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P-WAVE TRAVEL TIME DELAYS FOR TELESEISMIC EVENTS RECORDED IN THE SOCORRO, NEW MEXICO, AREA

by

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ABSTRACT

Relative station residuals were calculated for 78 teleseismic events recorded in the Socorro, New Mexico area to determine if any delays could be directly associated with an extensive mid-crustal magma body and/or postulated shallow magma bodies in the upper crust.

The observed relative station residuals in the Socorro area appear to reflect effects due to (1) a mid-crustal magma body, (2) shallow intrusive magma bodies, (3) complex geologic structure (e.g. crustal thickening and deep-seated caldera structures), and/or (4) low velocity material beneath the Socorro caldera.

Relative station residuals with respect to the local stations, WT and CC, indicate delays of teleseismic arrivals that can be attributed to the mid-crustal magma body and in some cases the postulated shallow intrusives. Large standard deviations (>0.20) for the residuals at some stations may reflect rapid lateral variations in crustal properties. Residuals obtained for station LPM suggest the boundary of the mid-crustal magma body could be extended further eastward.

Late arrivals at GM and HC to the southeast and FM and DM to the southwest support the presence of low velocity material in the lower crust and upper mantle beneath the Socorro caldera.

Crustal thickening to the west will not totally explain delays seen at stations GM and HC for P-arrivals of teleseismic events from the northwest.

Event residual averages with respect to ALQ are the result of low velocity raypaths in the Socorro area or high velocity raypaths in the Albuquerque area for events from the south-southwest and northwest.

INTRODUCTION

Earthquake research, in the past few years, at New Mexico Tech has centered on the study of an extensive magma body at 19 to 20 kilometers depth beneath the Rio Grande rift at Socorro, New Mexico. Data for this study have been local microearthquakes, regional man-made events, and teleseisms recorded by a moveable array of seismographs equipped with short-period seismometers.

The research described in this paper is directly concerned with the use of teleseisms and time delays along their raypaths that may be directly linked to the deep magma body, the possible nearby shallow intrusives, or other features of the complex crustal structure in the area.

Three previous studies are closely associated with the subject of this paper. Rinehart et al. (1979), using S to P reflections and S to S reflections, were able to locate reflection points and accurately map the southern boundary of an extensive magma body in the Socorro area (see Figure 1). Additional control on the east-west extent of the deep intrusive was provided by the Consortium for Continental Reflection Profiling (COCORP) using P-wave reflection data. The COCORP profiles relating to the deep magma body and geologic structures in the Rio Grande rift near Socorro are reviewed by Brown et al. (1979). Figure 1 shows the location of the COCORP reflection lines.

Yousef (1977), using P_n arrivals of mining explosions from the southwest, found a systematic delay of relative

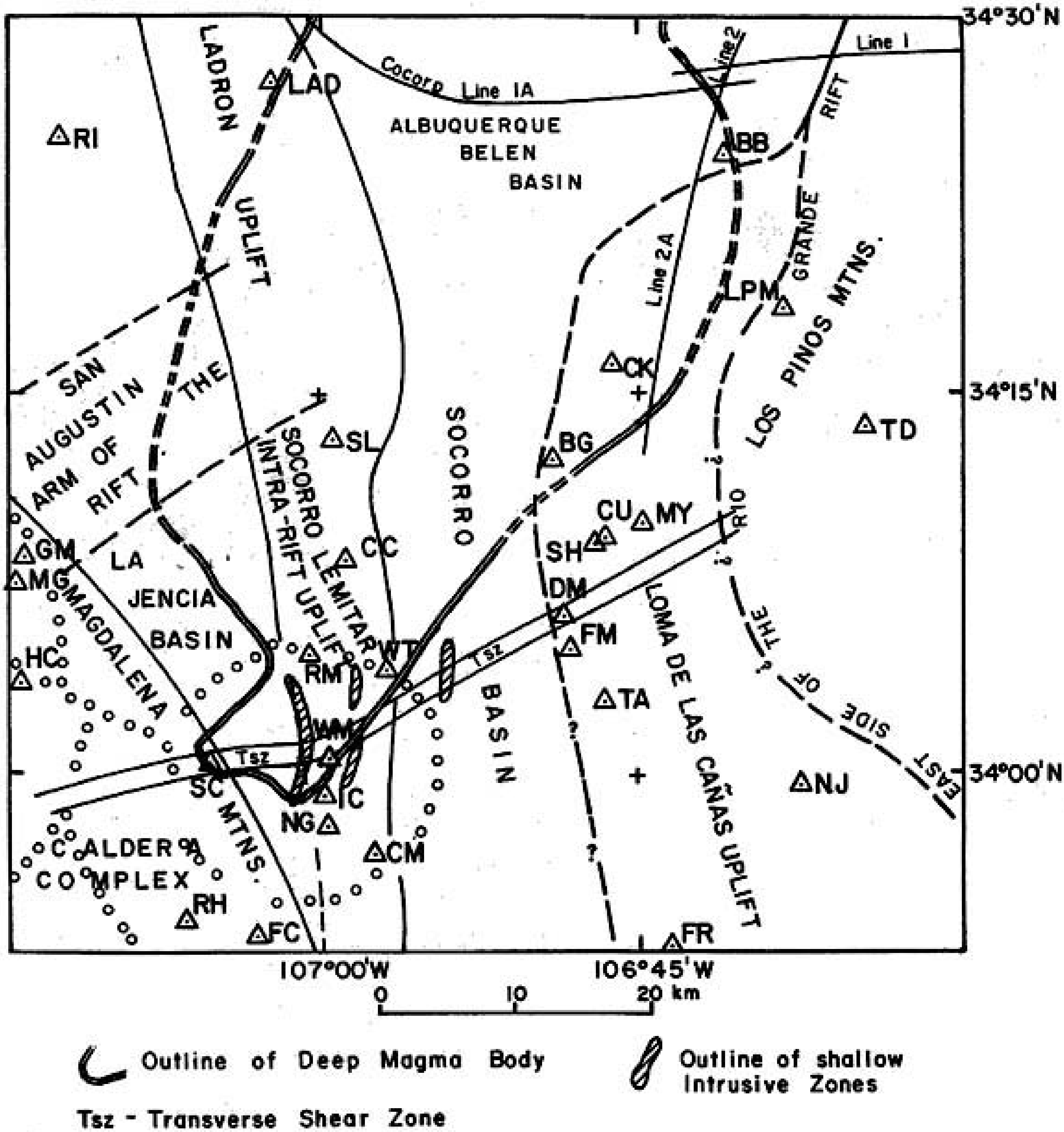


Figure 1. Seismic stations relative to local structural provinces.

travel-time residuals from the southwest to northeast (see Figure 2). He suggested a possible explanation for this delay was passage of the P_n waves to northeast stations through an extensive magma body.

Fischer (1977), using P-wave arrival times of teleseisms to determine their potential to study the crust in the Socorro area, concluded that azimuthal variation of residuals possibly reflected structures deep in the crust or upper mantle. Note that Fischer did not apply station corrections to his data. Upon making this correction Rinehart et al. (1979) showed that the delay that could be attributed to the deep magma body was not greater than 0.1 to 0.2 second. In addition, analysis of refraction data presented by Toppozada and Sanford (1976) did not support delays of P_n arrivals through the magma layer of much greater than 0.1 second.

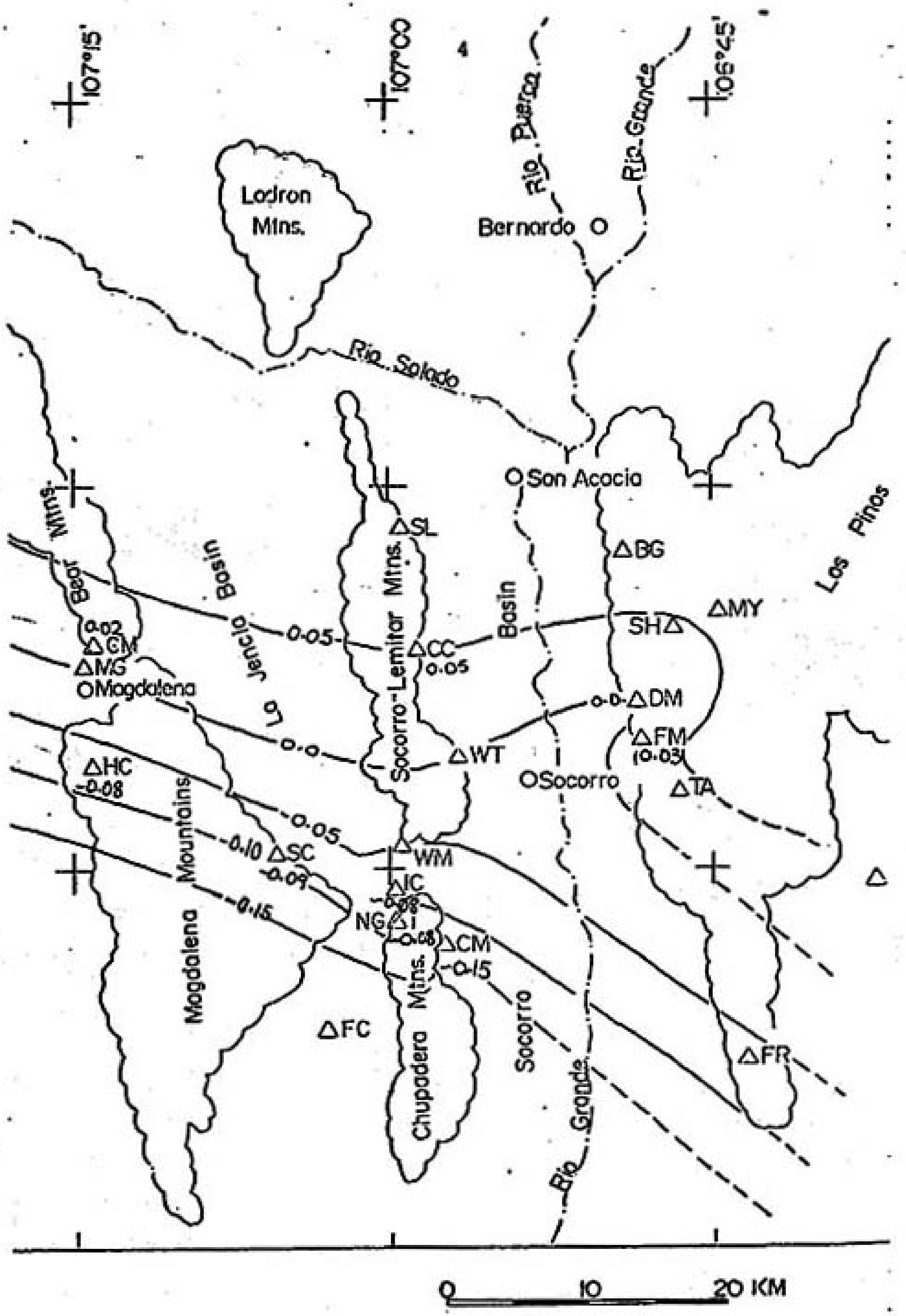


Figure 2. Residual map for P_N arrivals for mining explosions from the southwest (Yousef, 1977).

GEOLOGIC SETTING

The study area, shown in Figure 3, lies within the Rio Grande rift approximately 120 kilometers south-southwest of Albuquerque. Figure 4 shows the 29 seismic stations in the study area and their relation to the local physiographic provinces.

Since many good reviews have been written about the geologic and geophysical characteristics of the Rio Grande rift (Chapin, 1971; Chapin and Seager, 1975; Cordell, 1978) I will only briefly mention a few relevant structural characteristics of the study area.

The overlapping caldera complex in the lower left of Figure 1 is believed to have accompanied the formation of the rift in the three periods of magmatism (Chapin et al., 1978). Through this caldera complex passes a deeply penetrating transverse shear zone (see Figure 1), that is transected by the Rio Grande rift. For geological documentation of the shear zone and a map showing other major lineaments, the reader is referred to Chapin et al. (1978). Also a volume entitled Rio Grande Rift: Tectonics and Magmatism (Reicker (ed.), 1979) presents the latest geological and geophysical information related to the rift and its formation.

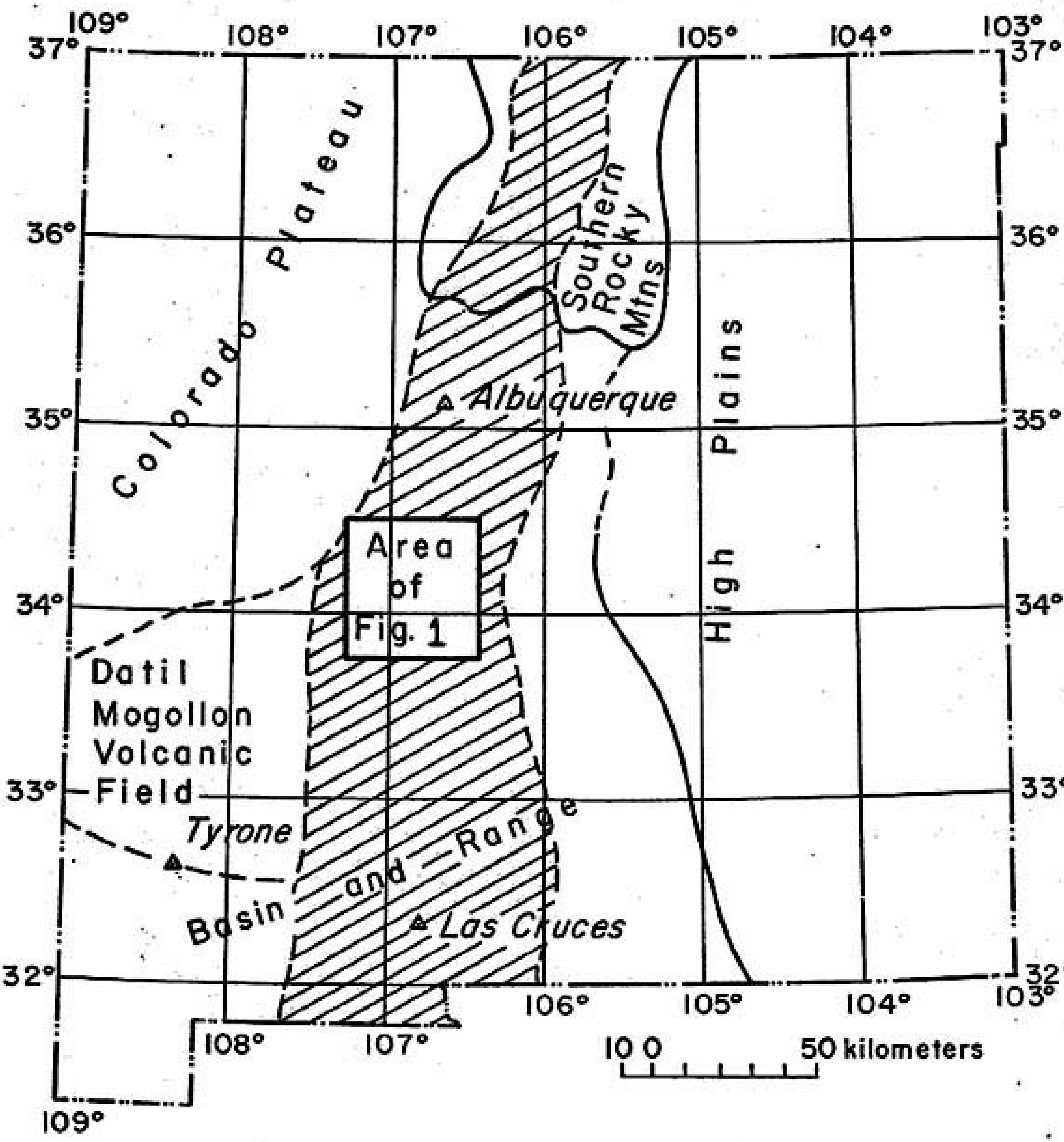


Figure 3. Generalized map of the Rio Grande rift in New Mexico and outline of the study area.

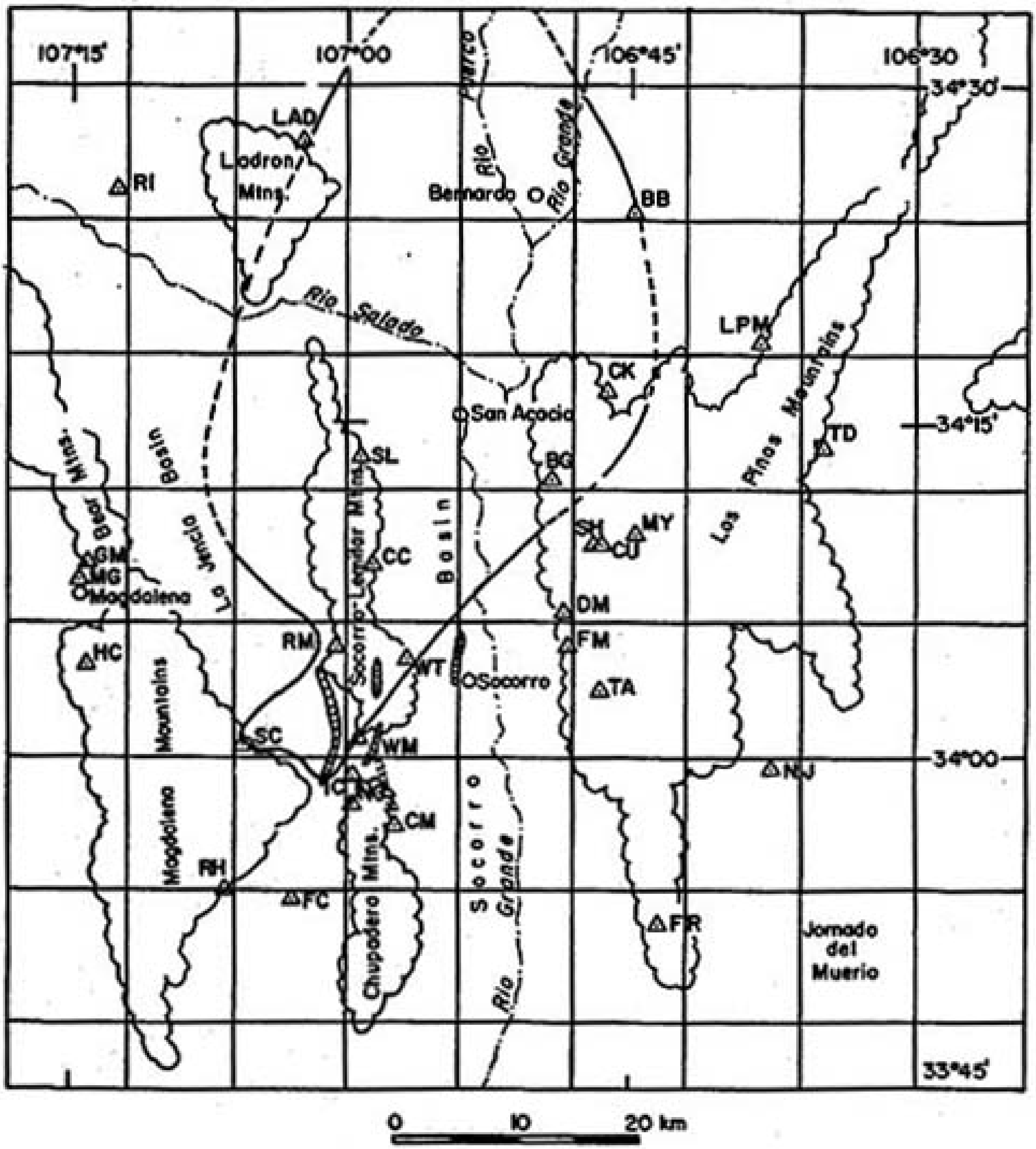


Figure 4. Station locations relative to the local physiographic provinces.

PROCEDURE

A movable array of 5 to 7 stations was used in the period April, 1975, to January, 1978, to collect microearthquake data and as a by-product many teleseisms were also recorded. Each station was occupied with a Sprengnether MEQ-800 smoked-drum recorder during the period April, 1975, to January, 1977. For the duration of this interval a Kinematics PS-1 analog unit was used to record signals from one of two telemetered stations (LAD, LPM) from the Albuquerque Seismological Laboratory (U.S.G.S.). Each of the stations, excluding the telemetered stations, was equipped with either a Mark Products L4-C (1.0 hz) or a Willmore (1.5 hz) vertical component seismometer. For a further description of the MEQ-800 seismograph system the reader is referred to Rinehart (1976). The locations and letter designations of the 29 stations used in this study are shown in Figure 4; their latitudes, longitudes, elevations, and station corrections are given in Table 1.

A total of 78 events (Appendix I) were used in this study, 42 events from Fischer's (1977) study were reread and incorporated in the data set. In addition, 36 more events were chosen according to their (1) clarity — to guarantee the first energy of the arrival; (2) implusiveness — to allow accurate readings to be made, and (3) signal strength — to obtain a reading from a majority of the stations in the array.

TABLE 1. STATION DATA

STATION	LATITUDE	LONGITUDE	ELEVATION (m)	STATION CORRECTION
ALQ	34.9425 N	106.4574 W	1849	0.00
BB	34.4090	106.6818	1615	-0.03
BG	34.2068	106.8205	1516	0.00
CC	34.1442	106.9812	1649	0.12
CK	34.2725	106.7702	1578	-0.04
CM	33.9501	106.9576	1640	-0.18
CU	34.1573	106.7785	1585	NSC
DM	34.1075	106.8079	1536	0.06
FC	33.8950	107.0504	1850	-0.27
FM	34.0829	106.8047	1537	0.00
FR	33.8745	106.7270	1558	NSC
GM	34.1454	107.2345	1945	0.04
HC	34.0658	107.2361	2240	-0.12
IC	33.9870	106.9967	1730	-0.14
LAD	34.4583	107.0375	1768	0.22
LPM	34.3076	106.6336	1737	0.21
MG	34.1305	107.2425	2024	NSC
MY	34.1667	106.7459	1645	0.08
NG	33.9648	106.9933	1730	-0.13
NJ	33.9924	106.6253	1644	NSC
RH	33.9002	107.1135	2080	NSC
RI	34.4234	107.2075	1530	-0.12
RM	34.0812	107.0069	1719	-0.24
SC	34.0100	107.0894	2073	-0.25
SH	34.1570	106.7802	1577	NSC
SL	34.2234	106.9910	1615	0.08
TA	34.0498	106.7751	1558	0.05
TD	34.2339	106.5778	1850	0.17
WM	34.0120	106.9929	1673	-0.12
WT	34.0722	106.9459	1555	0.15

The events used in this study ranged in magnitude (Mb) from 4.8 to 6.6. The sampled azimuth directions ranged from 74° to 343° (measured clockwise from North). Distances ranged from 8° to 98° (1 degree ≈ 111 km). The resulting angles of incidence were scattered from 14.4° to 63.2° (measured from the vertical with the major concentration being between 15° and 25°.

