540                                                           333900
  525 PRINT 526                                                           334000
  526 FORMAT('0 S',20X,'TIME-DISTANCE PLOT -- PRE-DEPTH VALUES WITH'      334100
     1,' TIE CORR IF JJOFF=0')                                            334200
      GO TO 540                                                           334300
  530 PRINT 531                                                           334400
  531 FORMAT (1H0,2H S,40X,39HTIME-DISTANCE PLOT  --  LAYER 1 REMOVED)    334500
  540 PRINT 541                                                           334600
  541 FORMAT (1H ,5H P  G,62X,50X,1HD/1H ,8H R  E  S,59X,50X,1HI/1H ,     334700
     1 8H E  O  P,59X,50X,1HS/1H ,2H A,62X,53X,1HT/1H ,2H D,40X,          334800
     238HT I M E    ( M I L L I S E C O N D S ))                          334900
      PRINT 584, (LB(I),I=1,11)                                           335000
  584 FORMAT (1H ,11I10)                                                  335100
      PRINT 585                                                           335200
  585 FORMAT (1H ,9X,1H+,10(10H---------+))                               335300
C                                                                         335400
C INITIALIZE POINTERS AND XLIM                                            335500
C   JPTR(M) FOR SP LABELS                                                 335600
C   KPTR(M) FOR GEO LABELS                                                335700
C   KJPT(J,M) FOR ARRIVAL TIMES                                           335800
C                                                                         335900
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      DO 595 M=1,NM                                                     336000
      KPTR(M)=1                                                         336100
      IF (M.EQ.1.OR.JJOFF.EQ.0) GO TO 586                               336200
      J=1                                                               336300
      GO TO 587                                                         336400
  586 J=JA(M)                                                           336500
  587 IF (XSP(J,M).GE.(XLIM1-XSCALE)) GO TO 588                         336600
      J=J+1                                                             336700
      IF (J.LE.NJ(M)) GO TO 587                                         336800
      J=NJ(M)                                                           336900
  588 JPTR(M)=J                                                         337000
      JN=NJ(M)                                                          337100
      DO 590 J=1,JN                                                     337200
      KJPT(J,M)=1                                                       337300
  590 CONTINUE                                                          337400
  595 CONTINUE                                                          337500
      XLIM=XLIM1                                                        337600
      XMIN=XLIM1-XSCALE                                                 337700
  627 KFLAG=0                                                           337800
      LBLJ=IBL                                                          337900
      LBLM=IBL                                                          338000
      XMID=XLIM-XSC02                                                   338100
C SET TYPE FOR PRINTING LBLM (SPREAD) AND LBLJ (SP), ALSO SET KFLAG     338200
C                                                                       338300
C     KFLAG=-1 FOR M AND J LABEL                                        338400
C     KFLAG= 0 FOR NO LABEL (BLANK)                                     338500
C     KFLAG= 1 FOR M, K AND J LABEL                                     338600
C                                                                       338700
      DO 645 M=1,NM                                                     338800
      KN=NK(M)                                                          338900
      JN=NJ(M)                                                          339000
      IF (M.EQ.NM) JN=JB(NM)                                            339100
      KP=KPTR(M)                                                        339200
      IF (KP.GT.KN) GO TO 635                                           339300
      IF (XG(KP,M).GE.XLIM) GO TO 635                                   339400
      KFLAG=1                                                           339500
      LBLM=IDSPR(M)                                                     339600
      LK=KP                                                             339700
      DIST=XG(KP,M)                                                     339800
      KPTR(M)=KPTR(M)+1                                                 339900
  635 JP=JPTR(M)                                                        340000
      IF (JP.GT.JN) GO TO 645                                           340100
      IF (XSP(JP,M).GE.XLIM.OR.XSP(JP,M).LT.XMIN) GO TO 645             340200
      IF (KFLAG.EQ.1) GO TO 638                                         340300
      KFLAG=-1                                                          340400
  638 LBLM=IDSPR(M)                                                     340500
      LBLJ=IDSP(JP,M)                                                   340600
      DIST=XSP(JP,M)                                                    340700
      JPTR(M)=JPTR(M)+1                                                 340800
  645 CONTINUE                                                          340900
C                                                                       341000
C SET TYPE FOR BACKGROUND AND BORDER OF GRAPH                           341100
C                                                                       341200
      DO 650 I=1,103                                                    341300
      IP(I)=IBL                                                         341400
  650 CONTINUE                                                          341500
      DO 655 II=1,53                                                    341600
  655 IT(II)=IBL                                                        341700
      IF (KFLAG.EQ.0) GO TO 662                                         341800
      DO 660 I=2,102,10                                                 341900
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  660 IP(I)=IPLUS                                                        342000
      DO 661 II=2,52,10                                                  342100
  661 IT(II)=IPLUS                                                       342200
      GO TO 665                                                          342300
  662 IP(2)=IDASH                                                        342400
      IP(102)=IDASH                                                      342500
      IT(2)=IDASH                                                        342600
      IT(52)=IDASH                                                       342700
C                                                                        342800
C SET TYPE FOR ARRIVAL TIMES                                             342900
C                                                                        343000
  665 DO 710 M=1,NM                                                      343100
      KN=NK(M)                                                           343200
      JN=NJ(M)                                                           343300
      DO 700 J=1,JN                                                      343400
      KK=KJPT(J,M)                                                       343500
      IF (KK.GT.KN) GO TO 668                                            343600
      IF (P(KK,J,M).GE.XLIM) GO TO 666                                   343700
      I=IFIX(TA(KK,J,M)/TSCALE + 2.5)                                    343800
      II=(I-2)/2+2                                                       343900
      GO TO 677                                                          344000
  666 IF (KK.NE.1) GO TO 669                                             344100
C                                                                        344200
C PREPARE TO INTERP BETWEEN TIME=0 AT JA(M) AND TA(1,J,M)                344300
C                                                                        344400
      IF (J.NE.JA(M)) GO TO 700                                          344500
      T2=TA(1,J,M)                                                       344600
      IF (T2.EQ.0.0) GO TO 700                                           344700
      P1=XSP(J,M)                                                        344800
      P2=P(1,J,M)                                                        344900
      T1=0.0                                                             345000
      GO TO 674                                                          345100
C                                                                        345200
C PREPARE TO INTERP BETWEEN TIME=0 AT JB(M) AND TA(KN,J,M)               345300
C                                                                        345400
  668 IF (J.NE.JB(M)) GO TO 700                                          345500
      T1=TA(KN,J,M)                                                      345600
      IF (T1.EQ.0.0) GO TO 700                                           345700
      P1=P(KN,J,M)                                                       345800
      P2=XSP(J,M)                                                        345900
      T2=0.0                                                             346000
      GO TO 674                                                          346100
C                                                                        346200
C PREPARE TO INTERP FOR KK=K2=2 TO KN AND K1=K2-1 USING TA(K1,..TA(K2,.. 346300
C                                                                        346400
  669 K2=KK                                                              346500
      K1=K2-1                                                            346600
  670 T1=TA(K1,J,M)                                                      346700
      IF (T1.NE.0.0) GO TO 671                                           346800
      IF (K1.EQ.KR(J,M).OR.K1.EQ.KL(J,M)) GO TO 700                      346900
      K1=K1-1                                                            347000
      IF (K1.LT.1) GO TO 700                                             347100
      GO TO 670                                                          347200
C                                                                        347300
  671 T2=TA(K2,J,M)                                                      347400
      IF (T2.NE.0.0) GO TO 672                                           347500
      IF (K2.EQ.KR(J,M).OR.K2.EQ.KL(J,M)) GO TO 700                      347600
      K2=K2+1                                                            347700
      IF (K2.GT.KN) GO TO 700                                            347800
      GO TO 671                                                          347900
```

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C                                                                       348000
C  NONZERO PAIR OF TA FOUND -- TEST IF SP J OCCURS BETWEEN P1 AND P2    348100
C    IF SO PREPARE TO INTERP BETWEEN TIME=0 AT SP AND APPROPRIATE TA    348200
C    IF NOT PREPARE TO INTERP BETWEEN TA PAIR                           348300
  672 P1=P(K1,J,M)                                                      348400
      P2=P(K2,J,M)                                                      348500
      IF (XSP(J,M).GT.P2.OR.XSP(J,M).LT.P1) GO TO 674                   348600
      IF (XMID.LE.XSP(J,M)) GO TO 673                                   348700
      P1=XSP(J,M)                                                       348800
      T1=0.0                                                            348900
      GO TO 674                                                         349000
C                                                                       349100
  673 P2=XSP(J,M)                                                       349200
      T2=0.0                                                            349300
C                                                                       349400
C  INTERPOLATE TO COMPUTE I AND THEN SET IP(I)                          349500
C                                                                       349600
  674 IF(XMID.LT.P1.OR.XMID.GT.P2) GO TO 700                            349700
      I=IFIX (TERP(P1,T1,P2,T2,XMID)/TSCALE+2.5)                        349800
      II=(I-2)/2+2                                                      349900
      IF (I.LT.2.OR.I.GT.102) GO TO 700                                 350000
      IF (IP(I).EQ.IBL.OR.IP(I).EQ.IPLUS.OR.IP(I).EQ.IDASH) IP(I)=ICOLN 350100
      IF(IT(II).EQ.IBL.OR.IT(II).EQ.IPLUS.OR.IT(II).EQ.IDASH)           350200
     1 IT(II)=ICOLN                                                     350300
      GO TO 700                                                         350400
  677 IF (I.GT.1) GO TO 678                                             350500
      I=1                                                               350600
      II=1                                                              350700
      GO TO 684                                                         350800
  678 IF (I.LT.103) GO TO 681                                           350900
      I=103                                                             351000
      II=53                                                             351100
  684 IP(I)=ISQ                                                         351200
      IT(II)=ISQ                                                        351300
      GO TO 690                                                         351400
  681 IF(IP(I).NE.IBL.AND.IP(I).NE.IPLUS.AND.IP(I).NE.IDASH) IP(I)=ISQ  351500
      IF(IT(II).NE.IBL.AND.IT(II).NE.IPLUS.AND.IT(II).NE.IDASH)         351600
     1IT(II)=ISQ                                                        351700
  686 LGP=LG(KK,J,M)                                                    351800
      IF (LGP.EQ.0) GO TO 687                                           351900
      IF(IP(I).NE.ISQ)IP(I)=IL(LGP)                                     352000
      IF(IT(II).NE.ISQ)IT(II)=IL(LGP)                                   352100