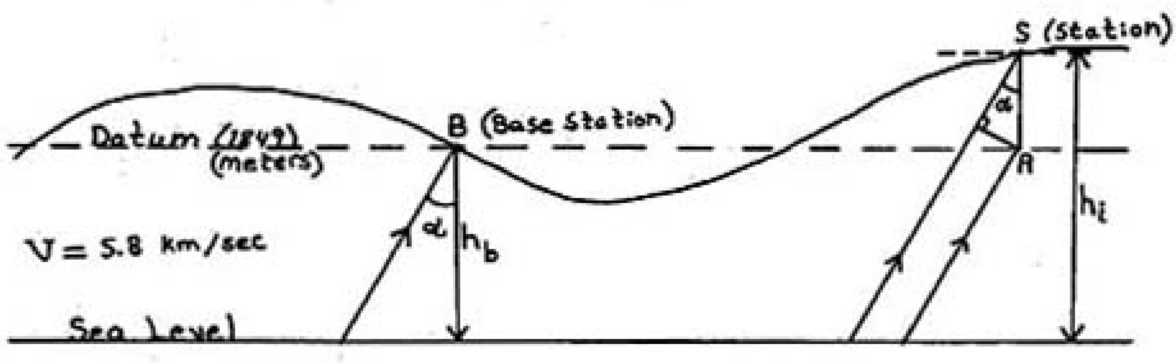
The origin time, magnitude, depth, and location of the seismic events were determined by the National Earthquake Information Service (NEIS) of the United States Geological Survey. Using NEIS depths with distances calculated from a program donated by Dr. John Schlue, I was able to use a simple linear interpolation method to obtain theoritical travel times from Herrin and Taggart's (1968) tables. Note that the distance program corrected for the ellipticity of the earth in generating a distance to the nearest 0.01 degree (Schlue, personal communication, 1979). This can lead to a maximum error ± 0.10 seconds (see Appendix 3) for close events ($\Delta \leq 12°$). Only 13 events were used with distances ≤ 20°; 5 in the southeast quadrant, 1 in the southwest quadrant, and 7 in the northwest quadrant. It is unknown if the higher standard deviations in these quadrants is due to this error or is caused by the different crustal properties sampled by events of variable distances. A way to check for this error would be to separate the events according to angle of incidence. The minimum error due to round-off of distances to the nearest 0.01° is ± 0.03 seconds.

The angle of incidence for a particular event was found using depth and distance to obtain values from tables by Pho and Behe (1972). It was necessary for event distances less than 20° to calculate the angle of incidence. These particular events are noted with an asterisk (*) near the value. These calculations were made using an accepted velocity model for the area (Sanford et al., 1977).

Clock corrections were applied to all travel time measurements when necessary. These corrections were found from the microearthquake data in which the drift was assumed linear for the recording week (~4 days). Inaccuracies for clock corrections and reading errors combined are believed to be ± 0.05 second (Rinehart, personal communication, 1979).

Elevation corrections were necessary to remove time residuals caused by different distances traveled in the crust. All stations were corrected to a level datum, 1849 meters, the elevation of the base station ALQ, to remove this effect. The following equation and figure describe this correction:

$$C_E = \frac{CS}{V} = \frac{AS \cos\alpha}{V} = (h_i - h_b) \frac{\cos\alpha}{V} \longrightarrow \qquad (1)$$



Station corrections were applied when required (see Table 1). Application of these corrections is necessary to remove the time residuals produced by rapid lateral variations in near surface geology. The station corrections were determined from explosion and microearthquake data.

All measurements of arrival times for stations in the study area are made on smoked-drum records (2 mm = 1 second, 2.5 mm = 1 second for the PS-1) using a traveling microscope with an accuracy of approximately ± 0.02 second. All ALQ records (1 mm = 1 second) were measured using a Keuffel and Esser scale with 0.5 mm divisions and a hand lens on 12x enlargements of 70 mm film chips. The accuracy of the latter measurements was no better than ± 0.10 second.

A procedure, different from Fischer's (1977) study, was used to increase the reading accuracy. On all events the first compression or dilatation was measured to eliminate much of the error present in measurements of the somewhat non-impulsive first arrivals. At the beginning of this study it was believed that the expected residuals might be on the order of 0.10-0.20 second (Sanford, personal communication, 1979). This magnitude of residual would not have been easily apparent in Fischer's study. The only error involved in making readings on the first peak or trough is that changes in amplitude for the same phase on different records could cause changes in the arrival time because of the curvilinear recording. A correction does exist to eliminate this error (Schlue, personal communication, 1979), but after some experimenting with measured amplitudes it was found that for all readings the correction was negligible.

TELESEISMIC TECHNIQUE

The anomalous increase or decrease in velocity encountered by a seismic ray along its travel path is estimated by a quantity termed the travel-time residual. This travel-time residual (TT_r) is obtained by subtracting the theoretical travel time (TT_t) from the observed travel time (TT_o) and applying clock, elevation, and station corrections. The observed travel time is easily found by subtracting the origin time (OT) from the measured arrival time (AT). This process is shown by the following simple relation:

$$TT_o = (AT - OT) \pm \text{clock corr.} - \text{elevation corr.} \pm \text{station corr.},$$
$$\text{and } TT_o - TT_t = TT_r \qquad (2)$$

The resulting travel-time residuals contain, in addition to crustal and mantle effects under investigation immediately beneath the recording station, effects from mislocation of the hypocenter, errors in origin time, and anomalous velocity structure along the path of propagation (Iyer and Stewart, 1977). This makes it necessary to establish a base station that presumably does not "see" any anomaly which would be present in the area of study. This station is considered to be "normal" with respect to stations in the study area. Subtracting the base station residual removes the errors in hypocenter location and origin time and anomalous velocity structure affecting all raypaths, thus leaving residuals due to properties in the crust and upper mantle below the station. In this case, station ALQ (Albuquerque) was chosen as a base. Because of possible variations in crustal structure beneath ALQ and the chance of large reading errors on records from that station, two other bases within the study area, WT and CC, were used. In all cases the base station travel-time residual (TT_{rb}) was subtracted from the station travel-time residual (TT_{rs}). Thus a positive residual indicates an anomalous delay for travel along the station's raypath relative to the base station or an anomalous earliness for travel along the base station's raypath with respect to the station. A negative residual would indicate a high velocity path for the station with respect to the base station or a low velocity region along the base station's raypath with respect to the station. The following relation shows the last step in obtaining the relative station residual for a particular event:

$$TT_{rs} - TT_{rb} = \text{relative station residual (fully corrected)} \quad (3)$$

EVENT RESIDUALS — DATA ANALYSIS

ALQ as a Base Station

The choice of ALQ as a base station was based on the premise that any variations in residuals for that station would be small enough to be hidden in the noise. As mentioned previously, the high standard deviation for relative travel time residuals (0.1 to 0.2 second) when using ALQ as a base is primarily due to errors in reading the ALQ records. With this thought in mind, it is still possible to see a systematic variation for the average of the relative travel-time residuals for each event when they are grouped according to azimuth and angle of incidence (Figures 5A through 5E, and Table 2).

In the southeast quadrant, we see at angles of incidence >30° dominantly negative average values. However, as the angle of incidence approaches 30°, we see a definite shift to positive values near the 140° azimuth.

In the southwest quadrant, the residual averages are positive with respect to ALQ, indicating that the stations in the study area are delayed. Note that events sampled from the southwest fall in a very narrow range of angles of incidence (14.5-16.0) with the larger angles of incidence showing slightly more delay.

The northwest quadrant reveals a definite variation with changes in angles of incidence. At steeper angles the residuals are moderately negative grading into lower negative values as the angle of incidence increases. Near

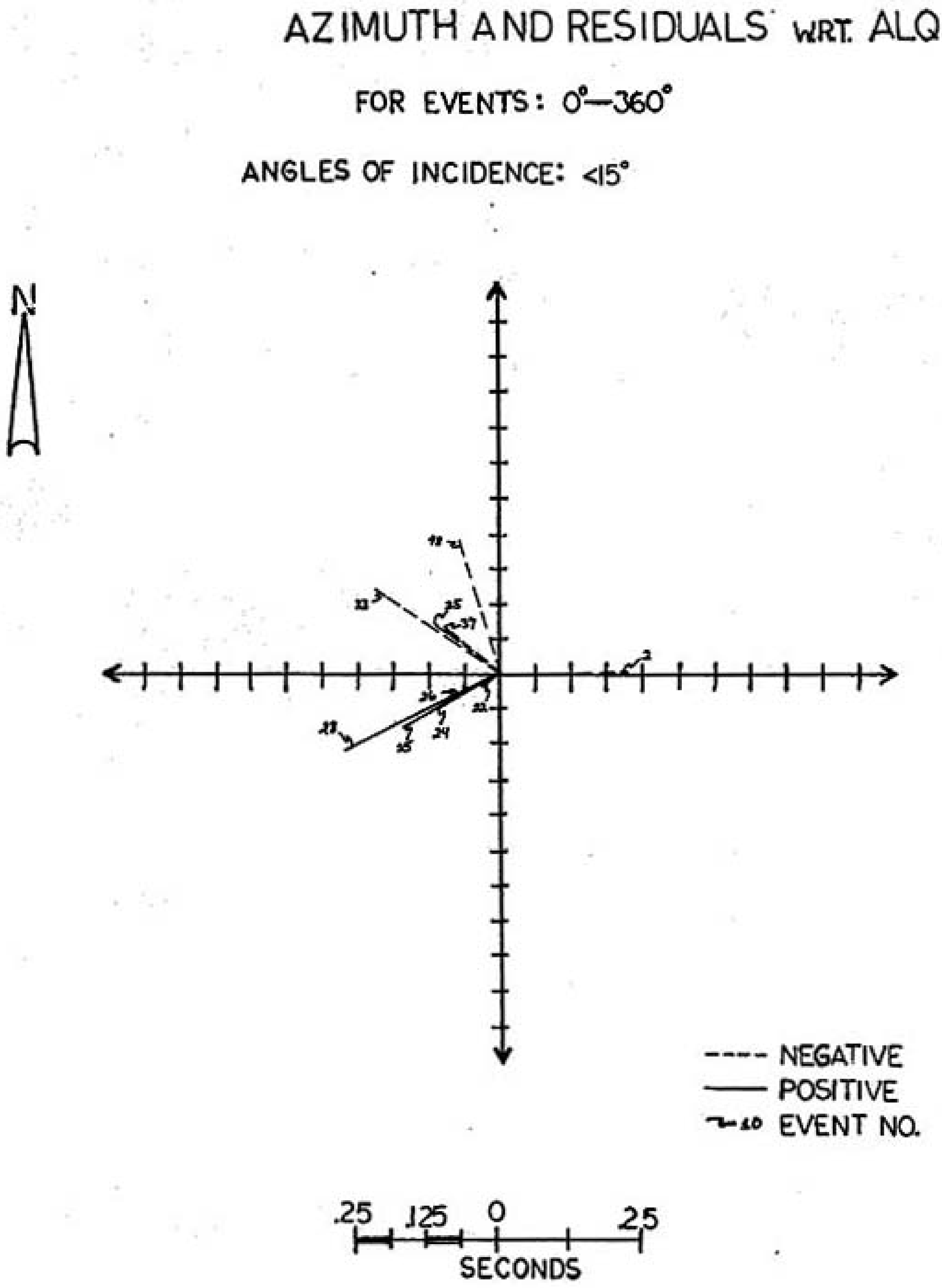


Figure 5A. Plot of event residual averages.

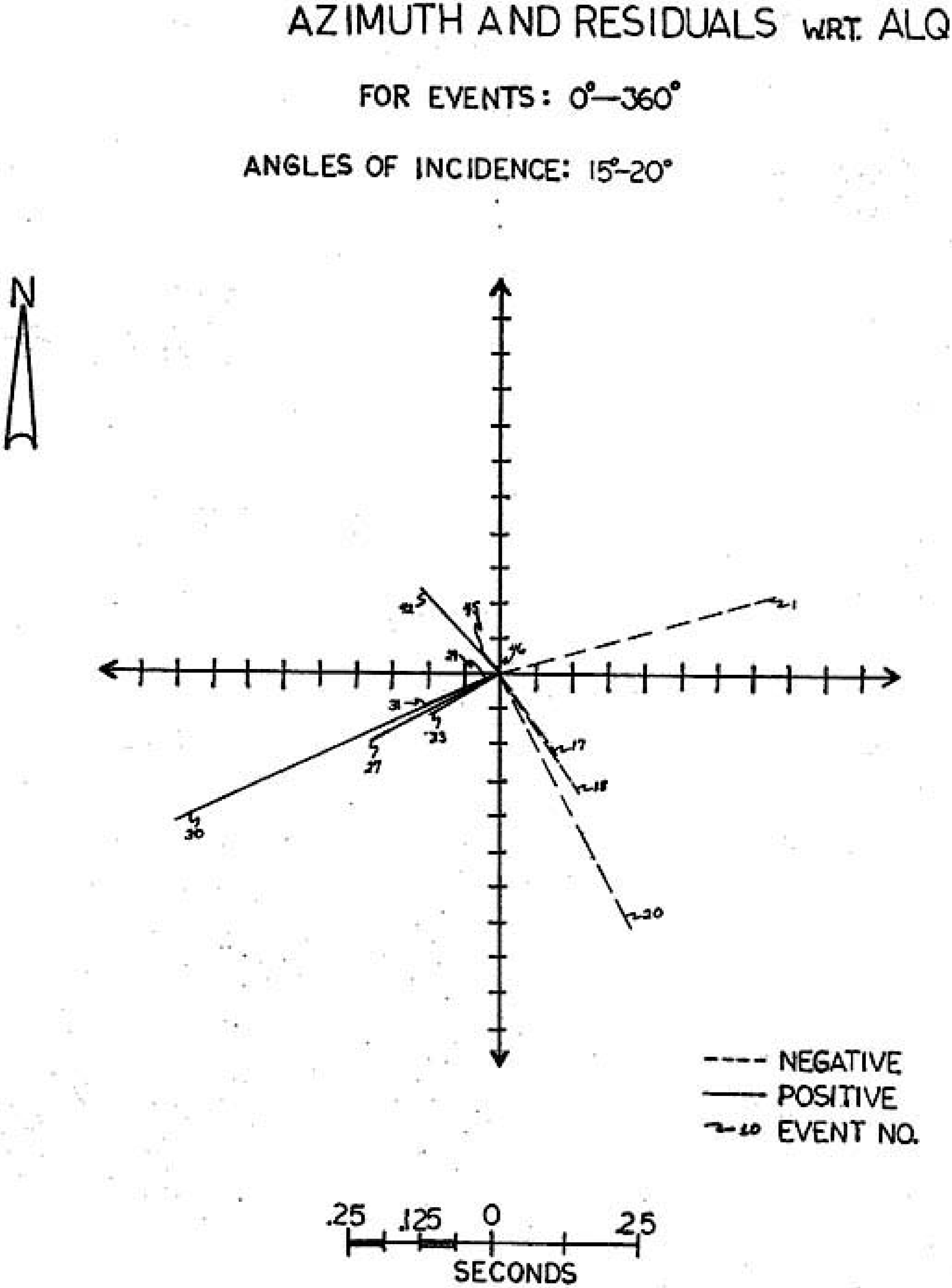


Figure 5B. Plot of event residual averages.

AZIMUTH AND RESIDUALS WRT. ALQ

FOR EVENTS: 0°—360°

ANGLES OF INCIDENCE: 20°-25°

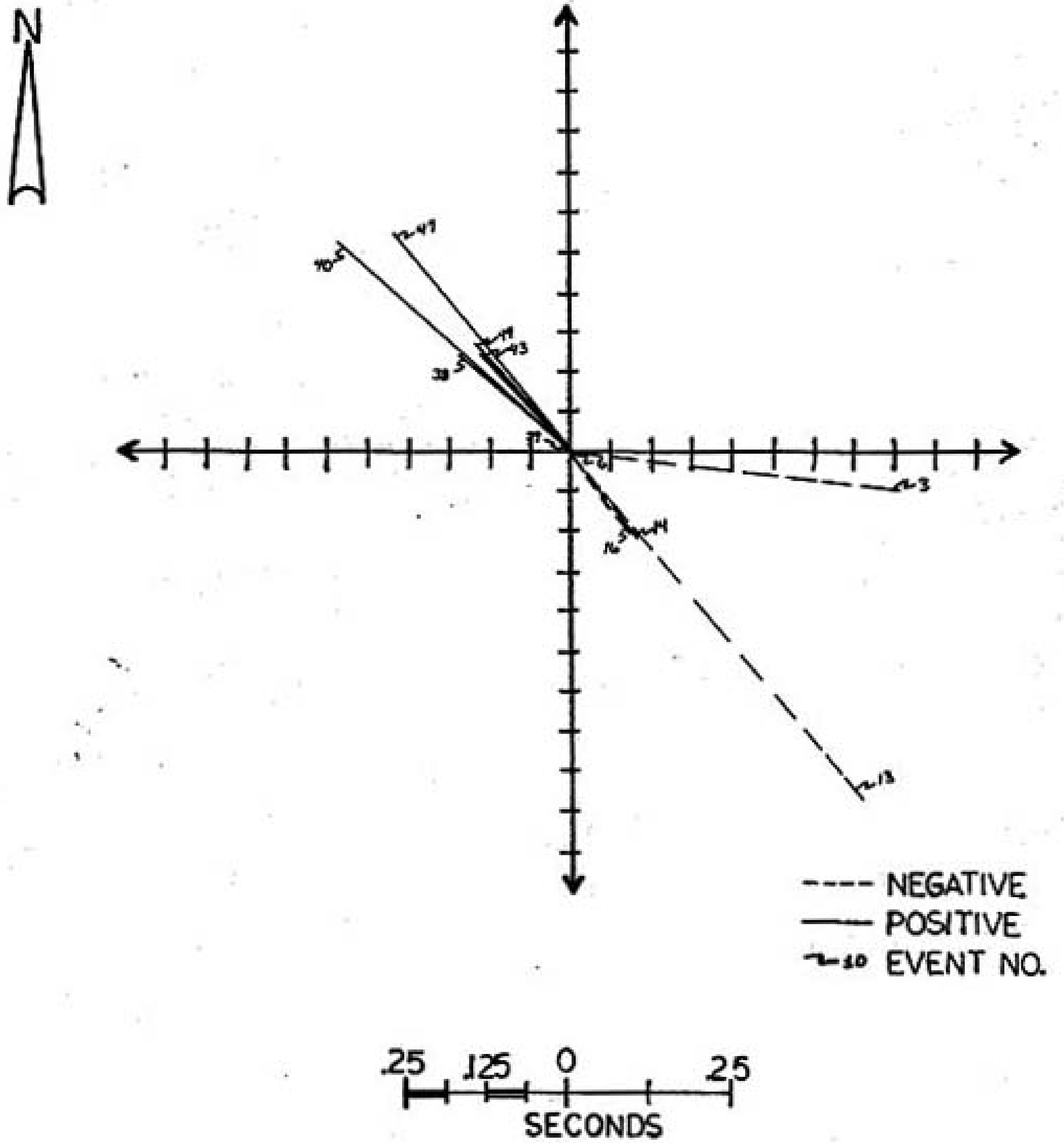


Figure 5C. Plot of event residual averages.

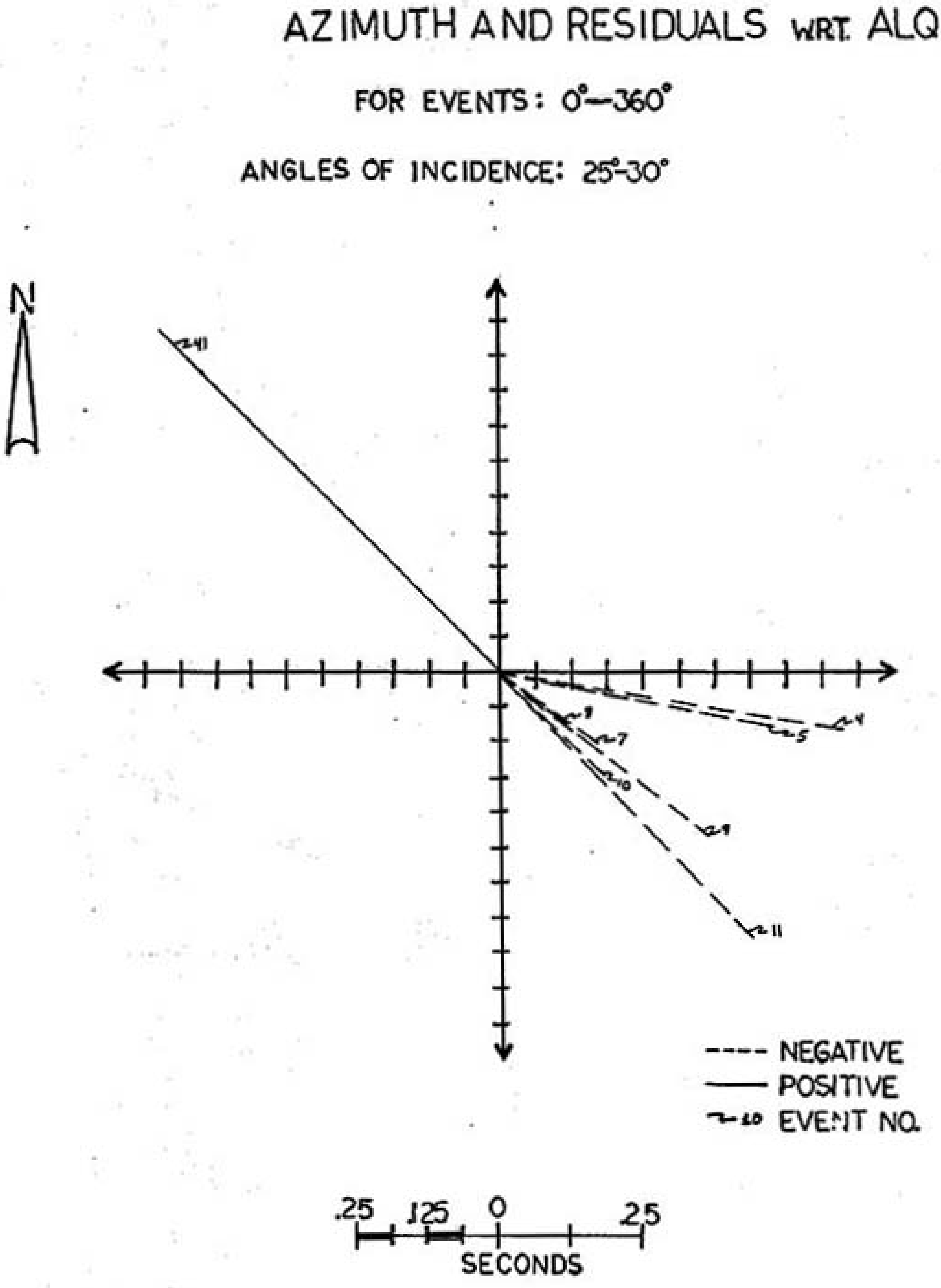


Figure 5D. Plot of event residual averages.