      GO TO 690                                                         352200
  687 IF(IP(I).NE.ISQ)IP(I)=IDSP(J,M)                                   352300
      IF(IT(II).NE.ISQ)IT(II)=IDSP(J,M)                                 352400
  690 KJPT(J,M)=KJPT(J,M)+1                                             352500
  700 CONTINUE                                                          352600
  710 CONTINUE                                                          352700
C                                                                       352800
C  PRINT A LINE OF GRAPH                                                352900
C                                                                       353000
      IF (KFLAG) 725,720,730                                            353100
  720 PRINT 722, (IP(I),I=1,103)                                        353200
  722 FORMAT (1H ,8X,50A1,53A1)                                         353300
      GO TO 745                                                         353400
  725 PRINT 727, LBLM,LBLJ,(IP(I),I=1,103),DIST                         353500
  727 FORMAT (1H ,1X,A1,5X,51A1,53A1,F10.0)                             353600
      GO TO 745                                                         353700
  730 PRINT 732, LBLM,LK,LBLJ,(IP(I),I=1,103),DIST                      353800
  732 FORMAT (1H ,1X,A1,I3,2X,51A1,53A1,F10.0)                          353900
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C                                                                       354000
C  INCREMENT XLIM FOR NEXT LINE AND LOOP BACK UNLESS GRAPH IS COMPLETE  354100
C                                                                       354200
  745 IF (XLIM.GT.XLIM2) GO TO 750                                      354300
      XLIM=XLIM+XSCALE                                                  354400
      GO TO 627                                                         354500
C                                                                       354600
C  GRAPH IS COMPLETE -- PRINT BOTTOM BORDER                             354700
C                                                                       354800
  750 PRINT 585                                                         354900
      PRINT 584, (LB(I),I=1,11)                                         355000
  800 RETURN                                                            355100
C                                                                       355200
C  END OF T-D PLOT ROUTINE                                              355300
C                                                                       355400
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 355500
C                                                                       355600
C  DEPTH PLOT ROUTINE                                                   355700
C                                                                       355800
C  FIRST FIND HIGHEST SURFACE ELEV (EMAX)                               355900
C                                                                       356000
 3000 EMAX=-BIG                                                         356100
      DO 3014 M=1,NM                                                    356200
      KN=NK(M)                                                          356300
      IF (JJOFF.EQ.0) GO TO 3002                                        356400
      J1=1                                                              356500
      J2=NJ(M)                                                          356600
      GO TO 3008                                                        356700
 3002 J1=JA(1)                                                          356800
      J2=JB(M)                                                          356900
 3008 DO 3010 J=J1,J2                                                   357000
      IF (ESP(J,M).GT.EMAX) EMAX=ESP(J,M)                               357100
 3010 CONTINUE                                                          357200
      DO 3012 K=1,KN                                                    357300
      IF (EG(K,M).GT.EMAX) EMAX=EG(K,M)                                 357400
 3012 CONTINUE                                                          357500
 3014 CONTINUE                                                          357600
C                                                                       357700
C  COMPUTE ELEV SCALE LABELS LB(I) -- COMPUTE EMIN                      357800
C                                                                       357900
      LBINC=IFIX (10.0*ESCALE+0.5)                                      358000
      LMAX=LBINC*(IFIX (EMAX+ESCALE)/LBINC+1)                           358100
      LB(1)=LMAX-10*LBINC                                               358200
      EMIN=FLOAT (LB(1))                                                358300
      DO 3016 I=2,11                                                    358400
      LB(I)=LB(I-1)+LBINC                                               358500
 3016 CONTINUE                                                          358600
C                                                                       358700
C  PRINT HEADING AND LABELS                                             358800
C                                                                       358900
      PRINT 57, IDENT                                                   359000
      PRINT 3018                                                        359100
 3018 FORMAT (1H ,60X,58X,1HS/1H ,4X,1HD,60X,50X,4HG  P/1H ,4X,1HI,60X,  359200
     1 47X,7HS  E  R/1H ,4X,1HS,38X,32HE L E V A T I O N   ( F E E T ),  359300
     2 37X,7HP  O  E/1H ,4X,1HT,60X,53X,1HA/1H ,60X,58X,1HD)            359400
      PRINT 584, (LB(I),I=1,11)                                         359500
      PRINT 585                                                         359600
C                                                                       359700
C  SORT PRG(K,J,M),ERG(K,J,M) ARRAYS INTO PRGALL(KJM),ERGALL(KJM) COLUMNS 359800
C                                                                       359900
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 3024 KJM=1                                                              360000
 3030 PMIN=BIG                                                           360100
      DO 3034 M=1,NM                                                     360200
      JN=NJ(M)                                                           360300
      KN=NK(M)                                                           360400
      DO 3033 J=1,JN                                                     360500
      DO 3032 K=1,KN                                                     360600
      IF (PRG(K,J,M).GE.PMIN.OR.ERG(K,J,M).EQ.0.0) GO TO 3032            360700
      PMIN=PRG(K,J,M)                                                    360800
      K1=K                                                               360900
      J1=J                                                               361000
      M1=M                                                               361100
 3032 CONTINUE                                                           361200
 3033 CONTINUE                                                           361300