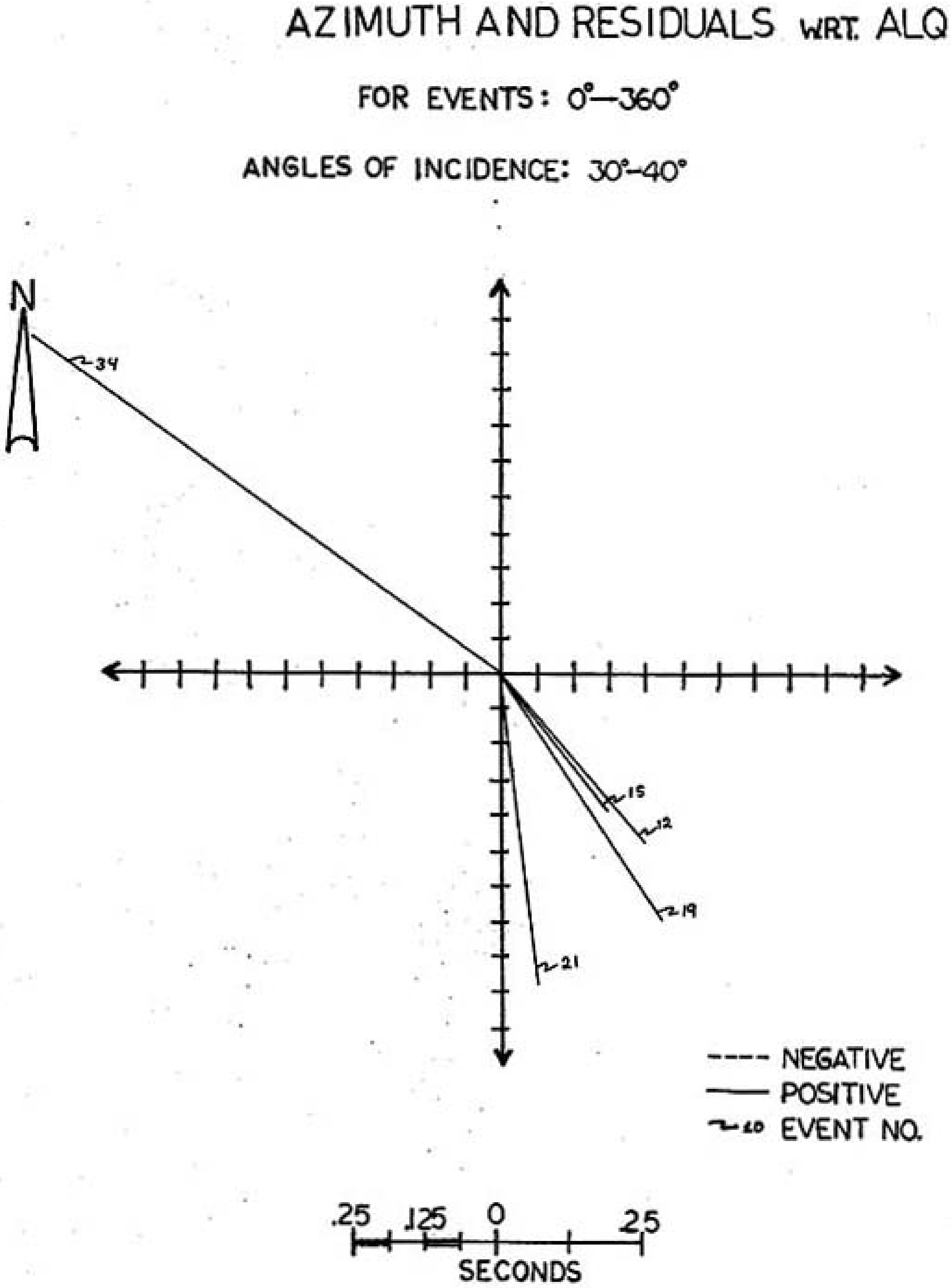


Figure 5E. Plot of event residual averages.

TABLE 2. RESIDUAL AVERAGES WITH RESPECT TO ALQ.

Event No.	Date	Azi.	∡ i	Depth (km)	Ave. Residual and (Number of Samples)	Std. Dev. (±)
1	2-16-77	74°	19.8°	33	-0.501 (7)	0.070
2	7-28-77	89°	14.6°	33	-0.226 (5)	0.118
3	12-13-77	97°	24.4°	33	-0.520 (6)	0.163
4	7-15-76	100°	26.3°	33	-0.615 (6)	0.182
5	7- 1-76	101°	25.5°	36	-0.492 (6)	0.136
6	9-21-77	110°	24.9°	33	-0.013 (6)	0.121
7	8-31-77	127°	26.8°	33	-0.214 (7)	0.226
8	9- 1-77	127°	26.8°	28	-0.149 (7)	0.281
9	11- 5-75	128°	26.8°	44	-0.476 (5)*	0.134
10	8-10-76	135°	26.3°	33	-0.262 (5)	0.108
11	5-27-76	137°	27.3°	33	-0.655 (6)**	0.127
12	6-26-75	140°	29.9°	76	+0.393 (4)	0.141
13	2- 5-76	141°	20.2°	98	-0.720 (5)	0.115
14	6-24-75	142°	20.7°	33	-0.170 (4)	0.050
15	2-23-77	142°	32.4°	118	+0.304 (5)	0.146
16	10-28-75	143°	20.4°	38	-0.162 (6)*	0.168
17	6- 7-77	145°	18.5°	111	-0.174 (5)	0.228
18	12- 6-77	146°	18.2°	19	-0.254 (7)	0.148
19	2-19-76	147°	35.3°	33	+0.525 (6)	0.156
20	5-28-75	153°	17.3°	24	-0.510 (4)	0.216
21	4-13-76	173°	40.0°	33	+0.560 (5)	0.115
22	3-24-76	235°	14.6°	33	+0.037 (6)*	0.150
23	12- 8-77	239°	15.0°	33	+0.140 (7)	0.122
24	2- 3-76	240°	14.4°	477	+0.122 (5)*	0.170
25	5-20-75	240°	14.6°	362	+0.193 (3)	0.100
26	5-29-75	242°	14.5°	616	+0.083 (4)	0.150
27	8-12-75	242°	15.7°	197	+0.257 (6)	0.117
28	8- 7-75	243°	14.5°	626	+0.306 (5)	0.151
29	2- 3-76	243°	16.0°	212	+0.032 (6)*	0.181
30	1-21-77	245°	15.0°	604	+0.688 (6)	0.153
31	2- 6-76	245°	15.0°	590	+0.145 (4)	0.121
32	8-19-77	296°	63.2°	0	+0.480 (2)	0.057
33	9- 6-75	305°	14.5°	374	-0.270 (5)**	0.113
34	7-28-77	306°	37.3°	15	+1.025 (6)	0.150
35	8- 4-76	308°	14.5°	435	-0.125 (6)	0.380
36	7-29-75	309°	38.0°	33	-0.612 (5)	0.165
37	8-12-75	310°	14.5°	391	-0.135 (4)	0.053
38	8-21-75	312°	22.7°	33	+0.230 (4)	0.130
39	2-18-76	312°	23.4°	39	+0.012 (6)	0.119
40	8-17-77	312°	23.7°	57	+0.488 (6)	0.248
41	7-20-77	316°	25.9°	53	+0.866 (5)	0.085
42	8- 6-75	318°	16.2°	230	-0.120 (5)	0.144
43	11- 4-75	318°	21.6°	24	+0.208 (5)*	0.127
44	8-15-75	318°	21.7°	4	+0.218 (5)	0.080
45	8-12-76	319°	17.0°	301	+0.048 (5)	0.155
46	9-21-77	319°	19.6°	231	+0.006 (7)	0.174
47	9-21-77	321°	21.0°	48	+0.448 (6)	0.125
48	7-29-76	343°	14.5°	0	-0.228 (6)	0.167

* One station used in the average that has no station correction.
** Two stations used in the average that have no station corrections.

angles of incidence of 20° the trend is toward increasing positive values. As in the southeast quadrant, this suggests that whatever is affecting these residuals, anomalous material or geologic structure, the angle of incidence is definitely controlling the distance traveled through the low velocity material in the Socorro area or conversely, the high velocity material in the Albuquerque area.

The runs of +'s and -'s in Table 2 indicate that the values are not statistically random and imply that something is definitely affecting the residuals at ALQ or in the study area. An average of all the values in Table 2 shows a value of 0.0044 ± 0.4034 second.

Station Residuals, — ALQ as a Base Station

Because of the large changes in event averages and the reading error associated with ALQ, relative time residuals for a particular station using the ALQ base have very large standard deviations, thus rendering any interpretation of crustal structure in the Socorro area from these residuals difficult. For this reason, a discussion of these residuals is not given in this report. However, for the reader's convenience, these residuals are listed in Table 3 and plotted on the simplified geological-geophysical maps shown in Figures 6A through 6G.

Station Residuals — WT as a Base Station

Standard deviations for station residuals within the local array tend to be much lower when a base station in the array is used because of the higher reading accuracy possible

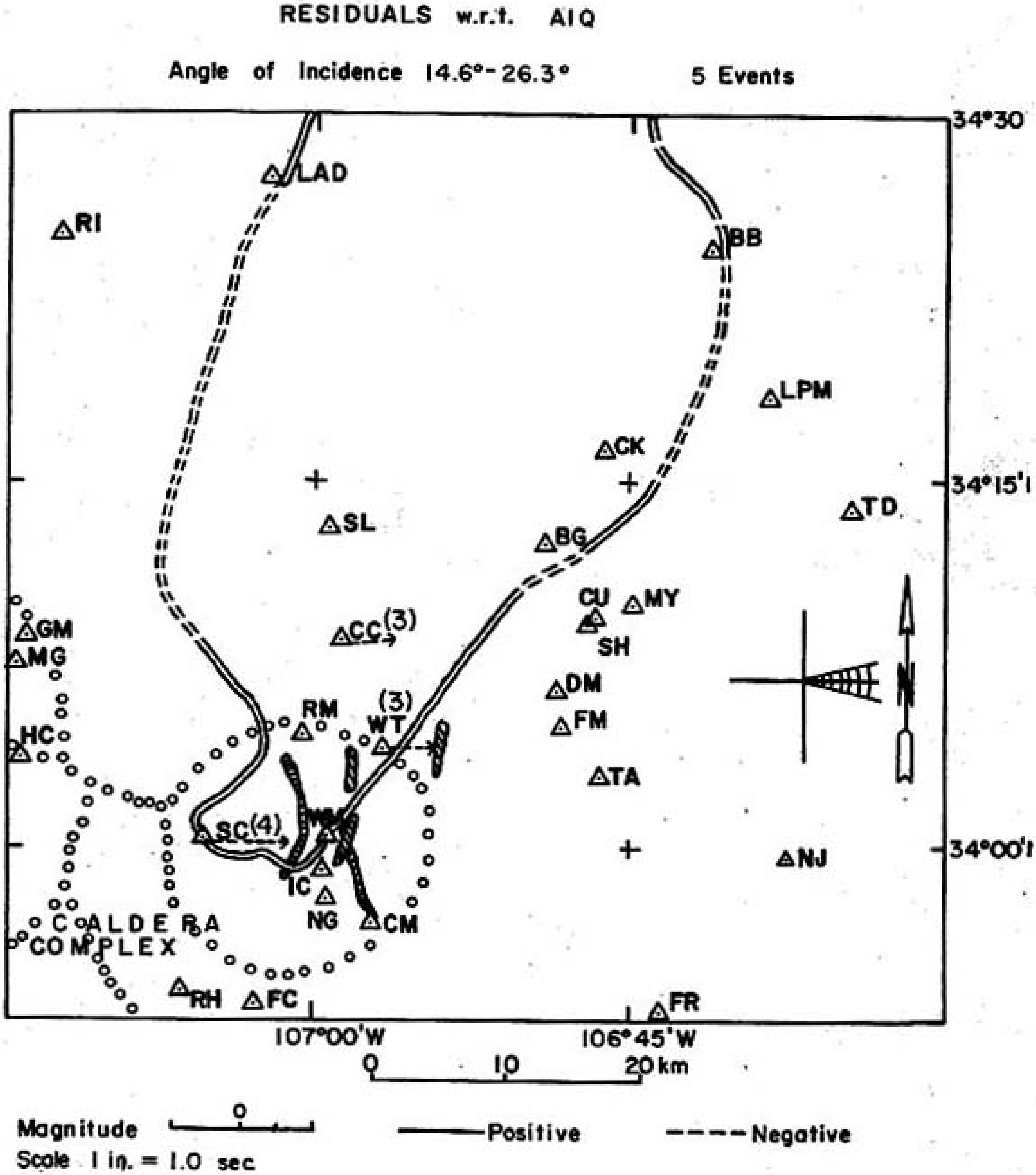


Figure 6A. Plot of residual averages for events 74° - 101° azimuth.

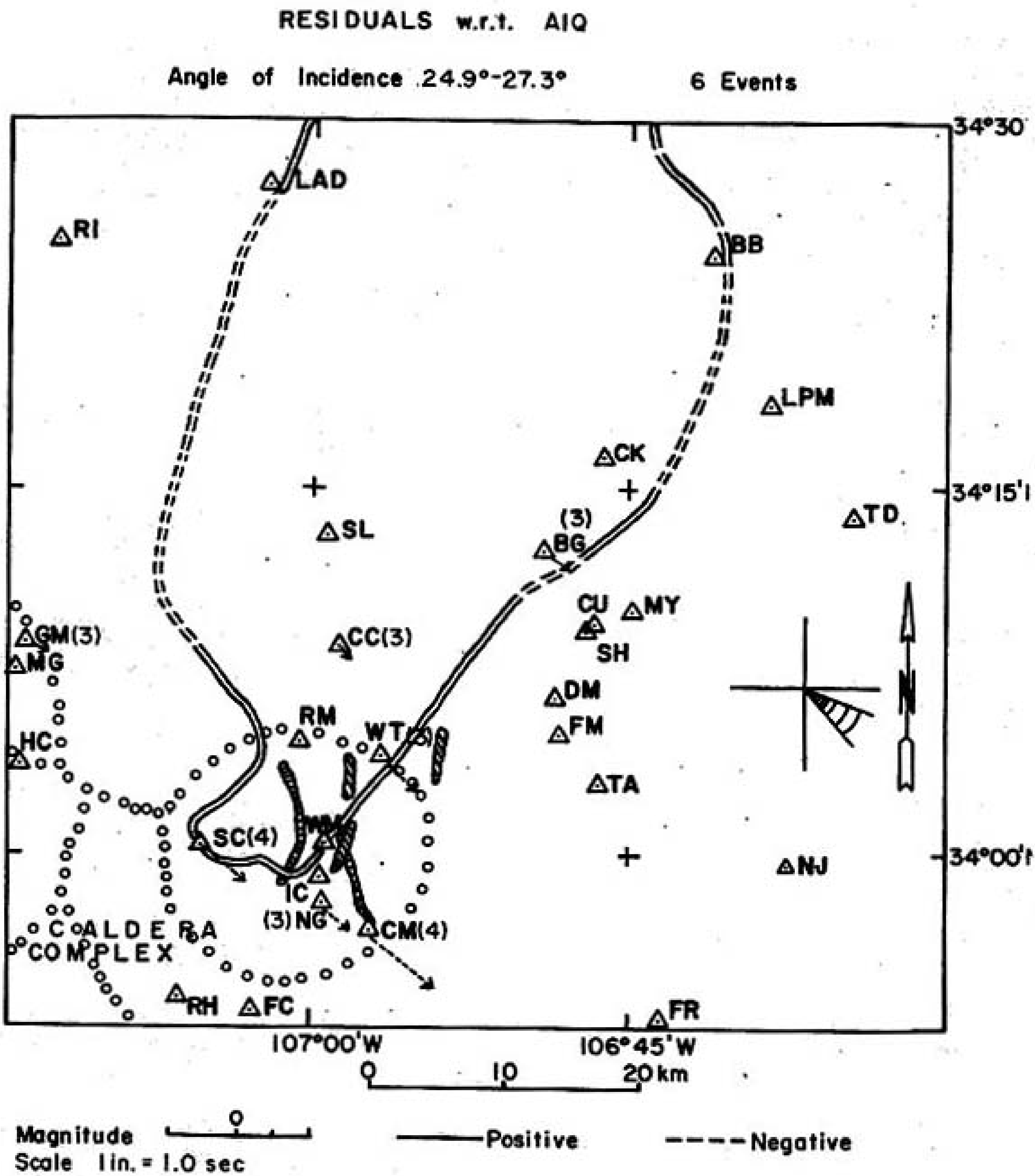


Figure 6B. Plot of residual averages for events 110° - 137° azimuth.

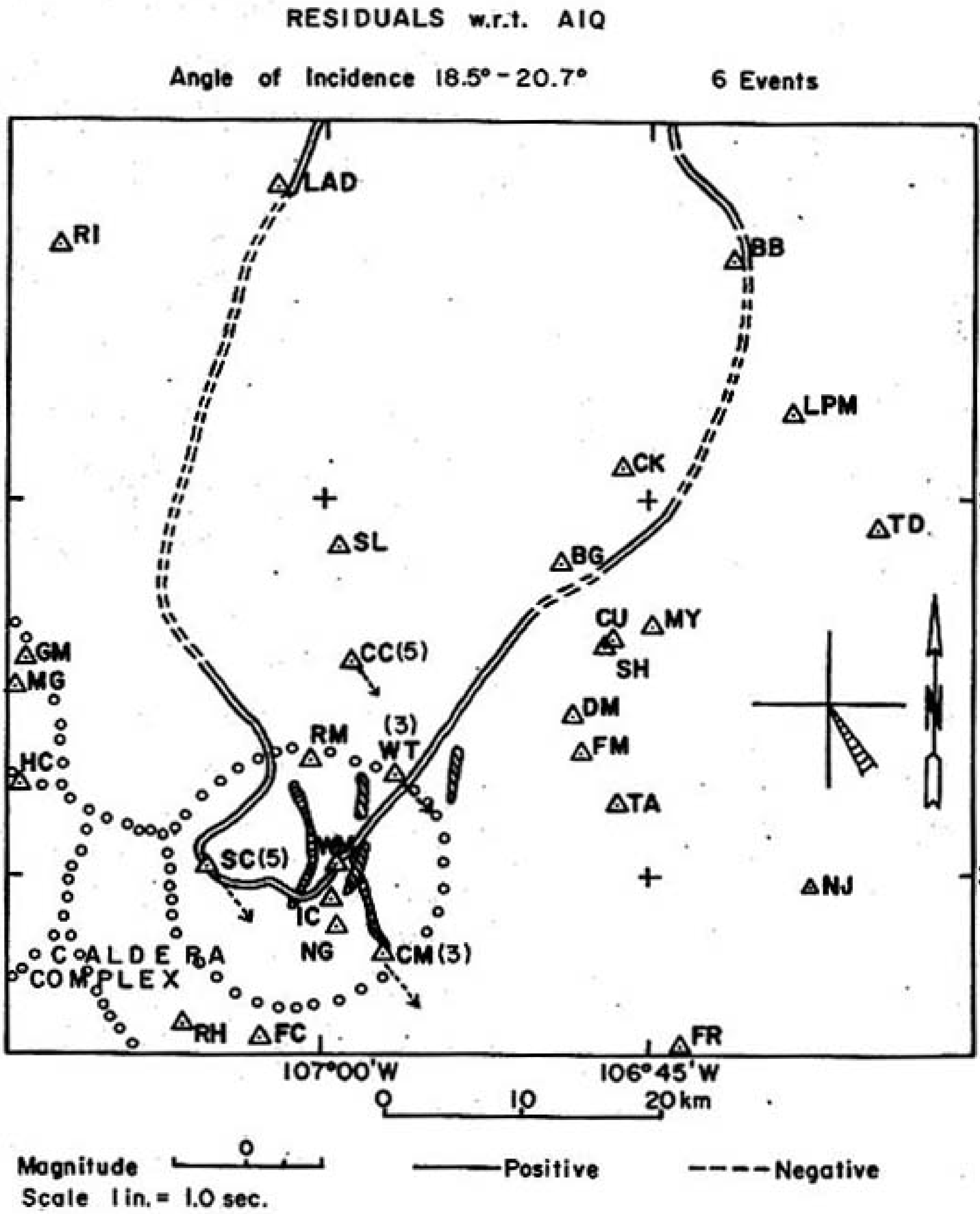


Figure 6C. Plot of residual averages for events 141° - 153° azimuth.