 3034 CONTINUE                                                           361400
C                                                                        361500
      IF (PMIN.EQ.BIG) GO TO 3040                                        361600
      PRGALL(KJM)=PMIN                                                   361700
      ERGALL(KJM)=ERG(K1,J1,M1)                                          361800
      ISYMBL(KJM)=KRG(K1,J1,M1)                                          361900
      IF (ISYMBL(KJM).EQ.IBL) ISYMBL(KJM)=IDSP(J1,M1)                    362000
      KJM=KJM+1                                                          362100
C                                                                        362200
      ERG(K1,J1,M1)=0.0                                                  362300
      GO TO 3030                                                         362400
C                                                                        362500
 3040 NKJM=KJM-1                                                         362600
C                                                                        362700
C SORT AND MERGE 4-D ARRAYS PRS2(J,M,L,I) AND ERS2(J,M,L,I) INTO COLUMN  362800
C ARRAYS PRSALL(JML) AND ERSALL(JML).                                    362900
C                                                                        363000
      JML=1                                                              363100
 3050 PMIN=BIG                                                           363200
      DO 3056 M=1,NM                                                     363300
      JN=NJ(M)                                                           363400
      DO 3055 J=1,JN                                                     363500
      DO 3054 L=1,LN                                                     363600
      DO 3052 LR=1,2                                                     363700
 3051 IF (PRS2(J,M,L,LR).GT.PMIN.OR.ERS2(J,M,L,LR).EQ.0.) GO TO 3052     363800
      PMIN=PRS2(J,M,L,LR)                                                363900
      J1=J                                                               364000
      M1=M                                                               364100
      L1=L                                                               364200
      I=LR                                                               364300
C                                                                        364400
 3052 CONTINUE                                                           364500
 3054 CONTINUE                                                           364600
 3055 CONTINUE                                                           364700
 3056 CONTINUE                                                           364800
C                                                                        364900
      IF (PMIN.EQ.BIG) GO TO 3070                                        365000
      PRSALL(JML)=PMIN                                                   365100
      ERSALL(JML)=ERS2(J1,M1,L1,I)                                       365200
      JSYMBL(JML)=KRS2(J1,M1,L1,I)                                       365300
      ERS2(J1,M1,L1,I)=0.0                                               365400
      IF (JSYMBL(JML).EQ.IBL) JSYMBL(JML)=IS                             365500
      JML=JML+1                                                          365600
      GO TO 3050                                                         365700
C                                                                        365800
 3070 NJML=JML-1                                                         365900
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C                                                                       366000
C SET POINTERS TO INITIAL VALUES -- JPTR(M) FOR SP  LABELS AND PLOT PTS 366100
C                                  KPTR(M) FOR GEO LABELS AND PLOT PTS  366200
C  AND INITIALIZE XLIM             JML     FOR PRSALL(JML)              366300
C  AFTER EXTENDING XLIM1 AND XLIM2 KJM     FOR PRGALL(KJM)              366400
C  TO RANGE XSP(J1,1)-XSP(J2,NM)                                        366500
C  OR PRGALL(1)-PRGALL(NKJM), WHICHEVER IS LARGER                       366600
C                                                                       366700
      KN=NK(1)                                                          366800
      DX=XG(KN,1)-XG(1,1)                                               366900
      DX3=DX+DX+DX                                                      367000
      J1=JA(1)                                                          367100
      J2=JB(NM)                                                         367200
      IF(JJOFF.EQ.0) GO TO 3071                                         367300
      J1=1                                                              367400
      J2=NJ(NM)                                                         367500
 3071 XLIM=XSP(J1,1)                                                    367600
      DO 13071 KJM=1,NKJM                                               367700
      IF(ISYMBL(KJM).NE.IQUES) GO TO 13072                              367800
13071 CONTINUE                                                          367900
      KJM=NKJM                                                          368000
13072 IF(PRGALL(KJM).LT.XLIM) XLIM=PRGALL(KJM)                          368100
      IF (XLIM.LT.XLIM1-DX3) XLIM=XLIM1-DX3                             368200
      IF (XLIM1.LE.XLIM) GO TO 3072                                     368300
      XLIM1=XLIM+XSCO2                                                  368400
 3072 XLIM=XSP(J2,NM)                                                   368500
      DO 3073 KJM=1,NKJM                                                368600
      KJMR=NKJM-KJM+1                                                   368700
      IF(ISYMBL(KJMR).NE.IQUES) GO TO 13073                             368800
 3073 CONTINUE                                                          368900
      KJMR=1                                                            369000
13073 IF(PRGALL(KJMR).GT.XLIM) XLIM=PRGALL(KJMR)                        369100
      IF (XLIM.GT.XLIM2+DX3) XLIM=XLIM2+DX3                             369200
      IF (XLIM2.LT.XLIM) XLIM2=XLIM                                     369300
C                                                                       369400
 3074 DO 3080 M=1,NM                                                    369500
      KPTR(M)=1                                                         369600
      IF (JJOFF.EQ.0) GO TO 3076                                        369700
      J=1                                                               369800
      GO TO 3077                                                        369900
 3076 J=JA(M)                                                           370000
 3077 IF (XSP(J,M).GE.(XLIM1-XSCALE)) GO TO 3078                        370100
      J=J+1                                                             370200
      IF (J.LE.NJ(M)) GO TO 3077                                        370300
      J=NJ(M)                                                           370400