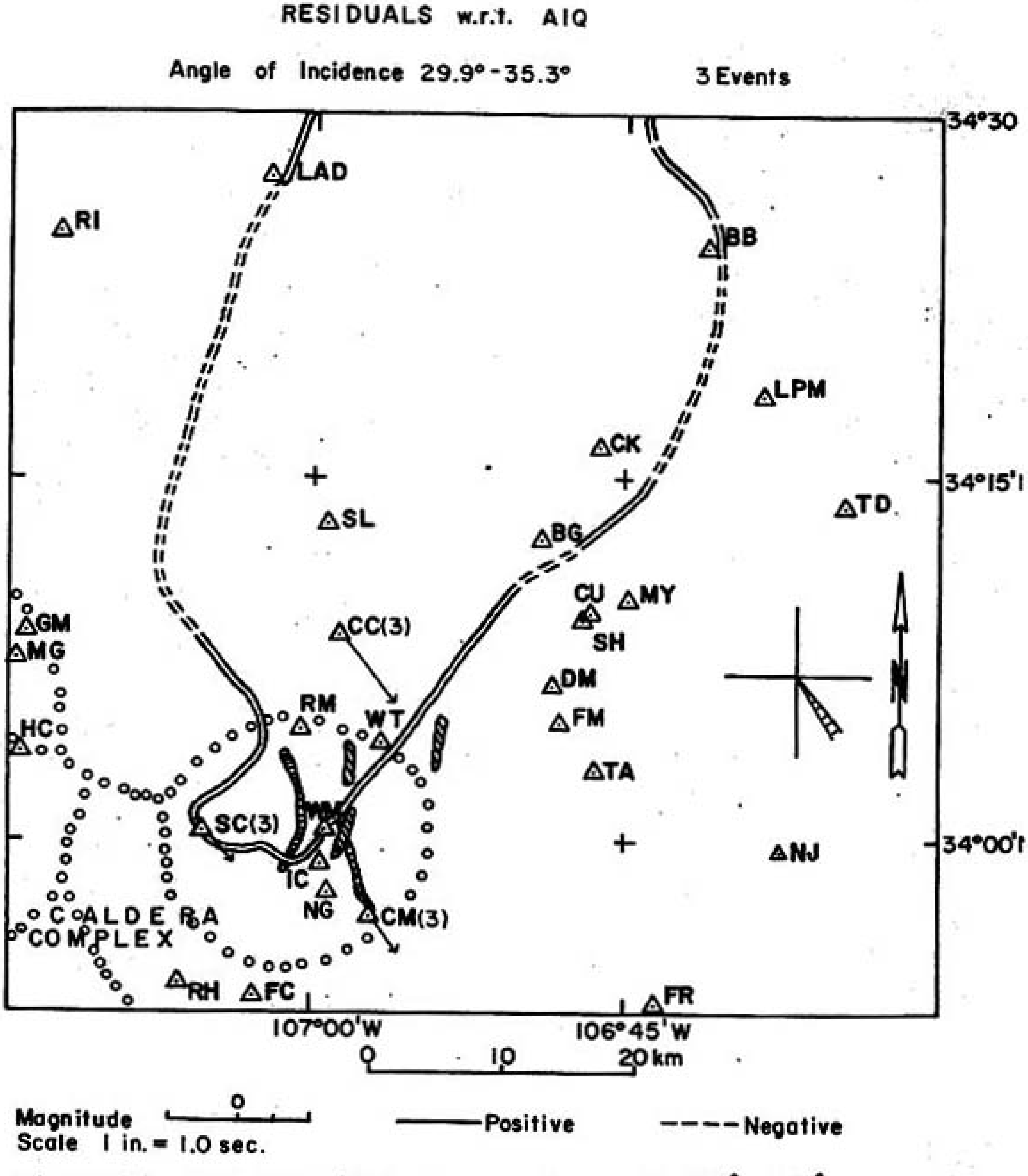


Figure 6D. Plot of residual averages for events 140° - 147° azimuth.

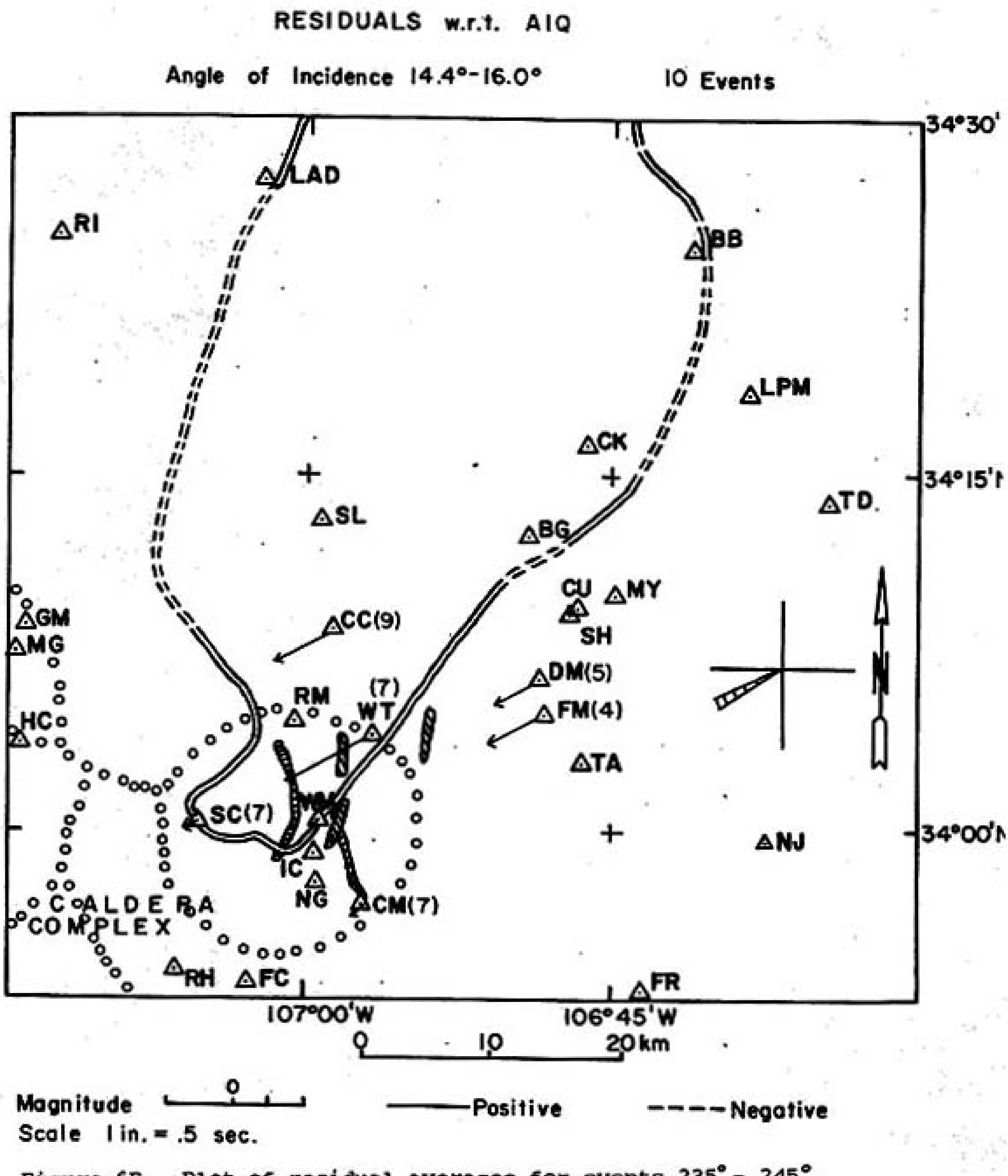


Figure 6E. Plot of residual averages for events 235° - 245° azimuth.

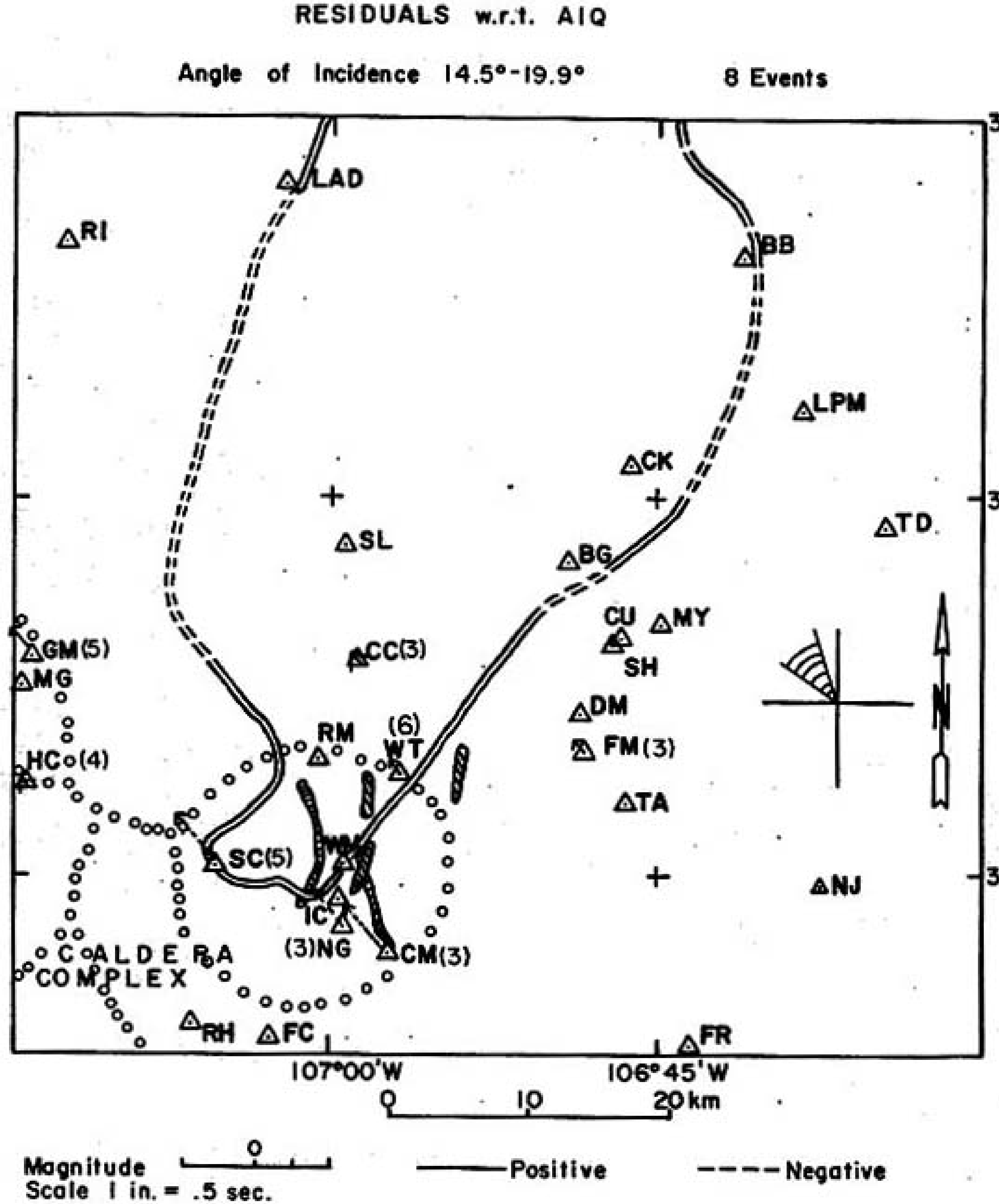


Figure 6F. Plot of residual averages for events 305° - 343° azimuth.

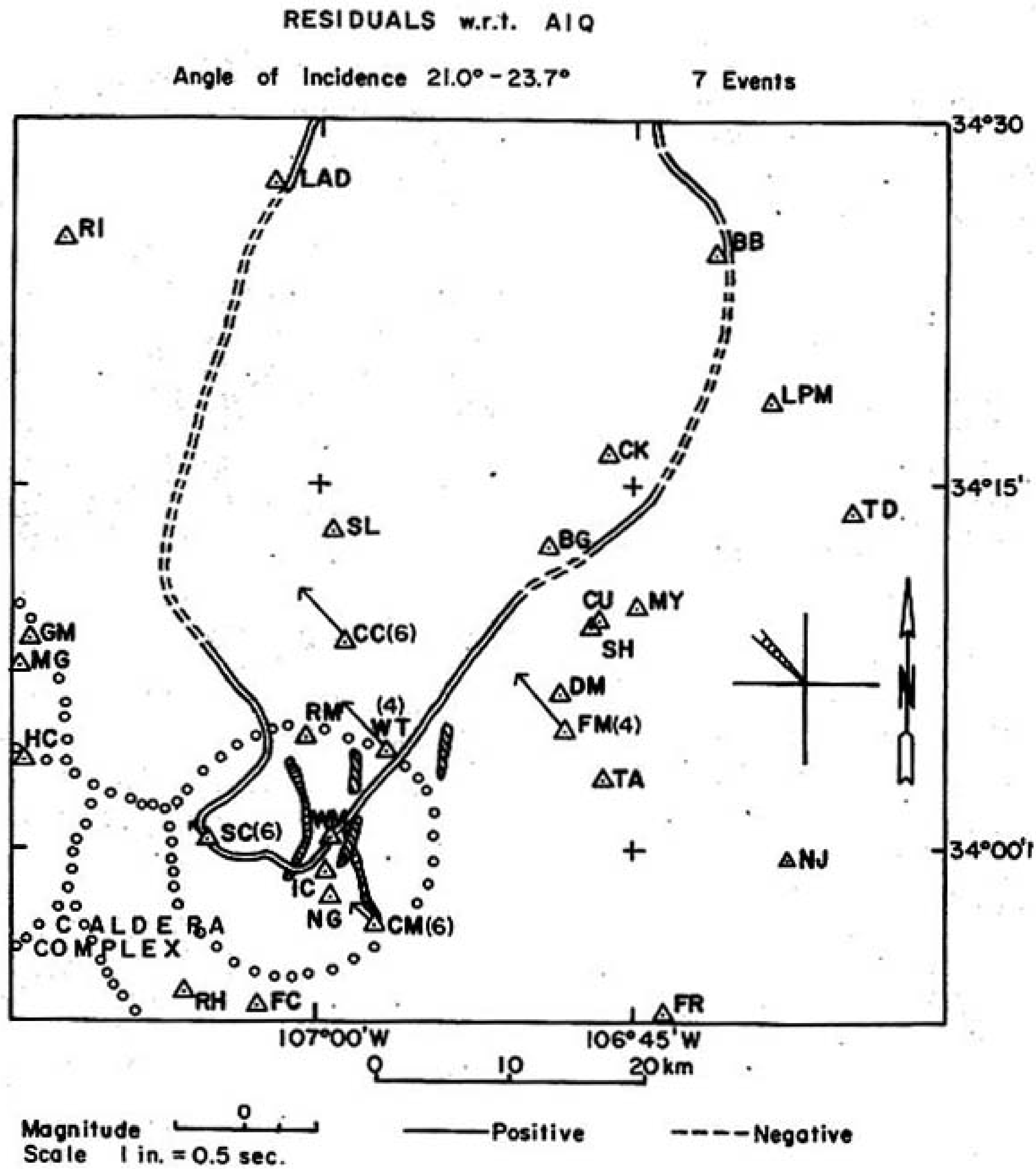


Figure 6G. Plot of residual averages for events 312° - 321° azimuth.

TABLE 3. RESIDUALS WITH RESPECT TO ALQ.

STA	Ave. ± Std. Dev.	Events Ave.	Comments
Azimuth 74°-101°	Angle of Incidence 14.6°-26.3°	5 Events	
SC	-0.590 ± 0.221	4	
WT	-0.377 ± 0.045	3	
CC	-0.377 ± 0.219	3	
BG	-0.370 ± 0.170	2	
LAD	-0.685 ± 0.177	2	
GM	-0.555 ± 0.021	2	
NG	-0.685 ± 0.007	2	
HC	-0.445 ± 0.191	2	
RM	-0.545 ± 0.120	2	
LPM	-0.195 ± 0.163	2	
Azimuth 110°-137°	Angle of Incidence 24.9°-27.3°	6 Events	
SC	-0.403 ± 0.142	4	
CM	-0.585 ± 0.192	4	
GM	-0.130 ± 0.098	3	
BG	-0.210 ± 0.226	3	
CC	-0.050 ± 0.106	3	
NG	-0.277 ± 0.046	3	
WT	-0.353 ± 0.242	3	
NJ	-0.505 ± 0.049	2	No station correction
Azimuth 141°-153°	Angle of Incidence 18.5°-20.7°	6 Events	
SC	-0.436 ± 0.211	5	
CC	-0.298 ± 0.197	5	
WT	-0.327 ± 0.374	3	
CM	-0.407 ± 0.225	3	
DM	-0.605 ± 0.389	2	
FM	-0.385 ± 0.318	2	
Azimuth 140°-147°	Angle of Incidence 29.9°-35.3°	3 Events	
CC	+0.617 ± 0.125	3	
SC	+0.327 ± 0.133	3	
CM	+0.303 ± 0.086	3	
WT	+0.510 ± 0.212	2	
IC	+0.330 ± 0.240	2	
Azimuth 235°-245°	Angle of Incidence 14.4°-16.0°	10 Events	
CC	+0.248 0.119	9	
CM	+0.014 0.140	7	
WT	+0.367 0.138	7	
SC	+0.049 0.188	7	
DM	+0.200 0.179	5	
FM	+0.243 0.075	4	
SH	+0.130 0.028	2	No station correction

TABLE 3. RESIDUALS WITH RESPECT TO ALQ (CONTINUED)

STA	Ave. ± Std. Dev.	Events Ave.	Comments
Azimuth 296°-317°	Angle of Incidence 25.6°-38.0°	4 Events	
SC	0.600 ± 0.236	4	
GM	0.847 ± 0.372	3	
CM	0.700 ± 0.262	3	
CC	0.847 ± 0.281	3	
LPM	1.005 ± 0.120	2	
Azimuth 305°-343°	Angle of Incidence 14.5°-19.9°	8 Events	
WT	-0.053 ± 0.150	6	
SC	-0.246 ± 0.143	5	
GM	+0.116 ± 0.167	5	
HC	-0.010 ± 0.128	4	
CM	-0.260 ± 0.155	3	
CC	-0.047 ± 0.065	3	
FM	-0.067 ± 0.107	3	
NG	-0.180 ± 0.233	3	
FC	-0.495 ± 0.488	2	
LAD	+0.190 ± 0.156	2	
Azimuth 312°-321°	Angle of Incidence 21.0°-23.7°	7 Events	
SC	+0.090 ± 0.122	6	
CC	+0.260 ± 0.143	6	
CM	+0.123 ± 0.170	6	
WT	+0.253 ± 0.132	4	
FM	+0.285 ± 0.093	4	
GM	+0.500 ± 0.240	2	
BG	+0.390 ± 0.042	2	

with local array records. I have plotted station residual averages with their associated error bars (Appendix 4) in the same manner as Fischer (1977) for ease of comparison with his results. In my work, a different approach to the interpretation of the residuals is made. The events are divided into three quadrants according to azimuth (SE, SW, and NW), the residuals plotted on a geologic-geophysical map of the area; each of which is discussed separately. Note, when looking at Table 4, that positive (+) implies a late P arrival and negative (-) implies an early P arrival with respect to WT. But note also that if the WT arrival is delayed a large amount, any station which is delayed a lesser amount will have a negative residual.

Southeast Quadrant. For this group of events (azimuth 100° - 173°, angle of incidence 18.5° - 40°, Figure 7A, and Table 4) the raypaths for base station WT do not pass through the mid-crustal magma body but delays may occur due to the shallow intrusive to the east. Extension of this shallow intrusive further southward is possible and could account for delays for most raypaths to WT (Sanford, personal communication, 1979).

Table 4 shows CM with the earliest average arrival relative to WT. The residual at station NG, whose value is comparable to CM, might be influenced by the shallow magma body to the east. This is not reflected significantly in the average value at NG.

Station CC has the only late arrival with respect to

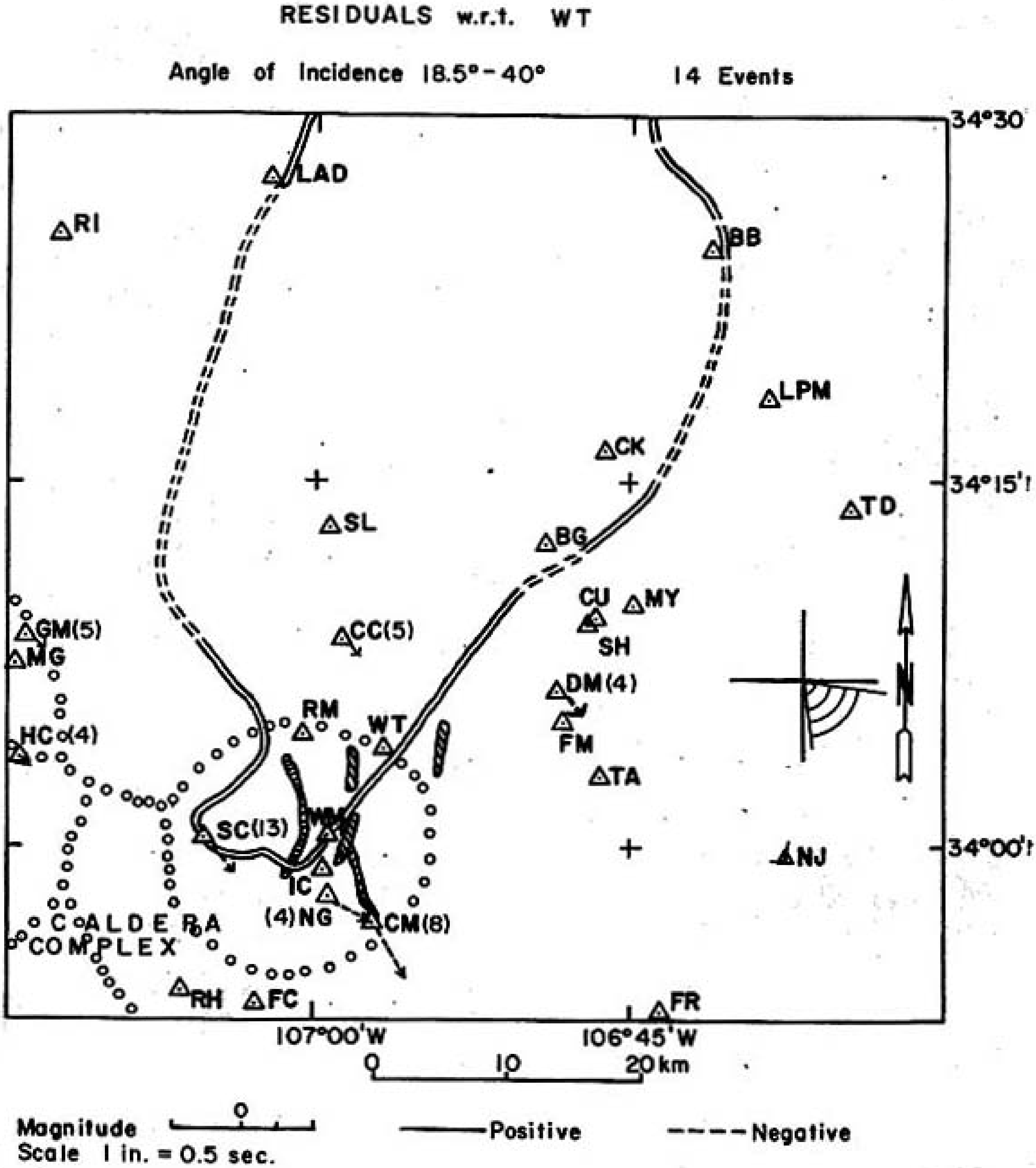


Figure 7A. Plot of residual averages for events 100° - 173° azimuth.

TABLE 4. RESIDUALS WITH RESPECT TO WT

STA	Ave. ± Std. Dev.	Events Ave.	Comments	
Azimuth 100°-173°	Angle of Incidence 18.5°-40°		14 Events	
SC	-0.178 ± 0.173	13	100°-135° - 0.335 ± 0.157	4
		($\angle_1$=20.5)	141°-142° + 0.013 ± 0.059	3
			143°-173° - 0.173 ± 0.118	6
CM	-0.234 ± 0.083	8		
CC	+0.068 ± 0.115	5		
GM	+0.060 ± 0.239	5	100°-101° - 0.220 ± 0.028	2
		($\angle_1$=20.7)	141°-145° + 0.233 ± 0.012	3
DM	-0.108 ± 0.036	4		
NG	-0.210 ± 0.142	4		
HC	-0.043 ± 0.143	4		
NJ	0.000 ± 0.202	4	No station correction	
			137°-157° + 0.097 ± 0.071	3
MY	-0.160 ± 0.044	3		
IC	-0.143 ± 0.067	3		
WM	-0.290 ± 0.000	2		
RM	-0.190 ± 0.156	2		
FC	-0.010 ± 0.057	2		
LPM	+0.210 ± 0.184	2		
Azimuth 235°-245°	Angle of Incidence 14.4°-16.0°		9 Events	
CM	-0.367 ± 0.049	7		
CC	-0.118 ± 0.049	6		
DM	-0.112 ± 0.087	6		
SC	-0.335 ± 0.088	6		
TA	-0.140 ± 0.226	2		
GM	-0.005 ± 0.064	2		
FM	-0.160 ± 0.014	2		
SH	-0.130 ± 0.057	2	No station correction	
Azimuth 296°-343°	Angle of Incidence 14.5°-63.2°		14 Events	
SC	-0.240 ± 0.138	12	-0.271 ± 0.091	11
CM	-0.174 ± 0.106	10		
CC	-0.084 ± 0.096	8		
GM	+0.070 ± 0.188	6	308°-320° + 0.173 ± 0.124	4
HC	+0.106 ± 0.085	5	305°-319° + 0.143 ± 0.028	4
NG	-0.105 ± 0.160	4	308°-319° - 0.027 ± 0.042	3
FM	+0.038 ± 0.100	4		
FC	-0.085 ± 0.021	2		
DM	-0.270 ± 0.269	2		
LAD	-0.110 ± 0.014	2		
IC	-0.080 ± 0.127	2		
NJ	-0.060 ± 0.170	2	No station correction	

WT and this may be attributed to raypaths passing through the mid-crustal magma body and also possibly the shallow intrusive east of WT. Station SC, while having a good chance of seeing both deep and shallow influences of the Socorro caldera and a postulated crustal shear zone (Chapin et al., 1978), is showing an early average arrival.

Station GM, whose arrival is late, and HC, whose arrival is slightly early, may be indicating previously undetected low velocity material in the lower crust and upper mantle beneath the Socorro caldera.

Southwest Quadrant. This group of events (azimuth 235° - 245°, angle of incidence 14.5° - 16.0°, Figure 7B, and Table 4) produces relatively low standard deviations for all station residuals. This is probably not due to more consistent geologic structure in this quadrant but is more likely the result of a small range in the angles of incidence in the sample. Raypaths to the base station WT can pass through a shallow magma body as well as the mid-crustal magma body. It may be these structures which cause the residual averages to be negative for all stations.

Stations CM and SC, even though passing through the Socorro caldera as WT does, are arriving early with respect to WT. Note that in all cases the depths sampled in the caldera are not the same, i.e. raypaths to SC and CM sample much shallower depths of this structure than raypaths to WT.

The residual at station CC indicates a slightly early arrival with respect to WT. Inasmuch as both CC and WT

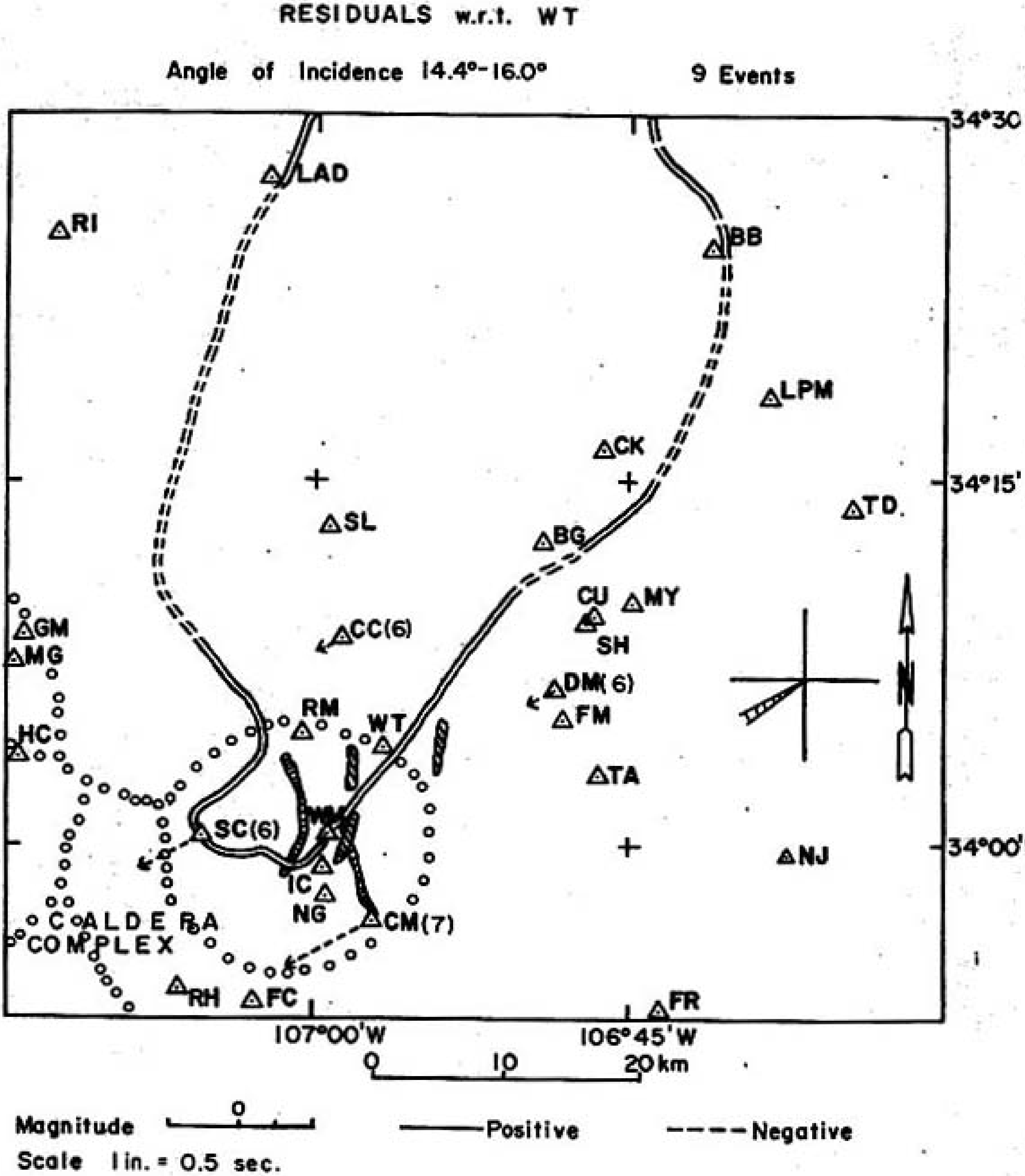


Figure 7B. Plot of residual averages for events 235° - 245° azimuth.

pass through the mid-crustal magma body, the difference could be the result of the added delay at WT arising from the proposed shallow magma body to the west of that station.

Station DM, whose raypaths do not intersect any of the proposed magma has a residual indicating an early arrival with respect to WT, but late relative to SC and CM. This could again be the result of previously undetected low velocity material in the lower crust and upper mantle beneath the Socorro caldera.

Northwest Quadrant. For this group of events (azimuth 296° - 343°, angle of incidence 14.5° - 63.2°, Figure 7C, and Table 4) the raypaths for base station WT pass through the mid-crustal magma body. This is also the case for raypaths to stations CC and NG, but the residuals for these stations indicate early arrivals relative to WT. This may reflect changing thickness of the mid-crustal magma body.

Stations CM and SC are early relative to WT, the difference between CM and SC possibly being attributed to some of CM's raypaths ($i \geq 26°$) encountering the mid-crustal body.

Stations GM and HC are showing positive residuals relative to WT. These inferred time delays are even greater when the azimuths sampled are constrained (see Table 4). Some of this delay could be attributed to crustal thickening to the west of the study area (Sanford, 1968). Calculations reveal that an approximately 0.14 second delay could be

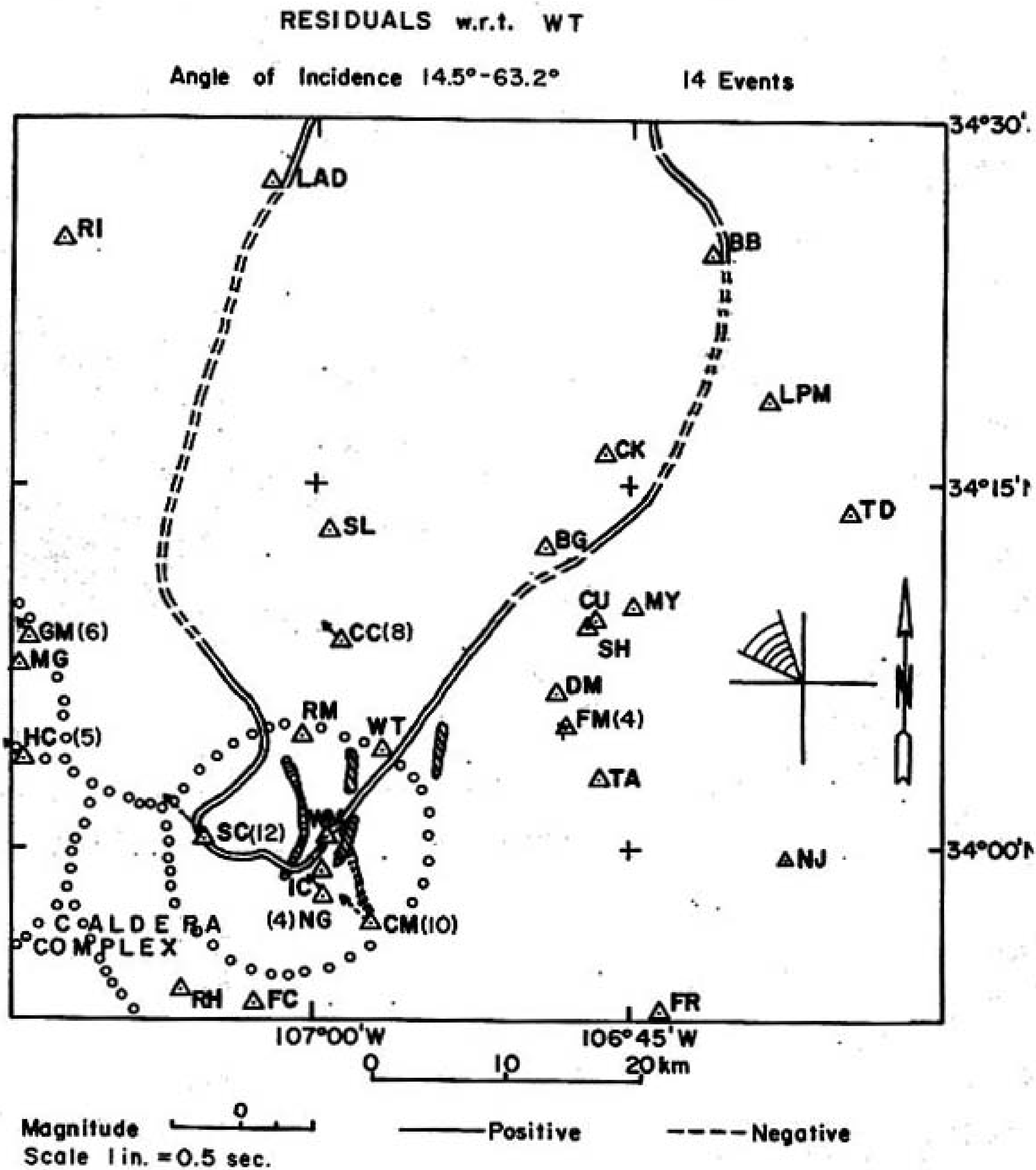


Figure 7C. Plot of residual averages for events 296° - 343° azimuth.

attributed to this crustal thickening (Sanford, personal communication, 1979). Figure 8 illustrates this effect on events approaching from the northwest and southwest, but it will not support delays at GM for events arriving from the southeast.

The late arrival at FM relative to WT may indicate that low velocity material exists in the lower crust beneath the mid-crustal magma.

Station Residuals - CC as a Base Station

Like the previous section, the standard deviations for station residuals with CC as a base are lower than those obtained using ALQ as a base. I have plotted the relative residuals with respect to CC in the same manner as Fischer (1977) for comparison with his results (Appendix 4). However, as before, interpretation of my results are made after the events are separated into three quadrants and the residuals plotted on a simplified geologic-geophysical map. Remember that if the CC base station arrival is delayed due to a shallow intrusive or the mid-crustal magma body, then all other delayed arrivals could have residuals with respect to CC which are reduced in magnitude, or even negative (as in Table 5) if the delay is sufficiently large at CC.

Southeast quadrant. For this group of events (azimuth 89° - 172°, angle of incidence 14.6° - 40°, Figure 9A, and Table 5), the raypaths to the base station CC pass through the mid-crustal magma body and possibly a proposed shallow

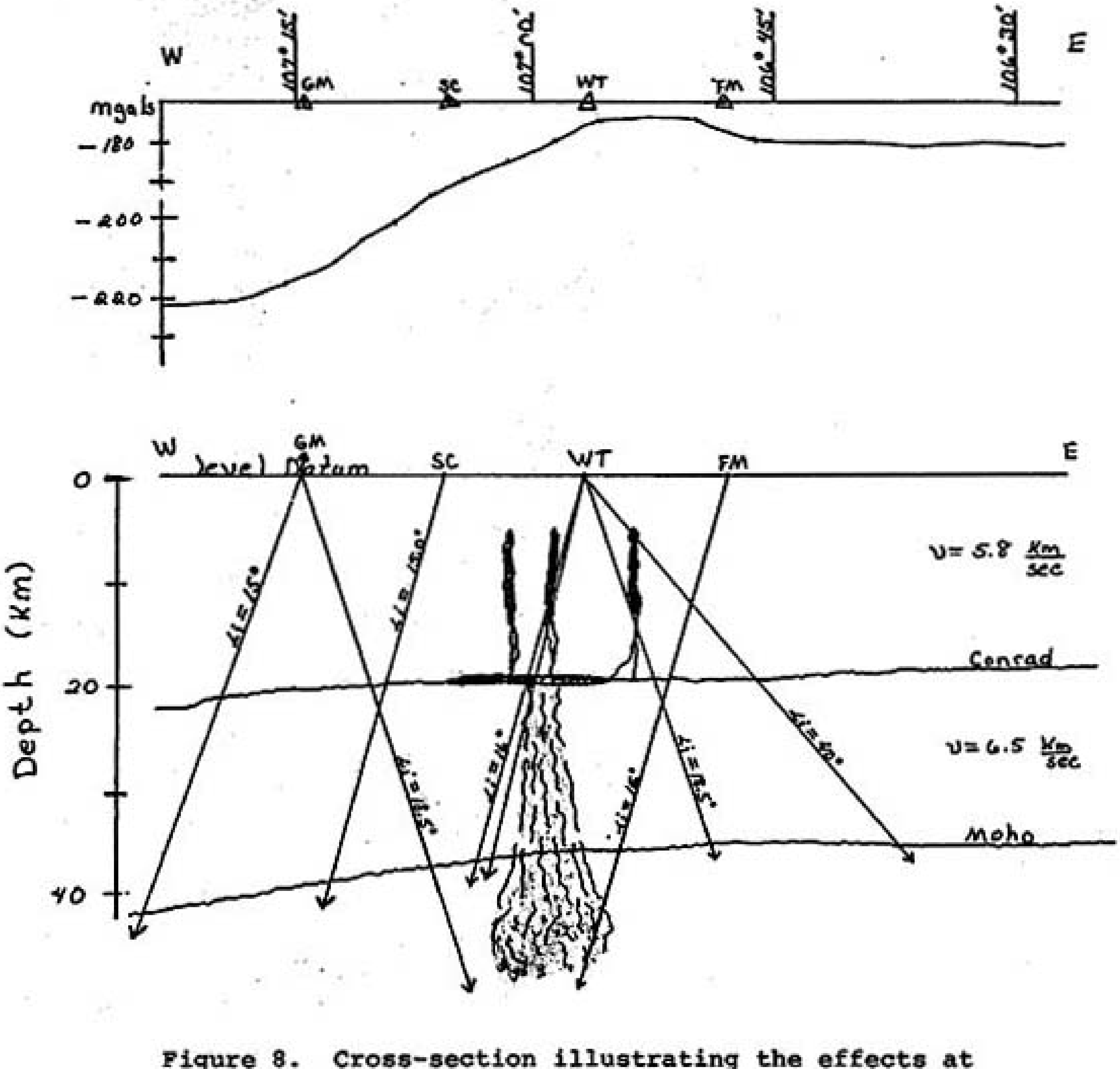


Figure 8. Cross-section illustrating the effects at seismic stations due to the shallow intrusives and/or the mid-crustal magma body.

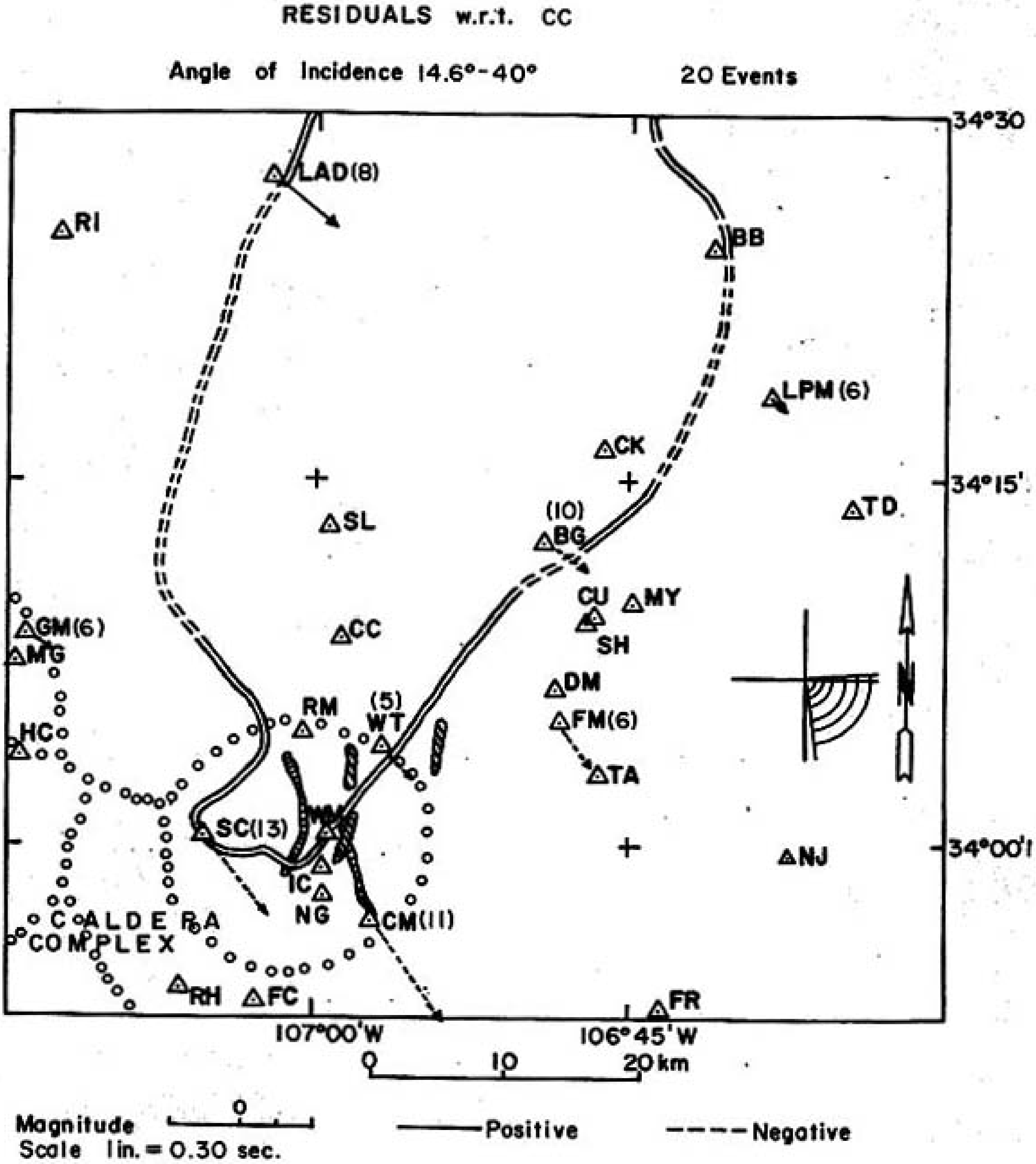


Figure 9A. Plot of residual averages from events 89° - 172° azimuth.