 3078 JPTR(M)=J                                                         370500
 3080 CONTINUE                                                          370600
      JML=1                                                             370700
      KJM=1                                                             370800
      XLIM=XLIM1                                                        370900
      XMIN=XLIM1-XSCALE                                                 371000
      XMID=XLIM-XSCO2                                                   371100
      PLAST=XLIM1                                                       371200
      PLSUR=PLAST                                                       371300
      ELSUR=ESP(1,1)                                                    371400
      IF(JJOFF.NE.0) GO TO 3084                                         371500
      JLEFT=JA(1)                                                       371600
      JRITE=JB(NM)                                                      371700
      GO TO 3086                                                        371800
 3084 JLEFT=1                                                           371900
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      JRITE=NJ(NM)                                                      372000
 3086 PJB=XSP(JRITE,NM)                                                 372100
      B1=SLOPE                                                          372200
      B2=SLOPE                                                          372300
      DO 3090 L=1,LN                                                    372400
      IF(IDIP.NE.0) GO TO 3088                                          372500
      KMID=NK(1)/2                                                      372600
      IF(KMID.LT.6) KMID=6                                              372700
      IF(KMID.GT.NK(1)) KMID=NK(1)                                      372800
      LCALL=L                                                           372900
      CALL DIP(LCALL,1,1,KMID,1,A,B1)                                   373000
      KMID=NK(NM)/2+1                                                   373100
      IF(KMID.LT.7) KMID=NK(NM)-5                                       373200
      IF(KMID.LT.1) KMID=1                                              373300
      CALL DIP(LCALL,NM,KMID,NK(NM),NK(NM),A,B2)                        373400
 3088 ELAST(L)=ERS(JLEFT,1,L)-B1*(XSP(JLEFT,1)-XLIM1)                   373500
      ERITE(L)=ERS(JRITE,NM,L)+B2*(XLIM2-PJB)                           373600
 3090 CONTINUE                                                          373700
      ELSUR=ESP(JLEFT,1)-SLOPE*(XSP(JLEFT,1)-XLIM1)                     373800
C                                                                       373900
C MAIN PLOT LOOP                                                        374000
C                                                                       374100
 3100 KFLAG=0                                                           374200
      LBLJ=IBL                                                          374300
      LBLM=IBL                                                          374400
      DO 3122 I=1,103                                                   374500
 3122 IP(I)=IBL                                                         374600
      DO 3123 I=1,53                                                    374700
 3123 IT(I)=IBL                                                         374800
      IP(2)=IDASH                                                       374900
      IP(102)=IDASH                                                     375000
      IT(2)=IDASH                                                       375100
      IT(102)=IDASH                                                     375200
C                                                                       375300
C SET TYPE FOR PRINTING SPREAD AND SP LABELS, DIST, AND PLOT PTS        375400
C                                                                       375500
C SET KFLAG=-1 FOR M AND J LABELS AND DIST                              375600
C     KFLAG= 0 FOR NO LABELS                                            375700
C     KFLAG= 1 FOR M, J AND K LABELS AND DIST                           375800
C                                                                       375900
      DO 3120 M=1,NM                                                    376000
      KN=NK(M)                                                          376100
      IF (JJOFF.EQ.0) GO TO 3101                                        376200
      JN=NJ(M)                                                          376300
      GO TO 3102                                                        376400
 3101 JN=JB(M)                                                          376500
 3102 JP=JPTR(M)                                                        376600
      IF (JP.GT.JN) GO TO 3110                                          376700
      IF (XSP(JP,M).GE.XLIM) GO TO 3110                                 376800
      IF(XSP(JP,M).LT.XMIN) GO TO 3108                                  376900
      KFLAG=-1                                                          377000
      LBLM=IDSPR(M)                                                     377100
      LBLJ=IDSP(JP,M)                                                   377200
      DIST=XSP(JP,M)                                                    377300
      DO 3103 I=2,102,10                                                377400
 3103 IP(I)=IPLUS                                                       377500
      DO 3104 I=2,52,10                                                 377600
 3104 IT(I)=IPLUS                                                       377700
      ELSUR=ESP(JP,M)                                                   377800
      PLSUR=XSP(JP,M)                                                   377900
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      CALL SETIP(ES(JP,M),EMIN,ESCALE,IAST)                              378000
      DO 3105 L=1,LN                                                     378100
      CALL SETIP(ERS(JP,M,L),EMIN,ESCALE,ICOLN)                          378200
      ELAST(L)=ERS(JP,M,L)                                               378300
 3105 CONTINUE                                                           378400
      PLAST=XSP(JP,M)                                                    378500
C                                                                        378600
 3108 JPTR(M)=JPTR(M)+1                                                  378700
      GO TO 3102                                                         378800
C                                                                        378900
 3110 KP=KPTR(M)                                                         379000
      IF (KP.GT.KN) GO TO 3120                                           379100
      IF (XG(KP,M).GE.XLIM) GO TO 3120                                   379200
      IF(XG(KP,M).LT.XMIN) GO TO 3118                                    379300
      IF (KFLAG.NE.0) GO TO 3115                                         379400
C                                                                        379500
      DIST=XG(KP,M)                                                      379600
      DO 3111 I=2,102,10                                                 379700
 3111 IF(IP(I).EQ.IBL) IP(I)=IPLUS                                       379800
      DO 3112 I=2,52,10                                                  379900
 3112 IF(IT(I).EQ.IBL) IT(I)=IPLUS                                       380000
C                                                                        380100
 3115 LK=KP                                                              380200
      LBLM=IDSPR(M)                                                      380300
      KFLAG=1                                                            380400
      E=EG(KP,M)+ESCALE                                                  380500
      CALL SETIP(E,EMIN,ESCALE,IDEE)                                     380600
      ELSUR=EG(KP,M)                                                     380700
      PLSUR=XG(KP,M)                                                     380800
      DO 3117 L=1,LN                                                     380900
      CALL SETIP(ERP(KP,M,L),EMIN,ESCALE,ICOLN)                          381000
      ELAST(L)=ERP(KP,M,L)                                               381100
 3117 CONTINUE                                                           381200
      PLAST=XG(KP,M)                                                     381300
C                                                                        381400
 3118 KPTR(M)=KPTR(M)+1                                                  381500
      GO TO 3110                                                         381600
 3120 CONTINUE                                                           381700
C                                                                        381800
 3124 IF (JML.GT.NJML) GO TO 3126                                        381900
      IF (PRSALL(JML).GE.XLIM) GO TO 3126                                382000
      CALL SETIP(ERSALL(JML),EMIN,ESCALE,JSYMBL(JML))                    382100
      JML=JML+1                                                          382200
      GO TO 3124                                                         382300
C                                                                        382400
 3126 IF (KJM.GT.NKJM) GO TO 3128                                        382500
      IF (PRGALL(KJM).GE.XLIM) GO TO 3128                                382600
      CALL SETIP(ERGALL(KJM),EMIN,ESCALE,ISYMBL(KJM))                    382700
      KJM=KJM+1                                                          382800
      GO TO 3126                                                         382900
C                                                                        383000
C INTERPOLATE TO FIND LAYER BOUNDARIES BETWEEN SPS AND GEOS              383100
C                                                                        383200
 3128 IF (KFLAG.NE.0) GO TO 3171                                         383300
      IF(XLIM.LE.PJB) GO TO 13129                                        383400
      PNEXT=XLIM2                                                        383500
      DO 13128 L=1,LN                                                    383600
13128 ENEXT(L)=ERITE(L)                                                  383700
      PNSUR=XLIM2                                                        383800
      ENSUR=ESP(JRITE,NN)+SLOPE*(XLIM2-PJB)                              383900
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      GO TO 3140                                                        384000
13129 PNEXT=BIG                                                         384100
      PNSUR=BIG                                                         384200
      KNM=NK(NM)                                                        384300
      DO 3138 M=1,NM                                                    384400
      JP=JPTR(M)                                                        384500
      KP=KPTR(M)                                                        384600
      IF (JJOFF.EQ.0) GO TO 3129                                        384700
      JN=NJ(M)                                                          384800
      GO TO 3130                                                        384900
 3129 JN=JB(M)                                                          385000
 3130 KN=NK(M)                                                          385100
      IF (JP.GT.JN.OR.KP.GT.KN) GO TO 3131                              385200
      IF (XG(KP,M).LE.XSP(JP,M)) GO TO 3132                             385300
      GO TO 3134                                                        385400
 3131 IF(KP.GT.KN.AND.JP.GT.JN) GO TO 3138                              385500
      IF(KP.GT.KN) GO TO 3134                                           385600
      IF(JP.GT.JN) GO TO 3132                                           385700
      IF(XSP(JP,M).LT.XG(KP,M)) GO TO 3134                              385800
 3132 IF (XG(KP,M).GT.PNEXT) GO TO 3138                                 385900
      PNEXT=XG(KP,M)                                                    386000
      PNSUR=PNEXT                                                       386100
      ENSUR=EG(KP,M)                                                    386200
      DO 3133 L=1,LN                                                    386300
 3133 ENEXT(L)=ERP(KP,M,L)                                              386400
      GO TO 3138                                                        386500
C                                                                       386600
 3134 IF (XSP(JP,M).GT.PNEXT.AND.XSP(JP,M).LE.XG(KNM,NM)) GO TO 3138    386700
      PNEXT=XSP(JP,M)                                                   386800
      PNSUR=PNEXT                                                       386900
      ENSUR=ESP(JP,M)                                                   387000
      DO 3135 L=1,LN                                                    387100
 3135 ENEXT(L)=ERS(JP,M,L)                                              387200
 3138 CONTINUE                                                          387300
C                                                                       387400
C                                                                       387500
 3140 I1=2+IFIX ((TERP(PLSUR,ELSUR,PNSUR,ENSUR,XMID)-EMIN)/ESCALE+0.5)  387600
      I2=(I1-2)/2+2                                                     387700
      IF (I1.LE.0) I1=1                                                 387800
      IF(I2.LE.0) I2=1                                                  387900
      IF(I2.GT.53) I2=53                                                388000
      IF (I1.GT.103) I1=103                                             388100
      IF(IT(I2).EQ.IBL) IT(I2)=ICOLN                                    388200
      IF (IP(I1).EQ.IBL) IP(I1)=ICOLN                                   388300
      DO 3169 L=1,LN                                                    388400
      I1=2+IFIX ((TERP(PLAST,ELAST(L),PNEXT,ENEXT(L),XMID)-EMIN)/ESCALE 388500
     1 +0.5)                                                            388600
      I2=(I1-2)/2+2                                                     388700
      IF (I1.LE.0) I1=1                                                 388800