TABLE 5. RESIDUALS WITH RESPECT TO CC

STA	Ave. ± Std. Dev.	Events Ave.	Comments
Azimuth 89°-172° Angle of Incidence 14.6°-40° 20 Events			
SC	-0.227 ± 0.135	13	89°-140° - 0.233 ± 0.078 4
			141°-142° - 0.010 ± 0.113 2
			142°-172° - 0.286 ± 0.108 7
CM	-0.275 ± 0.124	11	
BG	-0.093 ± 0.253	10	127°-142° - 0.203 ± 0.061 3
			97°-110° + 0.110 ± 0.071 2
			146°-147° + 0.087 ± 0.042 3
LAD	+0.170 ± 0.267	8	74°-97° - 0.185 ± 0.106 2
			110°-147° + 0.285 ± 0.183 6
LPM	+0.022 ± 0.277	6	
FM	-0.108 ± 0.172	6	
GM	-0.037 ± 0.101	6	89°-110° - 0.155 ± 0.035 2
			127°-147° + 0.023 ± 0.051 4
WT	-0.068 ± 0.115	5	
SL	+0.123 ± 0.076	3	Δ_1 = 18.2°-24.4°
RI	+0.043 ± 0.142	3	
CK	+0.060 ± 0.014	2	
NG	-0.180 ± 0.028	2	
TD	-0.065 ± 0.134	2	
MY	-0.085 ± 0.064	2	
BB	-0.120 ± 0.212	2	
Azimuth 189°-245° Angle of Incidence 14.4°-55.4° 14 Events			
SC	-0.258 ± 0.134	8	
FM	-0.059 ± 0.183	7	
WT	+0.118 ± 0.049	6	
BG	+0.204 ± 0.332	5	189°-203° + 0.550 ± 0.156 2
			239°-242° - 0.027 ± 0.095 3
CM	-0.240 ± 0.034	5	
LAD	+0.243 ± 0.279	4	189°-242° + 0.370 ± 0.140 3
DM	+0.010 ± 0.107	4	
GM	+0.037 ± 0.070	3	
TD	-0.093 ± 0.126	3	
LPM	+0.043 ± 0.095	3	
RI	-0.185 ± 0.247	2	
SL	+0.080 ± 0.042	2	
CK	+0.150 ± 0.042	2	
BB	-0.055 ± 0.078	2	
SH	-0.070 ± 0.141	2	No station correction

TABLE 5. RESIDUALS WITH RESPECT TO CC (CONTINUED)

STA	Ave. ± Std. Dev.	Events Ave.	Comments
Azimuth 289°-330° Angle of Incidence 14.6°-63.2° 23 Events			
SC	−0.178 ± 0.063	14	
CM	−0.102 ± 0.135	13	
GM	+0.072 ± 0.080	10	
FM	+0.004 ± 0.120	10	
BG	−0.059 ± 0.186	10	
LAD	+0.187 ± 0.257	9	
WT	+0.084 ± 0.096	8	
LPM	+0.016 ± 0.220	7	
RI	−0.048 ± 0.120	6	311°-321° - 0.006 ± 0.068 5
TD	−0.084 ± 0.086	5	
BB	−0.100 ± 0.057	2	
SL	−0.015 ± 0.092	2	
CK	−0.100 ± 0.014	2	
DM	+0.185 ± 0.092	2	
IC	−0.065 ± 0.007	2	

magma body to the east of station WT. The effect of the shallow intrusive may become apparent at angles of incidence ≥ 30°. Note this assumes a depth for the shallow intrusive of at least 21 kilometers. As the angle of incidence decreases, the effect should be due to the mid-crustal magma body only.

The residuals in Table 5 show that SC and CM both have early arrivals relative to CC. The raypaths to station CM are probably the least affected by low velocity structures inasmuch as it has the highest negative average in the group.

Station WT, whose average residual is based on raypaths all lying south of the shallow intrusive (as mapped), is only slightly early relative to CC. This indicates that WT is being delayed which may add support for an extension of the shallow intrusive to the south.

The residual at station LAD indicates arrivals are late on the average with respect to CC. However, the large standard deviation and change in the sign of the residual with azimuth (see Table 5) makes interpretation impossible.

Residuals at stations LPM and BG should not be influenced by the mid-crustal magma body. All of the stations show fairly high standard deviations which may reflect rapid lateral changes in crustal structure. These large deviations makes interpretation almost useless, if not impossible.

Inasmuch as station GM does not pass through any of the postulated magma bodies, its small residual with respect to CC must arise from some other cause, perhaps (as suggested before) because of low velocity material in the lower crust or upper mantle beneath the Socorro caldera.

<u>Southwest Quadrant</u>. For this group of events (azimuth 189° - 245°, angle of incidence 14.4° - 55.4°, Figure 9B, and Table 5) all raypaths to the base station CC pass through the mid-crustal magma body. Raypaths to station WT pass through a shallow intrusive as well as the mid-crustal magma body and this may be the reason for the positive residuals at that station.

Both station CM and SC are early relative to CC, apparently because raypaths to these stations do not pass through any of the postulated magma bodies. Station LAD's delay relative to CC may be partially explained by crustal thickening to the west (Sanford, 1968), but it is unlikely that it would be the total cause as SC would surely show some effect of this influence.

The large positive residual at BG may be the result of raypaths passing through a shallow magma body as well as the mid-crustal magma body. Support for a shallow intrusive southwest of station BG is found in Fender, 1978.

The slightly negative residual at FM relative to CC and the slightly positive residual at DM may be the result of low velocity material in the lower crust and upper mantle. Figure 8 shows the depth sampled for most raypaths to FM in

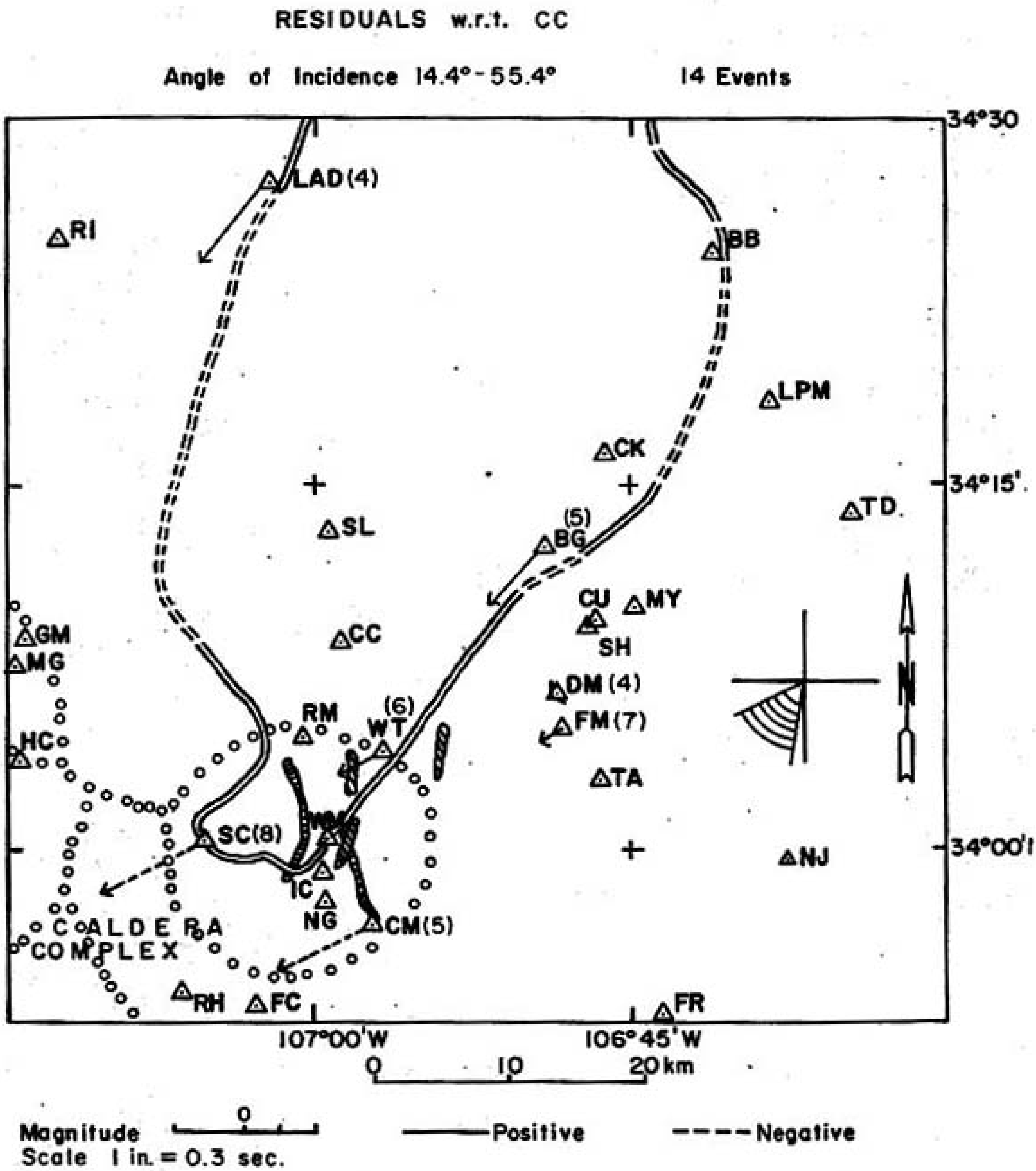


Figure 9B. Plot of residual averages from events 189° - 245° azimuth.

this quadrant. The late arrivals at DM are also sampling approximately the same depths. It is apparent that none of the raypaths intersect the deep magma body.

Northwest quadrant. For this group of events (azimuth 289° - 330°, angle of incidence 14.6° - 63.2°, Figure 9C, and Table 5) the raypaths to the base station pass through the mid-crustal magma body. Residuals again indicate that stations SC and CM are early relative to CC.

Residuals for stations GM and LAD, which are west of the mid-crustal magma body boundaries, indicate late arrivals relative to CC. As mentioned in the previous section, crustal thickening could cause delays of around 0.14 seconds to the west of the study area and this could account for some of the delay at GM and LAD. It is not known why the RI residual is not essentially the same as GM and LAD if crustal thickening is the cause.

No raypaths at station FM pass through the mid-crustal magma body but the residual average indicates a value approximately the same as CC. Unless anomalous material is being encountered under the mid-crustal body, the delay cannot be accounted for using known structures.

Raypaths to station WT, as well as the base station CC, pass through the mid-crustal magma body. The positive residual at WT could be attributed to a thickness difference in the mid-crustal body. The raypaths traveling to BG also pass through the deeper magma body. If the slightly negative residual relative to CC can be considered real, then this may

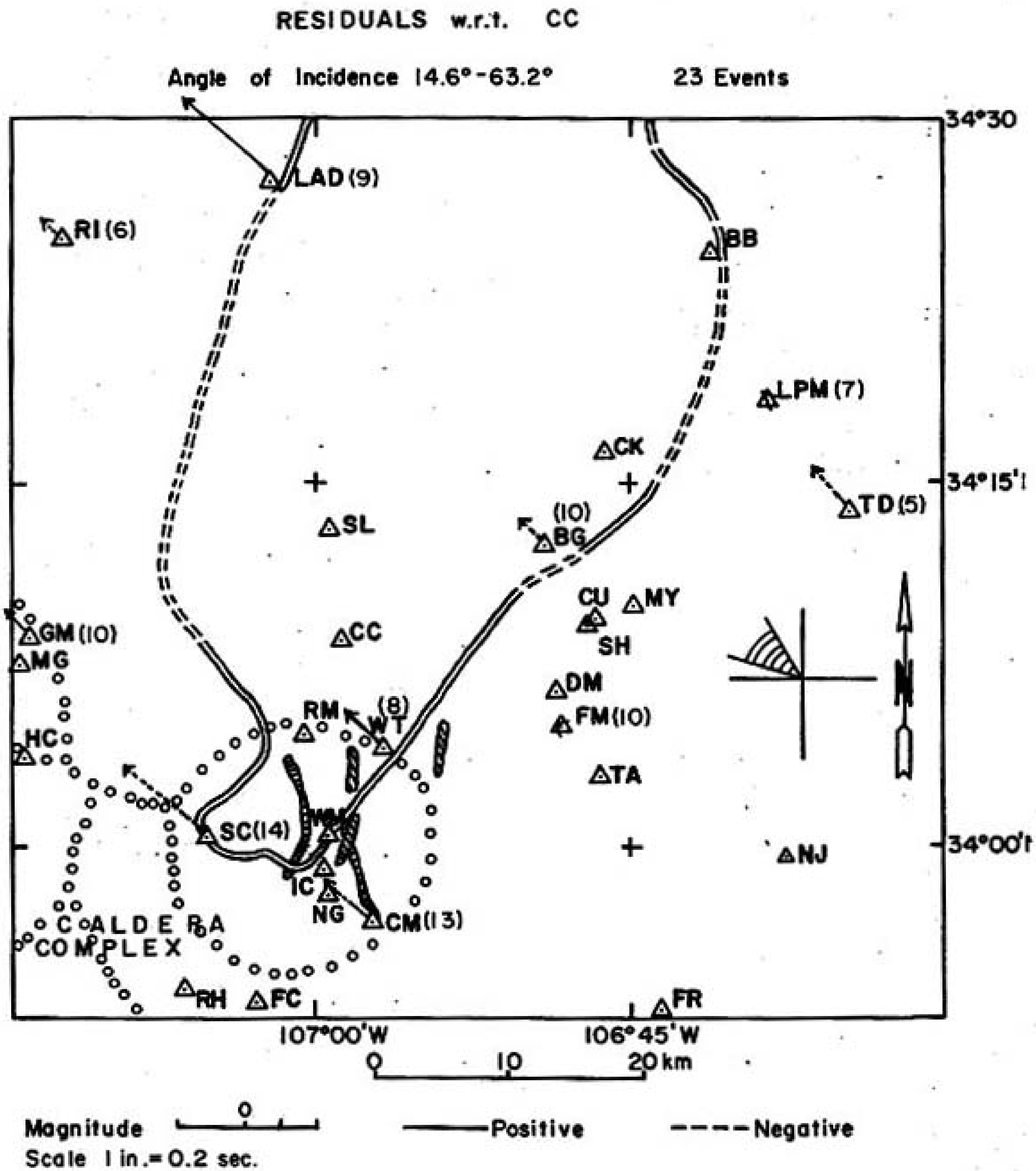


Figure 9C. Plot of residual averages for events from 289° - 330° azimuth.

also support a variation in thickness of the mid-crustal magma layer.

Some raypaths to station LPM probably pass through the mid-crustal magma layer and some not; the higher standard deviation may reflect the differences in paths. Raypaths to station TD are not sampling the deeper magma body (as presently mapped) and this probably is the reason for the negative residual, even though it is not as negative as might be expected for arrivals not encountering magma or anomalous geologic structure.

CONCLUSIONS

Although the standard deviations are extremely large, the nearly systematic change in the sign of the event residuals with respect to ALQ with increasing azimuth appears to be significant and may reflect gross differences in crustal structure between ALQ and the Socorro area stations. An interesting aspect of this data set is the large number of positive residuals in the southwest and northwest quadrants. Previous studies have indicated that the crust is thicker at ALQ than in the immediate vicinity of Socorro (Toppozada, 1974; Toppozada and Sanford, 1976; Olsen et al., 1979). Regional gravity data (Sanford, 1968) indicate probable thickening of the crust to the west of Socorro but the computed thickening makes the crust traversed by raypaths to the Socorro stations on the average no greater in thickness (probably slightly less) than beneath the ALQ station. Thus a difference in crustal thickness cannot explain the positive residuals observed for events arriving from the southwest and northwest at the Socorro stations. Admittedly for events from these directions, a majority of the stations used in the study do have raypaths which intersect the proposed magma bodies, but I feel at this time, due to the lack of knowledge of crustal structure at ALQ, that these delays, cannot be attributed with certainty to the magma bodies in the Socorro area.

Average station residuals listed in Tables 4 and 5 indicate that SC and CM have early P arrivals relative to CC and WT. Inasmuch as crustal structure and velocity are not likely to change greatly over the volume of crust sampled by raypaths to these stations, the probable reason for this observation is that arrivals to stations CC and WT are delayed because of passage through the mid-crustal magma layer and/or the postulated shallow magma bodies.

An alternate explanation for this observation is that station corrections for CM and SC are too large relative to WT and CC. However, the information to date from surface explosions and residuals from microearthquake locations suggests that the station corrections are reasonably accurate — to perhaps ± 0.05 second (Sanford, personal communication, 1979).

Arrivals at GM and HC for events approaching from the southeast and arrivals at DM and FM from the southwest are delayed more than expected from crustal structure. These delays may be attributed to the possible existence of low velocity regions in the lower crust or upper mantle beneath the Socorro caldera.

Large standard deviations (>0.20) that substantially exceed errors that can be attributed to residual calculation error (reading, clock drift, and distance round-off) can probably be associated with rapidly varying crustal structure in the vicinity of the station. Stations which have higher standard deviations than expected on the relative residuals are: LAD and BG for events from the southwest and LPM for events from the northwest.

Residuals at WT compare closely with those from CC for events arriving from the southeast. Because raypaths traveling to CC from the southeast pass through the mid-crustal magma body but those to WT do not, the residual at WT must have another explanation. Southward extension of the shallow magma body to the east of WT would insert low velocity material in the raypaths to station WT.

Late residuals at LPM relative to CC, which has raypaths passing through the mid-crustal body, may indicate the boundary of this magma body could lie further to the east in the vicinity of LPM.

Large positive residuals for events arriving at BG from the southwest may add support for a shallow magma body in the vicinity. Fender's (1978) data does indicate a low velocity region in the upper crust in this area.

Consistent late arrivals for events from the northwest at GM and HC relative to WT and at GM and RI relative to CC may be partially explained by crustal thickening (Sanford, 1968) to the west of the study area. At present, the remaining delay cannot be explained by known structures.

Calculated residuals for station LAD, which were recorded on the Kinematics PS-1, may contain additional errors because of a few inaccurate time corrections, variable event character, and possible phase reversals (caused by reversed connections). Thus interpretation of LAD residuals is uncertain.

RECOMMENDATIONS

Suggestions for future studies should center on collection of additional good quality events with an emphasis on finding events arriving from the northeast. Even though these events are probably of a lower quality than those used in this study, the method I have used may allow these events to be analyzed if care is taken in reading arrival times.

For each quadrant some attempt should be made, using station residuals with respect to WT or CC, to divide events into narrower ranges of angles of incidence to better isolate effects due to complex structure or magma bodies in a station's vicinity.

Any future study in this area, using P or P_n arrivals of distant events should make an attempt to determine if the station corrections used have azimuthal dependence and to what depth the applied correction will hold true.

Most important in any future study of this type is to avoid rounding-off distances to the nearest 0.01 degree as this can cause an error ranging from ± 0.10 second for events at distances of less than 12° to ± 0.03 second for events at distances of near 100°. The possible effect of this error on the data set used in this study can be estimated from the histogram of number of events versus distance shown in Figure 10.