      IF(I2.LE.0) I2=1                                                  388900
      IF (I1.GT.103) I1=103                                             389000
      IF(I2.GT.53) I2=53                                                389100
      IF (IP(I1).EQ.IBL) IP(I1)=ICOLN                                   389200
      IF(IT(I2).EQ.IBL) IT(I2)=ICOLN                                    389300
 3169 CONTINUE                                                          389400
C                                                                       389500
C PRINT A LINE OF GRAPH                                                 389600
C                                                                       389700
 3171 IF (KFLAG) 3172,3176,3180                                         389800
 3172 PRINT 3174, DIST,(IP(I),I=1,103),LBLJ,LBLM                        389900
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 3174 FORMAT (1H ,F8.0,50A1,53A1,1X,A1,5X,A1)                          390000
      GO TO 3200                                                       390100
 3176 PRINT 3178, (IP(I),I=1,103)                                      390200
 3178 FORMAT (1H ,8X,50A1,53A1)                                        390300
      GO TO 3200                                                       390400
 3180 PRINT 3182, DIST,(IP(I),I=1,103),LBLJ,LK,LBLM                    390500
 3182 FORMAT (1H ,F8.0,50A1,53A1,1X,A1,I3,2X,A1)                       390600
C                                                                      390700
C PREPARE TO LOOP BACK TO COMPUTE NEXT LINE, OR IF DONE PRINT BORDER    390800
C                                                                      390900
 3200 IF (XLIM.GT.XLIM2) GO TO 3210                                    391000
      XMIN=XLIM                                                        391100
      XLIM=XLIM+XSCALE                                                 391200
      XMID=XLIM-XSC02                                                  391300
      KN=NK(NM)                                                        391400
      JN=JB(NM)                                                        391500
      IF(JJOFF.NE.0) JN=NJ(NM)                                         391600
      GO TO 3100                                                       391700
C                                                                      391800
 3210 PRINT 585                                                        391900
      PRINT 584, (LB(I),I=1,11)                                        392000
      PRINT 3018                                                       392100
      RETURN                                                           392200
      END                                                              392300
C                                                                      392400
C---------------------------------------------------------------------- 392500
C                                                                      392600
      SUBROUTINE SETIP(E,EMIN,ESCALE,ISYM)                             392700
C  IN PROGRAM SIPB                                                     392800
C SETS TYPE FOR LINE OF DEPTH PT GRAPH                                 392900
C                                                                      393000
      COMMON IBL,IQUES,IP,IT,ICOLN,IPLUS,ISQ,IDASH                     393100
C                                                                      393200
      DIMENSION IP(103),IT(53)                                         393300
C                                                                      393400
      I=2+IFIX ((E-EMIN)/ESCALE+0.5)                                   393500
      II=(I-2)/2+2                                                     393600
      IF (I.GT.0) GO TO 1                                              393700
      I=1                                                              393800
      II=1                                                             393900
      GO TO 2                                                          394000
C                                                                      394100
    1 IF (I.LE.103) GO TO 2                                            394200
      I=103                                                            394300
      II=53                                                            394400
C                                                                      394500
    2 IPI=IP(I)                                                        394600
      ITI=IT(II)                                                       394700
      IF(IPI.EQ.IBL.OR.IPI.EQ.ICOLN.OR.IPI.EQ.IPLUS.OR.IPI.EQ.IDASH)   394800
     1 GO TO 4                                                         394900
      IP(I)=ISQ                                                        395000
      GO TO 6                                                          395100
    4 IP(I)=ISYM                                                       395200
    6 IF(ITI.EQ.IBL.OR.ITI.EQ.ICOLN.OR.ITI.EQ.IPLUS.OR.ITI.EQ.IDASH)   395300
     1 GO TO 8                                                         395400
      IT(II)=ISQ                                                       395500
      GO TO 10                                                         395600
    8 IT(II)=ISYM                                                      395700
   10 RETURN                                                           395800
      END                                                              395900
```

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C                                                                       396000
C-----------------------------------------------------------------------396100
C                                                                       396200
      SUBROUTINE HTIME(K,J,M,P1,E1,P2,E2,HV,TH)                         396300
C  IN PROGRAM SIPB                                                      396400
      COMMON/BLK2/XG,ERP,SLOPE,IDIP                                     396500
     5       /BLK5/IDSPR,IDSP,KL,KR,D                                   396600
     7       /BLK7/JA,JB,TRS,ERS,XSP,ESP,LS                             396700
     9       /BLK9/EG,ES                                                396800
     9       /BLK10/BLIM,ITRACE,TANSG                                   396900
C                                                                       397000
      DIMENSION XG(25,5),ERP(25,5,4),JA(5),JB(5),TRS(7,5,4),ERS(7,5,4)  397100
     1,XSP(7,5),ESP(7,5),LS(7,5),EG(25,5),ES(7,5),IDSPR(5),IDSP(7,5)    397200
     2,KL(7,5),KR(7,5),D(25,7,5)                                        397300
C                                                                       397400
      DE=E2-E1                                                          397500
      DP=P2-P1                                                          397600
      DSX=XG(K,M)-XSP(J,M)                                              397700
      DSE=EG(K,M)-ES(J,M)                                               397800
      SH=SQRT(DSX**2+DSE**2)                                            397900
      D1=D(K,J,M)                                                       398000
      DP=SIGN(DP,DSX*DP*D1)                                             398100
      IF (DSX.EQ.0..OR.DP.EQ.0.) GO TO 10                               398200
      IF (ABS(DE/DP).GT.BLIM) DE=BLIM*DP                                398300
      TH=SIGN(D1*SQRT(DP**2+DE**2)/SH,DP)/HV                            398400
      RETURN                                                            398500
  10  DH=D1-ABS(P1-XSP(J,M))-ABS(P2-XG(K,M))                            398600
      TH=SIGN(SQRT(DH**2+DE**2),DH)/HV                                  398700
      RETURN                                                            398800
      END.                                                              398900
C                                                                       399000
C-----------------------------------------------------------------------399100
C                                                                       399200
      SUBROUTINE TIE(L2,M,J,JJ,K11,K22,KT1,KT2,KN,I,JJTIE)              399300
      COMMON IBL,IQUES,IP,IT,ICOLN,IPLUS,ISQ,IDASH,IS,IAST,IDEE,IL,NL   399400
      COMMON/BLK0/LG                                                    399500
     1       /BLK3/TA,TR,DSG                                            399600
     2       /BLK4/VVA,VHA                                              399700
     3       /BLK5/IDSPR,IDSP,KL,KR,D                                   399800
C                                                                       399900
C  IN PROGRAM  SIPB                                                     400000
C MAKES TIE CORRECTION FOR OUTLYING SP JJ TO NEXT INNER SP J            400100
      DIMENSION LG(25,7,5),TA(25,7,5),DSG(25),TR(25,7,5),D(25,7,5),     400200
     1IP(103),IT(53),IL(5),IDSPR(5),IDSP(7,5),KL(7,5),KR(7,5),VVA(5,5)  400300
     2,VHA(5,5)                                                         400400
C                                                                       400500
      CALL KENDS(L2,M,J,KT1,KT2,KT11,KT22)                              400600
      IF (KT11.EQ.0) GO TO 99                                           400700
      DO 10 K=1,KN                                                      400800
   10 DSG(K)=ABS(D(K,J,M))                                              400900
      SUM1=0.                                                           401000
      PTS1=0.                                                           401100
      K1=MAXO(K11,KT11)                                                 401200
      K2=MINO(K22,KT22)                                                 401300
      IF(K2.LT.K1) GO TO 50                                             401400
C                                                                       401500
C OVERLAP BETWEEN J AND JJ ARRIVALS                                     401600
C                                                                       401700
   20 DO 30 K=K1,K2                                                     401800
      IF (LG(K,JJ,M).NE.L2) GO TO 30                                    401900
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      SUM1=SUM1+TR(K,JJ,M)-TR(K,J,M)                                    402000
      PTS1=PTS1+1.                                                      402100
   30 CONTINUE                                                          402200
      IF (PTS1.EQ.0.) GO TO 50                                          402300
      SUM1=SUM1/PTS1                                                    402400
   35 DO 40 K=K11,K22                                                   402500
      IF (LG(K,JJ,M).EQ.L2) TR(K,JJ,M)=TR(K,JJ,M)-SUM1                  402600
   40 CONTINUE                                                          402700
      IF(JJTIE.EQ.0) GO TO 60                                           402800
      IF(I.EQ.2) GO TO 44                                               403000
      KK=K22+1                                                          403100
      IF(KK.GT.KN) GO TO 99                                             403200
      DO 42 K=KK,KN                                                     403300
      IF(TR(K,JJ,M).NE.0) TR(K,JJ,M)=TR(K,JJ,M)-SUM1                    403400
   42 CONTINUE                                                          403500
      GO TO 99                                                          403600
   44 KK=K11-1                                                          403700
      IF(KK.LT.1) GO TO 99                                              403800
      DO 46 K=1,KK                                                      403900
      IF(TR(K,JJ,M).NE.0) TR(K,JJ,M)=TR(K,JJ,M)-SUM1                    404000
   46 CONTINUE                                                          404100
      GO TO 99                                                          404150
C                                                                       404200
C GAP BETWEEN J AND JJ ARRIVALS                                         404300
C                                                                       404400
   50 CALL REGRES(KT11,KT22,J,M,L2,VJ,TJ,PT,1)                          404500
      IF(PT.EQ.0.) GO TO 99                                             404600
      CALL REGRES(K11,K22,JJ,M,L2,VJJ,TJJ,PT,1)                         404700
      IF(PT.EQ.0.) GO TO 99                                             404800
      IF(I.EQ.2) GO TO 54                                               404900
      DMID=(DSG(K22)+DSG(KT11))/2                                       405000
   52 SUM1=(TJJ+TJJ+DMID/VJJ)-(TJ+TJ+DMID/VJ)                           405100
      GO TO 35                                                          405200
   54 DMID=(DSG(K11)+DSG(KT22))/2                                       405300
      GO TO 52                                                          405400
C                                                                       405500
C TIE DOWN POINTS FOR DEEPER LAYERS L2+1 THRU NL (SP JJ)                405600
C                                                                       405700
   60 LNEXT=L2+1                                                        405800
      IF(LNEXT.GT.NL) GO TO 99                                          405900
      DT1=SUM1                                                          406000
      DO 80 L=LNEXT,NL                                                  406100
      L1=L-1                                                            406200
      DT2=DT1*VHA(M,L1)/VHA(M,L)                                        406300
      DO 70 K=1,KN                                                      406400
      IF(LG(K,JJ,M).EQ.L) TR(K,JJ,M)=TR(K,JJ,M)-DT2                     406500
   70 CONTINUE                                                          406600
      DT1=DT2                                                           406700
   80 CONTINUE                                                          406800
      JJTIE=1                                                           406900
C                                                                       407000
   99 RETURN                                                            407100
      END                                                               407200
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