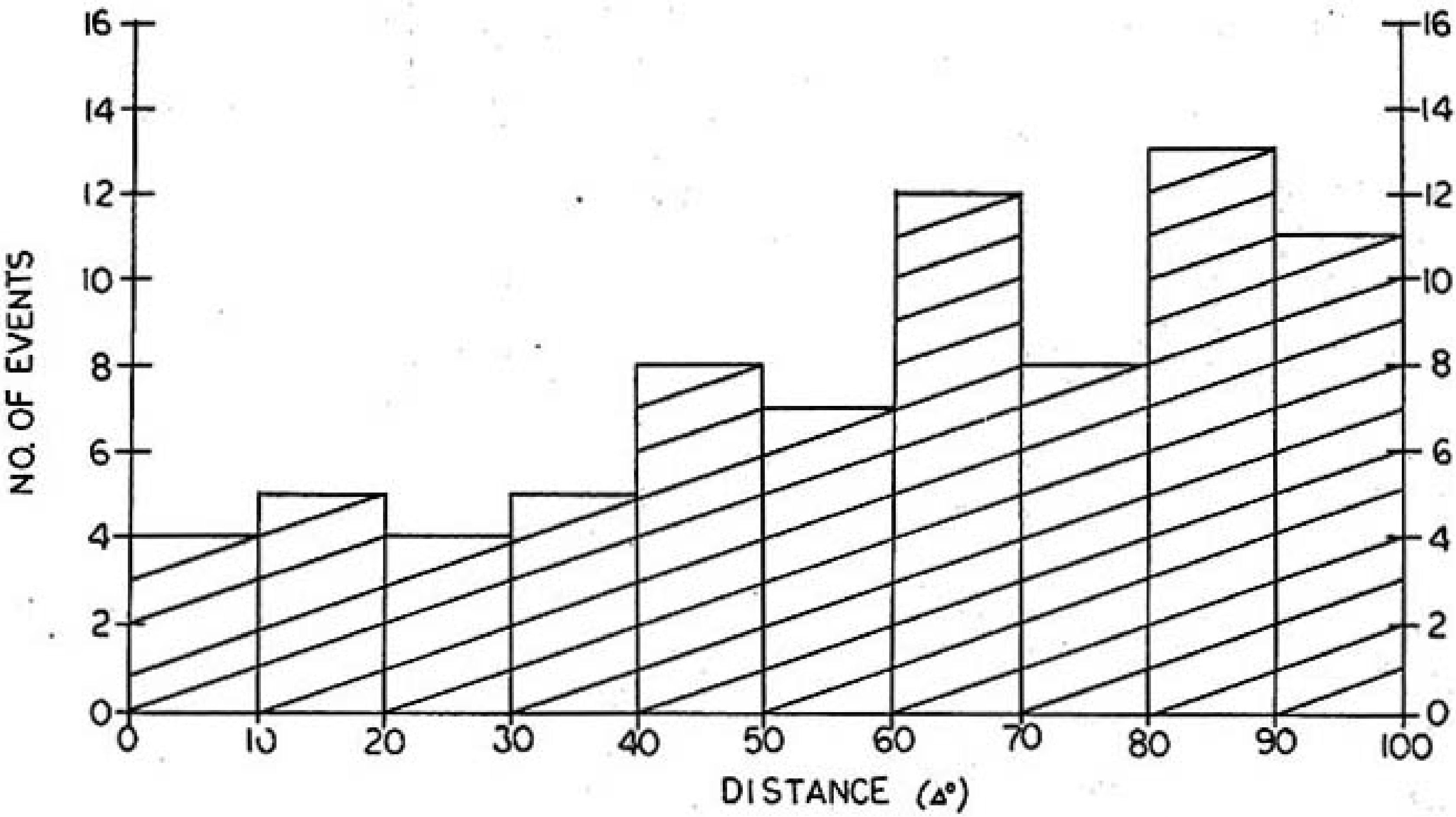


Figure 10. Histogram showing distance distribution for events used in this study.

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● Denotes event not used in event residual average or station residual average for ALQ.

Date / Origin time / Latitude / Longitude / Focal Depth / Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theo)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o sta. correction	Residual w.r.t. Base w/ sta. correction
2/16/77	74	19.8	ALQ	01:00:30.99	10:59.78	10:55.53	ok		—	3.91	—	—
00:49:31.2			SC	:35.78	11:05.58	11:00.44	−.17	−0.25	−0.04	3.93	−0.28	−0.53
25.973N			CC	:34.96	10:03.26	10:59.62	−.03	0.12	0.03	3.64	−0.57	−0.45
26.258W			IC	:35.05	:03.85	11:00.00	−.02	−0.14	0.08	3.85	−0.36	−0.50
33			WT	:34.38	:03.18	10:59.62	+.03	0.15	0.05	3.64	−0.57	−0.42
5.5			DM	:33.72	:02.52	:58.87	+.01	0.06	0.05	3.71	−0.50	−0.44
			CM	:34.86	:03.66	:59.87	−.04	−0.18	0.03	3.78	−0.42	−0.61
			LAD	:43.56	:12.36	:59.31	−9.63	0.22	0.01	3.43	−0.78	−0.56
7/28/77	89	24.6	ALQ	00:45.30	13:12.60	13:08.04	ok		—	4.56	—	—
01:47:32.7			CC	:47.03	:14.33	:10.02	+.03	0.12	0.03	4.31	−0.25	−0.13
1.149S			LAD	not recorded								
14.635W			LPN	:45.85	:13.15	:08.74	−.16	0.21	0.02	4.27	−0.29	−0.08
33			SC	:43.96	:11.26	:10.49	−1.28	−0.25	−0.04	4.45	−0.11	−0.36
5.3			SM	:48.00	:15.30	:11.04	−.03	0.04	−0.02	4.21	−0.35	−0.31
			CM	:45.25	:12.55(?)	:09.98	−.13	−0.18	0.03	2.57		
			BG	:56.32	:23.62	:09.48	−9.89	0.00	0.06	4.31	−0.25	−0.25
12/13/77	97	29.4	ALQ	:23:05.97	8:47.37	8:42.78	ok		~	4.59	—	—
01:19:18.6			LPN	:05.97	:47.37	:43.33	ok	0.21	0.02	4.06	−0.52	−0.31
17.359N			CK	:06.38	:48.28	:45.17	−.01	−0.04	0.04	4.14	−0.44	−0.48
54.898W			BB	too noisy								
33			BG	:07.04	:48.44	:44.40	ok	0.00	0.25	4.19	−0.40	−0.27
5.7			CC	:07.88	:49.28	:45.39	−.01	0.12	0.13	3.91	−0.67	−0.55
			SL	:08.10	:49.50	:45.46	−.16	0.08	0.04	4.02	−0.56	−0.58
			LAD	:10.63	:52.03	:46.00	−2.49	0.22	0.01	3.55	−1.03	−0.81

Appendix 1. Residuals with respect to ALQ, pp. 58-79.

Date / Origin time / Latitude / Longitude / Focal Depth / Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor)	Corrections Applied			Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
							Clock	Station	Elevation			
7/15/76			AIA	:15:36.25	7:39.65	7:35.22	ok		—	4.43	—	—
00:07:56.6			WT	:37.62	:41.02	:37.12	ok	0.15	0.05	3.95	−0.48	−0.33
19.218 N			SC	:38.28	:41.68	:38.03	+0.17	−0.25	−0.03	3.79	−0.64	−0.89
64.134 W	100	26.3	NG	:37.76	:41.16	:37.28	−0.03	−0.13	0.02	3.87	−0.56	−0.69
33 -			GM	:40.86	:44.26	:39.18	−1.25	0.04	−0.01	3.82	−0.61	−0.57
5.0			HC	:38.73	:42.13	:39.10	1.00	−0.12	−0.06	3.97	−0.46	−0.52
			RM	:38.17	:41.57	:37.33	−0.02	−0.24	0.02	4.04	−0.39	−0.63
7/1/76			BIA	:46:21.59	8:09.49	8:05.08	ok		—	4.41	—	—
03:38:12.1			SC	:24.57	:12.47	:07.64	−0.72	−0.25	−0.03	4.08	−0.33	−0.58
16.597 N			HC	:25.13	:13.03	:08.67	−0.08	−0.12	−0.06	4.22	−0.19	−0.31
61.241 W			GM	:25.01	:12.91	:08.83	−0.24	0.04	−0.01	3.83	−0.58	−0.54
36	101	25.5	RM	:23.55	:11.45	:07.24	−0.04	−0.24	0.02	4.19	−0.22	−0.46
5.1			NG	:42.89	:30.79	:06.92	−20.03	−0.13	0.02	3.86	−0.55	−0.68
			WT	:22.77	:10.67	:06.84	ok	0.15	0.05	3.88	−0.53	−0.38
9/21/77			AIA	13:42.53	8:29.83	8:25.32	ok		—	4.51	—	—
16:05:12.7			RI	:13:45.91	:33.21	:28.52	−.05	−0.12	0.05	4.69	0.18	0.06
10.498 N			GM	:13:44.98	:32.28	:27.98	−.05	0.04	−0.02	4.23	−0.28	−0.24
62.573 W	110	24.9	FM	:13:42.54	:29.84	:25.17	−.27	0.00	0.05	4.45	−0.06	−0.06
33			BG	:42.82	:30.12	:25.56	−.05	0.00	0.05	4.56	0.05	0.05
5.2			CC	:43.49	:30.79	:26.42	+.06	0.12	0.03	4.28	−0.05	0.07
			LAO	:47.38	:34.68	:27.51	−2.85	0.22	0.01	4.33	−0.18	0.04
			TO	too noisy								

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theo)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o Stat. Correction	Residual w.r.t. Base w/ Stat. Correction
9/1/77			AIG	:44:34.03	7:27.23	7:23.23	ok		—	4.00	—	—
17:37:06.8			GM	:34.31	:27.51	:23.36	−.08	0.04	−0.01	3.86	−0.14	−0.10
7.443N			LAO	:37.43	:30.63	:23.98	−2.46	0.22	0.01	4.20	0.20	0.42
76.258W	127	26.8	NG	:31.91	:25.11	:21.30	+.05	−0.13	0.02	3.82	−0.18	−0.05
2t			SC	:33.23	:26.43	:22.05	−.32	−0.25	−0.03	4.03	0.03	−0.22
5.3			CC	:32.66	:25.86	:22.14	+.04	0.12	0.03	3.79	−0.21	−0.09
			CM	:31.64	:24.84	:21.05	−.08	−0.18	0.03	3.74	−0.26	−0.44
			BG	:31.98	:25.18	:21.55	−.04	0.00	0.05	3.64	−0.36	−0.36
8/31/77			AIG	:49:33.19	7:27.79	7:23.01	ok		—	4.78	—	—
00:42:05.4			SC	:32.06	:26.66	:21.83	−.15	−0.25	−0.03	4.65	−0.13	−0.38
7.335N			NG	:31.02	:25.62	:21.08	+.02	−0.13	0.02	4.58	−0.20	−0.33
76.298W	127	26.8	LAO	:36.37	:30.97	:23.76	−2.48	0.22	0.01	4.74	−0.04	0.18
33			GM	:33.48	:28.08	:23.34	−.04	0.04	−0.01	4.69	−0.09	−0.05
5.7			CM	:30.73	:25.33	:20.83	−.04	−0.18	0.03	4.49	−0.29	−0.47
			CC	:31.80	:26.40	:21.92	+.02	0.12	0.03	4.53	−0.25	−0.13
			BG	:31.16	:25.76	:21.33	−.02	0.00	0.05	4.46	−0.32	−0.32
11/5/75			AIG	02:06:23.15	7:29.25	7:25.23	ok		—	4.02	—	—
01:58:54.4			MY	:20.67	:26.27	:22.75	−.09	0.05	0.03	3.48	−0.54	−0.46
6.253N			CC	not recorded								
76.918W	128	26.8	DIT	:29.5	:34.75	:21.22	−10.08		0.03	3.48	−0.54	
44			CM	:20.31	:25.91	:22.21	ok	−0.18	0.03	3.63	−0.39	−0.57
5.4			WT	:21.28	:26.88	:23.21	ok	0.15	0.05	3.62	−0.40	−0.25
			SC	:21.95	:27.55	:23.81	ok	−0.25	−0.0[illegible]	3.71	−0.31	−0.56

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o Stat. Correction	Residual w.r.t. Base w/ Stat. correction
8/10/76			AIQ	:18:14.58	7:44.68	7:42.95	OK		—	4.73	—	—
00:10:26.9			WT	:11.51	:44.61	:40.25	−0.01	0.15	0.05	4.40	−0.33	−0.18
2.136N			SC	:12.01	:45.11	:40.57	0.02	−0.25	−0.03	4.53	−0.20	−0.45
79.024W	135	26.3	HC	:13.26	:46.36	:41.64	−0.01	−0.12	−0.06	4.65	−0.08	−0.20
33			CM	not recorded								
5.5			NG	:11.94	:44.44	:39.84	−0.01	−0.13	0.02	4.61	−0.12	−0.25
			FC	:11.42	:44.52	:39.75	0.00	−0.27	0	4.77	0.04	−0.23
5/27/76			AIQ	:53:22.04	7:11.94	7:07.18	OK		—	4.76	—	—
14:46:10.1			WT	:18.15	:08.05	:04.12	OK	0.15	0.05	3.98	−0.78	−0.63
4.940N			NJ	:26.55	:16.45	:02.08	−10.11		0.03	4.29	−0.47	
82.561W	137	27.3	DM	:18.98	:08.88	:03.69	− 1.23	0.06	0.05	4.01	−0.75	−0.69
33			ER	:15.99	:05.89	:01.82	−0.02		0.04	4.09	−0.67	
4.8			CM	:17.52	:07.42	:03.44	+0.07	−0.18	0.03	4.08	−0.68	−0.86
			TA	:17.30	:07.20	:03.10	−0.04	0.05	0.04	4.10	−0.66	−0.61
6/26/75			AIQ	:40:38.92	5:21.32	5:17.84	OK		—	3.48	—	—
06:45:17.6			SC	:35.87	:18.27	5:14.23	−.04	−0.25	−0.03	3.97	0.49	0.24
13.995N	140	29.9	CC	:36.09	:18.49	:14.60	OK	0.12	0.03	3.92	0.44	0.56
90.770W			EM	:44.85	:27.25	:13.30	−10.07	0.00	0.05	3.93	0.45	0.45
76 4.8			CM	:34.74	:17.14	:13.12	−.07	−0.18	0.03	3.98	0.50	0.32
2/5/76			AIQ	h:57.51	10:45.81	10:41.82	OK		—	3.99	—	—
09:53:11.7			CC	:54.61	:42.91	:39.61	OK	0.12	0.03	3.30	−0.69	−0.57
21.702S			DM	:53.80	:42.10	:38.88	−.22	0.06	0.05	3.05	−0.94	−0.88
68.222W	141	20.2	SC	:54.67	:42.97	:39.39	−.03	−0.25	−0.04	3.58	−0.41	−0.66
98			SH	:54.01	:42.31	:39.00	−.11		0.04	3.24	−0.75	
5.8			WT	:53.88	:42.18	:39.13	OK	0.15	0.05	3.10	−0.89	−0.74

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
8/20/76 06:54:11.3 20.412S 69.993W 81 5.6	141	20.6	AIQ	07:04:		10:30.98			—			
			GM	:44.86	10:33.56	:29.48	−0.37	0.04	−0.02	3.69		
			FC	:52.73	:41.43	:27.58	−10.06	−0.27	0	3.79		
			NG	:52.62	:41.32	:27.78	−10.05	−0.13	0.02	3.51		
			HC	:44.53	:33.23	:29.08	−0.45	−0.12	−0.06	3.64		
			WT	:42.74	:31.44	:28.10	−0.05	0.15	0.05	3.34		
			SC	:43.51	:32.21	:28.30	−0.14	−0.25	−0.04	3.73		
3/8/77 13:08:56.3 11.961S 74.202W 41 5.6	141	22.9	AIQ	:18:32.92	9:36.62	9:32.01	OK		—	4.61	—	—
			SC	:30.36	:34.06	:29.28	OK	−0.25	−0.04	4.74	0.17	−0.08
			WT	:29.91	:33.61	:29.06	+.02	0.15	0.05	4.62	0.01	−0.16
			DM	:28.60	:32.30	:28.78	+1.01	0.06	0.05	4.58	−0.03	0.03
			GM	:31.86	:35.56	:30.58	−.01	0.04	−0.02	4.95	0.34	0.38
			LPN	:30.26	:33.96	:29.21	−.13	0.81	0.02	4.64	0.03	0.24
			CM	:29.46	:33.16	:28.49	−.04	−0.18	0.03	4.66	0.05	−0.13
			LAP		no record							
9/20/77 16:23:13.3 23.354S 68.328W 114 5.3	142	19.9	AIQ	:34:	10:	10:42.42			—			
			GM	:03.69	:50.59	:46.99	−.03	0.04	−0.02	3.55		
			RI	:05.20	:51.90	:48.30	−.02	−0.12	0.05	3.63		
			BG	:02.72	:49.42	:45.98	−.02	0.00	0.05	3.47		
			CC	:02.90	:49.60	:46.16	+.03	0.12	0.03	3.50		
			TD	:01.96	:48.66	:45.34	−.03	0.17	0.00	3.29		
			FM	not	recorded							
			LAP	too	small							

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o S.t. correction	Residual w.r.t. Base w/ S.t. correction
6/24/75			AIQ	:30:27.77	10:40.37	10:37.04	ok		—	3.33	—	—
00:39:47.4			SC	:30:25.27	:37.87	10:34.36	ok	−0.25	−0.04	3.47	0.14	−0.11
20.611S			CC	:25.30	:37.90	:34.69	ok	0.12	0.03	3.03	−0.30	−0.18
70.115W 33	142	20.7	CM	:24.36	:36.96	:33.64	−.07	−0.18	0.03	3.88	−0.05	−0.23
5.6			FM	:34.31	:46.91	:33.78	−10.01	0.00	0.05	3.17	−0.16	−0.16
2/23/77			AIQ	:40:54.97	4:49.97	4:46.43	ok		—	3.54	—	—
19:36:05.0			IC	:40:00.30	:55.30	:41.96	−10.02	−0.14	0.02	3.84	0.30	0.16
15.925 N	142	32.4	CC	:39:51.60	:46.60	:42.66	−.02	0.12	0.03	3.95	0.41	0.53
93.345 W			WT	:50.60	:45.60	:41.86	−.03	0.15	0.04	3.75	0.81	0.76
118			SC	:51.10	:46.10	:42.06	+.04	−0.25	−0.03	4.05	0.51	0.26
4.9			CM	:49.93	:44.93	:40.95	−.08	−0.18	0.03	3.93	0.39	0.21
10/28/75			AIQ	:05:13.20	10:50.80	10:47.41	ok		—	3.39	—	—
06:54:20.4			SC	:10.26	:47.86	:44.58	ok	−0.25	−0.04	3.24	−0.15	−0.40
22.962S			CC	:10.44	:48.04	:44.90	ok	0.12	0.03	3.17	−0.22	−0.10
70.508W			NS	:18.77	:56.37	:42.97	−10.03		0.03	3.40	0.01	
38 5.9	143	20.4	WT	:16.02	:47.62	:44.45	+.01	0.15	0.05	3.23	−0.16	−0.01
			MY	:09.85	:47.44	:44.26	−.04	0.08	0.03	3.17	−0.22	−0.14
			CM	:09.48	:47.08	:43.87	ok	−0.18	0.03	3.84	−0.15	−0.33
6/7/77			AIQ	:42:50.85	11:26.55	11:23.28	ok		—	3.27	—	—
13:31:24.3			LPN	:48.15	:23.85	:20.72	+.02	0.21	0.02	3.17	−0.10	0.11
29.327S			SM	:49.22	:24.92	:21.65	−.01	0.04	−0.02	3.24	−0.03	0.01
67.745W	145	18.5	DM	:47.40	:23.10	:20.25	−.02	0.06	0.05	2.88	−0.39	−0.33
111			WT	:47.58	:23.28	:20.48	+.04	0.15	0.05	2.89	−0.38	−0.23
5.2			SC	:48.15	:23.85	:20.60	−.12	−0.25	−0.04	3.09	−0.18	−0.43
			LPO	no record found								

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o Stat. Correction	Residual w.r.t. Base w/ Stat. correction	
6/25/75			AIQ	09:	4:	4 : 43.44			—				
06:05:13.0			CC	:47.29	:44.29	4 : 39.17	ok	0.12	0.03	5.15			
16.172 N	145	34.8	FM	10: 65.96	:52.96	:37.71	−10.05	0.00	0.04	5.24			
94.436 W			SC	09: 56.69	:43.69	:38.55	−.02	−0.25	−0.03	5.09			
66 4.8			CM	:55.55	:42.55	:32.39	−.07	−0.18	0.03	5.12			
12/6/77			AIQ	:16:50.83	11:44.43	11 :40.80	ok		~	3.63	—	—	
17:05:06.4			CC	:47.81	:41.41	:38.36	−.01	0.12	0.03	3.07	−0.56	−0.44	
31.168 S			BG	:47.95	:41.55	:38.25	−.06	0.00	0.05	3.29	−0.34	−0.34	
67.718 W			BB	17: 08.46	12:02.06	:38.83	−20.02	−0.03	0.04	3.25	−0.38	−0.41	
19	146	18.2	LPN	16: 47.97	11:41.57	:38.19	−.04	0.21	0.02	3.36	−0.27	−0.06	
5.9			CK	:48.38	:41.98	:38.42	−.13	−0.04	0.04	3.47	−0.16	−0.20	
			SL	:48.48	:42.08	:38.77	−.03	0.08	0.04	3.32	−0.31	−0.23	
			LAD	:52.64	:46.24	:39.99	−2.95	0.22	0.01	3.31	−0.32	−0.10	
1/17/78			AIQ	:44:	11:	11: 38.17			~				
11:33:13.8			LPN	:54.98	:41.18	:37.71	−.03	0.21	0.02	3.46			
31.37 S			LAD	:59.58	:45.78	:39.51	−2.46	0.22	0.01	3.62			
67.97 W	147	18.2	CC	:55.29	:41.49	:37.82	+.02	0.12	0.03	3.72			
26			BB	seismometer down									
5.5			SL	:55.88	:42.08	:38.23	−.04	0.08	0.04	3.85			
			BG	:55.44	:41.64	:37.71	−.02	0.00	0.05	3.96			
			CK	:55.64	:41.39	:37.85	−.07	−0.04	0.04	3.93			
10/5/77			AIQ	:45:	11:	11 : 13.81			—				
04:34:09.8			TD	:24.04	:14.24	:10.33	−.24	0.17	0.0	3.47			
28.248 S			RT	:26.81	:17.01	:13.20	−.06	−0.12	0.05	3.80			
70.736 W	147	19.1	LPN	:24.30	:15.50	:11.08	−.02	0.21	0.02	3.42			
52			GD	:25.37	:15.59	:11.93	−.02	0.04	−0.02	3.62			
5.4			BG	:24.46	:14.66	:11.08	+.02	0.00	0.05	3.65			
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]			

Date Origin time Latitude Longitude Focal Depth Magnitude	Hzi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o Sta. correction	Residual w.r.t. Base w/ Sta. correction
2/19/76			AIA	:36:20.59	4:49.49	4:45.72	ok		—	3.77	—	—
18:31:31.1			WT	:15.58	:44.48	:40.21	−0.03	0.15	0.04	4.28	0.51	0.66
15.935N			CC	:16.43	:45.33	4:40.95	ok	0.:2	0.03	4.41	0.64	0.76
95.076W	147	35.3	SC	:15.95	:44.85	:40.32	ok	−0.25	−0.03	4.50	0.73	0.48
33			IC	:15.41	:44.31	:39.67	−2.25	−0.14	0.02	4.41	0.64	0.50
5.1			WM	:15.38	:44.28	:39.89	−0.15	−0.12	0.08	4.26	0.49	0.37
			CM	:14.53	:43.43	:39.13	ok	−0.18	0.03	4.33	0.56	0.38
1/20/78			AIA	:54:	11:	11:43.97			~			
04:42:50.3			CK	:34.73	:44.43	:41.56	−.24	−0.04	0.04	2.67		
34.34 S			JL	:34.93	:44.63	:41.84	−.14	0.08	0.04	2.69		
68.69 W	149	17.6	LPN	:34.41	:44.11	:41.39	−.11	0.21	0.02	2.63		
100			BG	:34.18	:43.88	:41.33	−.05	0.0)	0.05	2.55		
5.5			BR	:35.55	:45.25	:42.01	−.29	−0.03	0.04	2.99		
			CC	:34.78	:44.48	:41.45	+.05	0.12	0.03	3.11		
			LAD	:38.96	:48.66	:53.07	−2.68	0.22	0.01	2.92		
5/28/75			AIA	14:09:37.78	12:03.24	12:00.01	ok		—	3.23	—	—
13:57:34.5			SC	:09:34.13	11:59.63	11:56.69	ok	−0.25	−0.04	2.90	−0.33	−0.58
37.926S 73.417W	153	17.3	FM	:33.57	:59.07	11:56.47	−.03	0.00	0.05	2.62	−0.61	−0.61
24			CC	:34.52	12:00.02	11:57.13	ok	0.12	0.03	2.92	−0.31	−0.19
5.8			CM	:33.30	11:58.80	11:56.08	ok	−0.18	0.03	2.75	−0.48	−0.66
10/29/75			AIA	:58:20.00	4:19.30	4:14.25	ok		—	5.05	—	—
04:54:00.7			WT	:12.09	:11.39	:06.51	+.06	0.15	0.04	4.93	−:.12	0.03
17.229N			CC	:13.09	:12.39	:07.47	ok	0.12	0.03	4.95	−0.10	−0.02
99.537W	157	37.0	SC	:12.34	:11.64	:06.39	ok	−0.25	−0.03	5.22	0.17	−0.08
35			CM	:11.01	:10.31	:05.18	ok	−0.18	0.03	5.16	0.11	−0.07
5.2			MY	:12.37	:11.67	:06.75	−.09	0.08	0.03	4.86	−0.19	−0.11
			NJ	:20.26	:19.56	:09.32	−10.08		0.03	5.19	0.14	

Date / Origin time / Latitude / Longitude / Focal Depth / Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
6/25/75			AIQ	06:02:	3:	3:27.69			—			
05:59:16.2			CC	:31.30	:23.10	3:18.23	ok	0.12	.0.03	4.90		
19.792 N	172	40	FM	:48.26	:39.06	:17.19	−10.05	0.00	.0.04	4.86		
104.766 W			SC	:37.96	:21.76	:16.67	−.08	−0.25	−0.03	5.04		
90			CM	:36.48	:20.78	:15.77	−.07	−0.18	0.03	4.97		
4.8												
4/13/76			WT	:21:28.31	3:40.11	3:35.68	oK	0.15	0.04	4.47	0.53	0.62
20:17:48.2			SC	:37.55	:49.35	:34.64	−10.04	−0.14	0.02	4.69	0.75	0.61
18.546 N			CM	:26.91	:38.71	:34.12	oK	−0.18	0.03	4.62	0.62	0.50
104.303 W			SC	:28.30	:40.10	:35.16	−0.10	−0.25	−0.03	4.81	0.27	0.62
33	173	40	CC	no record								
5.3			WM	:27.68	:39.48	:35.03	−0.02	−0.12	0.08	4.45	0.51	0.39
			AIQ	:38.35	:50.15	:46.21	oK		—	3.94	—	—
9/21/77			AIQ	13:	3:	3:28.64			—			
13:15:57.3			BG	:22.84	:25.54	:18.49	−.04	0.00	0.03	7.04		
20.033 N			CC	:20.90	:23.60	:17.42	+.06	0.12	0.02	6.26		
109.154 W	189	55.9°	RI	:24.19	:26.89	:20.79	−.04	−0.12	0.03	6.14		
33			SM	:20.76	:23.46	:17.03	−.05	0.04	−0.01	6.37		
5.7			FM	:20.26	:23.36	:16.89	−.25	0.00	0.03	6.67		
			TD	:22.88	:25.58	:19.28	−.05	0.17	0.00	6.25		
			LAO	:27.98	:30.68	:21.40	−2.86	0.22	0.01	6.43		
1/5/78			AIQ	:33:	9:	9:52.71						
03:23:26.89			LAO	:23.71	:57.01	9:50.62	−3.62	0.22	0.01	2.78		
20.8075			CC	:17.77	:51.07	:48.71	−.04	0.12	0.03	2.35		
126.941 W	203	22.2	SL	:18.63	:51.93	:49.20	−.27	0.08	0.04	2.50		
26.4			BG	:19.01	:52.31	:49.41	−.04	0.00	0.05	2.91		
5.5			CK	:19.39	:52.69	:49.99	−.11	−0.04	0.04	2.63		
			RB	:20.25	:53.95	:51.04	−.05	−0.03	0.04	2.90		
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.02	2.02		

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs)	travel time (theor)	Corrections Applied			Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction	
							Clock	Station	Elevation				
3/24/76 04:46:04.4 29.887S 177.873 W 33 6.4	235	14.6	AIA	:59:18.19	13:13.79	13:10.49	ok		—	3.30	—	—	
			FR	:14.62	:10.20	:06.84	−0.02		0.05	3.41	0.11		
			IC	:13.97	:09.57	:06.29	0.03	−0.14	0.02	3.33	0.03	−0.11	
			DM	:14.92	:10.52	:07.21	−0.05	0.06	0.05	3.31	0.01	0.07	
			CM	:14.07	:09.67	:06.33	ok	−0.18	0.03	3.37	0.07	−0.11	
			WT	:14.44	:10.04	:06.66	ok	0.15	0.05	3.43	0.13	0.29	
			TA	:14.89	:10.49	:07.17	−0.14	0.05	0.05	3.23	−0.07	−0.02	
6/18/76 01:45:37.3 24.814S 175.356W 33 5.6	238	15	AIA	:58:28.09	12:50.79	12:47.38	ok		—	3.41	—	—	
			SM	:25.78	:48.48	:43.77	−2.30	0.04	−0.02	3.39	−0.02	0.08	
			SC	:23.58	:46.22	:42.92	+0.07	−0.25	−0.04	3.33	−0.08	−0.33	
			WT	:23.98	:46.68	:43.54	+0.05	0.15	0.05	3.24	−0.17	−0.12	
			WM	:24.05	:46.75	:43.25	−0.11	−0.12	0.03	3.58	0.17	0.05	
			NG	:23.70	:46.40	:43.11	−0.03	−0.13	0.02	3.28	−0.13	−0.26	
			~~BM~~	~~:24.32~~	~~:47.02~~	~~:43.35~~	~~−0.04~~	~~−0.24~~	~~0.05~~	3.65	0.24	0.02	
12/8/77 06:15:16.2 24.132S 175.602W 33 5.5	239	15.0	AIA	:28:05.49	12:49.29	12:46.18	ok		~	3.11	—	—	
			CK	:03.35	:47.15	:43.45	−.31	−0.04	0.05	3.44	0.33	0.29	
			SL	:02.00	:45.30	:42.58	−.07	0.08	0.04	3.19	0.08	0.16	
			LRN	:03.30	:47.10	:44.03	+.07	0.21	0.02	3.16	0.05	0.26	
			BB	:23.48	13:07.28	:44.12	−20.06	−0.03	0.04	3.14	0.03	0.00	
			AO	:05.20	12:49.00	:43.01	−3.14	0.22	0.01	2.86	−0.25	−0.03	
			BG	:02.69	:46.49	:43.11	−.14	0.00	0.06	3.30	0.19	0.19	
			CC	:01.74	:45.54	:42.44	−.03	0.12	0.03	3.10	−0.01	0.11	

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
9/21/77			AIQ	40:	12:	12:45.47			~			
09:27:59.5			GDD	:44.25	:45.45	:40.81	−.05	0.04	−0.02	4.57		
23.500S			TD	:47.20	:47.70	:43.29	−.05	0.17	0.00	4.36		
175.228W	239	152	FM	:46.37	:46.87	:42.17	−.23	0.00	0.05	4.52		
15			LGD	too noisy								
5.5			RT	:45.28	:46.38	:41.64	−.04	−0.12	0.05	4.75		
			CC	:45.62	:46.12	:41.69	+.06	0.12	0.03	4.52		
			BG	:46.47	:46.97	:42.41	−.04	0.00	0.06	4.58		
1/20/76			AIQ	:25:49.33	12:37.33	12:34.15	ok		—	3.18	—	—
19:16:12.0			CM	:44.79	:32.79	:29.28	ok	−0.18	0.02	2.94	−0.29	−0.42
21.921S			DM	:45.84	:33.84	:30.78	−.02	0.06	0.05	3.09	−0.09	−0.03
174.104W	239	156	TA	:45.89	:33.89	:30.78	−.01	0.05	0.05	3.15	−0.03	+0.02
33			SC	not recorded								
5.4			WT	:55.21	:43.21	:30.23	−10.00	0.15	0.05	3.03	−2.15	−0.00
2/3/76			AIQ	39:49.32	12:19.22	12:16.57	ok		—	2.65	—	—
12:27:30.1			CC	:45.78	:15.68	:13.01	ok	0.12	0.03	2.70	0.05	0.17
25.136S			CM	not recorded								
179.693E	240	14.4	DM	:46.33	:16.23	:13.52	−.05	0.06	0.05	2.71	0.06	0.12
477			SC	:45.27	:15.17	:12.37	−.01	−0.25	−0.04	2.75	0.10	−0.15
5.8			SH	:46.59	:16.49	:13.71	−.03		0.05	2.80	0.15	
			WT	:45.84	:15.74	:12.97	ok	0.15	0.05	2.82	0.17	0.32
5/20/75			AIQ	44:16.80	12:26.40	12:23.50	ok		—	2.90	—	—
14:31:50.4 25.091S			FM	44:13.76	12:23.36	12:20.34	+.03	0.00	0.05	3.10	0.20	0.20
178.994W 362	240	14.6	CC	44:13.31	12:22.91	12:19.87	ok	0.12	0.03	3.07	0.17	0.29
5.1			SC	44:12.90	12:22.50	12:19.22	ok	−0.25	−0.04	3.24	0.34	0.09

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs.) (phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Resid. w.r.t. Base w/ stat. correction
7/24/75 19:01:42.6 23.476S 179.775W 579 5.6	241	14.5	AIQ	:13:	11:	12:00.78			—			
			SC	:40.10	:59.30	11:56.61	ok	−0.25	−0.04	2.85		
			CC	:42.81	12:00.21	:57.26	ok	0.12	0.03	2.98		
			FM	:43.16	:00.56	:57.72	−.11	0.00	0.05	2.78		
			CM	no record								
10/17/77 17:26:40.4 27.914S 173.084E 33 6.6	242	14.4	AIQ	:40:	13:	13:34.17			—			
			BG	:14.86	:34.46	:31.39	ok	0.00	0.06	3.13		
			CC	:14.18	:33.78	:30.70	ok	0.12	0.03	3.11		
			GM	no record								
			LAO	:18.11	:37.71	:31.00	−3.20	0.22	0.01	3.92		
			LPN	:15.62	:35.22	:32.21	ok	0.21	0.02	3.03		
			RI	no record								
			TO	:15.51	:35.11	:32.25	−.01	0.17	0.0	2.85		
5/29/75 06:42:12.8 22.438S 179.527E 616 5.6	242	14.5	AIQ	06:54:12.83	12:00.03	11:56.96	−.150		—	2.92	—	—
			SC	:54:18.77	:05.97	11:52.84	−10.00	−0.25	−0.04	3.09	0.17	−0.08
			CC	:09.31	11:56.51	:53.49	ok	0.12	0.03	3.05	0.13	0.25
			FM	:09.87	:57.07	:54.00	−.04	0.00	0.05	3.08	0.16	0.16
			CM	:09.03	:56.23	:53.16	ok	−0.18	0.03	3.10	0.18	0.00
8/12/75 01:12:05.8 19.043S 175.542W 197 4.9	242	15.7	AIQ	:24:20.41	12:14.61	12:11.28	ok		—	3.33	—	—
			MY	:16.68	:10.88	:08.44	+1.00	0.08	0.03	3.47	0.14	0.22
			FM	:17.43	:11.63	:08.04	−.02	0.00	0.05	3.62	0.29	0.29
			SC	:16.49	:10.69	:06.34	ok	−0.25	−0.04	3.81	0.48	0.23
			WT	:16.86	:11.06	:07.49	ok	0.15	0.05	3.62	0.29	0.44
			CM	:16.58	:10.78	:07.19	−.03	−0.18	0.03	3.59	0.26	0.08
			CC	:16.80	:11.00	:07.54	ok	0.12	0.03	3.49	0.16	0.28

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
8/7/75			AIQ	24:16.33	12:01.13	11:59.34	ok		—	1.79	—	—
20:12:15.2			FM	:13.70	11:58.50	:56.39	-.10	0.00	0.05	2.11	0.32	0.32
22.836S			CM	:12.95	:57.75	:55.51	-.16	-0.18	0.03	2.11	0.32	0.14
178.912E	243	14.5	SC	:12.65	:57.45	:55.23	+.03	-0.25	-0.04	2.21	0.42	0.17
626			CC	:13.13	:57.93	:55.82	ok	0.12	0.03	2.08	0.29	0.41
5.4			WT	:12.98	:57.78	:55.83	+.13	0.15	0.05	2.13	0.34	0.49
2/3/76			AIQ	:16:00.53	12:08.53	12:04.84	ok		—	3.69	—	—
18:03:52.0			WT	:15:56.70	:04.70	:01.01	ok	0.15	0.05	3.74	0.05	0.20
18.108S			SH	:57.60	:05.60	:01.81	-.04		0.05	3.80	0.11	
175.032W			SC	:56.14	:04.14	:00.39	-.01	-0.25	-0.04	3.75	0.06	-0.19
212	243	16	DM	:57.46	:05.46	:01.61	-.08	0.06	0.05	3.92	0.13	0.19
5.7			CC	:56.68	:04.68	:01.06	ok	0.12	0.03	3.65	-0.04	0.08
			CM	:56.34	:04.34	:00.70	ok	-0.18	0.03	3.67	-0.02	-0.20
1/21/77			AIG	22:46.03	11:40.43	11:38.04	ok		—	2.39	—	—
06:11:05.6			DM	:43.47	:37.37	:35.08	ok	0.06	0.05	2.84	0.45	0.51
18.014S			CM	:42.59	:36.99	:34.22	-.03	-0.18	0.03	2.77	0.38	0.20
178.379W	245	15.0	SC	:52.44	:46.84	:33.88	-10.01	-0.25	-0.04	2.91	0.52	0.27
604			WT	:42.92	:37.32	:34.55	ok	0.15	0.05	2.32	0.49	0.58
5.8			CC	:42.86	:37.26	:34.55	-.05	0.12	0.03	2.69	0.30	0.42
			GM	:42.15	:36.55	:33.64	-.01	0.04	-0.02	2.88	0.49	0.53
2/6/76			AIQ	14:14.90	11:42.40	11:39.77	ok		—	2.63	—	—
00:02:32.5			CC	:11.49	:38.99	:36.29	ok	0.12	0.03	2.73	0.10	0.22
18.174S			CM	:11.27	:38.77	:36.00	ok[NC]	-0.18	0.03	2.80	0.17	-0.01
178.402W	245	15	DM	:12.26	:39.76	:36.86	-.27	0.06	0.05	2.68	0.05	0.11
590			SC	unclear arrival								
5.2			SH	too noisy								
			WT	:11.48	:38.98	:36.29	ok	0.15	0.05	2.74	0.11	0.26

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Date / Origin time / Latitude / Longitude / Focal Depth / Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
12/14/77	289	63.2°	AIQ	:		1:58.34	ok		~			
15:30:00.169			BB	32:00.59	2:00.42	:58.48	-.04	-0.03	0.02	1.92		
37.136 N			SL	31:58.66	1:58.49	:56.30	-.29	0.08	0.02	1.92		
116.086 W			CC	:58.88	:58.71	:56.84	-.06	0.12	0.02	1.83		
665 m			CK	32:10.46	2:10.29	:58.34	-10.07	-0.04	0.02	1.90		
5.7			BG	:00.32	:00.15	:58.21	ok	0.00	0.03	1.97		
NTS			LPN	not recorded								
			LAD	"	"							
8/19/77	296	63.2°	AIQ	:56:59.33	1:59.26	1:52.93	ok		—	1.33	—	—
17:55:00.075			SC	:58.66	:58.59	:56.03	-.45	-0.25	-0.02	2.09	0.77	0.52
37.111 N			LFN	not recorded								
116.055W			LAD	no record								
701 m			GM	:55.78	:55.71	:53.84	-.14	0.04	-0.01	1.72	0.40	0.44
5.6			DM	no record								
NTS			CM	"	"							
			BG	"	"							
4/27/77	296	63.2°	AIQ		:	1:57.66			~			
15:00:00.084			CC	:01:57.78	1:57.70	:56.03	+.03	0.12	0.02	1.72		
37.095 N			LAD	:01:58.31	:58.23	:53.24	-2.70	0.22	0.01	1.70		
116.028W			DM	:02:00.09	2:00.01	:58.07	-.06	0.06	0.02	1.90		
594 m			GM	:01:55.36	1:55.28	:53.43	-.02	0.04	-0.01	1.82		
5.4			WT	:58.75	:58.67	:56.84	+.04	0.15	0.02	1.89		
NTS			CM	:59.52	:59.44	:57.39	-.03	-0.18	0.02	2.04		
			SC	:58.01	:57.93	:55.75	-.28	-0.25	-0.02	1.88		

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Corrections Applied: Station	Corrections Applied: Elevation	Absolute Residual	Residual w.r.t. Base w/o Stat. Correction	Residual w.r.t. Base w/ Stat. Correction
4/5/77 15:00:00.147 37.120 N 116.062 W 690 m 5.6 NTS	296	63.2*	AIQ	:01:	1:	1:58.07			—			
			GM	:56.96	:56.79	:53.98	−1.03	0.04	−0.01	1.77		
			DM	:02:00.57	2:00.40	:58.48	−.01	0.06	0.08	1.93		
			CC	:01:58.35	1:58.18	:56.57	−.01	0.12	0.02	1.62		
			CM	:02:00.09	:59.92	:57.93	−.02	−0.18	0.02	1.99		
			SC	:01:58.38	:58.21	:56.16	−.12	−0.25	−0.32	1.91		
			LAO	:58.28	:58.11	:54.25	−2.23	0.22	0.01	1.64		
12/21/77 01:00:32.8 25.510 N 143.112 E 33 6.2	303	14.6	AIQ	:13: no record		12:59.78	OK		—			
			CK	:36.84	13:03.44	13:00.38	−.07	−0.04	0.05	3.04		
			LAO	:37.21	:04.41	:01.41	−.42(?)	0.22	0.01	2.59		
			BR	:38.38	:05.58	:00.34	−2.28	−0.03	0.04	3.00		
			SL	:35.53	:02.73	12:59.78	−.04	0.08	0.04	2.95		
			LPN	:35.81	:03.01	13:00.38	OK	0.21	0.02	2.65		
			CC	:35.73	:02.93	:00.01	+.04	0.12	0.03	2.99		
			BG	:36.08	:03.28	:00.38	+.05	0.00	0.06	3.01		
9/16/75 11:09:07.8 27.276 N 140.125 E 374 5.2	305	14.5	AIQ	:21:37.01	12:29.21	12:25.93	OK		—	3.28	—	—
			NT	:48.77	:40.97	:27.91	−10.03		0.03	3.06	−0.22	
			CM	:37.85	:30.05	:26.99	−.04	−0.18	0.03	3.05	−0.23	−0.41
			MG	:36.38	:28.58	:25.60	OK		−0.03	2.95	−0.33	
			WT	:37.31	:29.51	:26.71	OK	0.15	0.05	2.35	−0.93	−0.23
			HC	:36.96	:29.16	:25.79	−.01	−0.12	−0.07	3.29	0.01	−0.11

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o Stat. correction	Residual w.r.t. Base w/ stat. correction
7/28/77 15:22:18.5 44.244 N 128.967 W 15 5.1	306	37.3	AIA	:26:49.18	4:30.68	4:27.14	ok		—	3.54	—	—
			GM	:49.79	:31.29	:26.57	−.04	0.00	−0.01	4.67	1.13	1.17
			SC	:53.13	:34.63	:28.61	−1.35	−0.25	−0.03	4.64	1.10	0.85
			LON	:53.02	:34.52	:29.48	−.14	0.21	0.02	4.42	0.88	1.09
			LBD	too nonimpulsive								
			CDD	:27:03.03	:44.53	:29.98	−10.04	−0.18	0.03	4.54	1.00	0.82
			CC	:26:51.46	:32.96	:28.50	+.04	0.12	0.03	4.53	0.99	1.11
			BG	:27:02.27	:43.77	:29.30	−9.87	0.00	0.05	4.65	1.11	1.11
8/4/76 23:21:44.2 30.159 N 138.470 E 435 5.4	308	14.5	AIA	:34:02.93	12:18.73	12:16.09	ok		—	2.64	—	—
			NG	:14.25	:30.05	:17.24	−10.03	−0.13	0.06	2.80	0.16	0.03
			SC	:03.71	:19.51	:16.83	ok	−0.25	−0.04	2.64	0.00	−0.25
			GM	:03.23	:19.03	:16.00	−0.23	0.04	−0.02	2.78	0.14	0.17
			©WS	:04.30	:20.10	:18.03	ok	−0.27	0	2.07	−0.57	−0.84
			WT	:03.74	:19.54	:17.10	0.01	0.15	0.05	2.56	−0.14	0.01
			HC	:03.45	:19.25	:16.23	−0.07	−0.12	−0.07	2.88	0.24	0.12
7/29/75 01:48:16.2 43.687 N 126.103 W 33 5.2	309	38.0	AIA	:52:22.19	4:05.99	4:00.00	ok		—	5.99	—	—
			CC	:23.13	:06.93	4:01.71	−.01	0.12	0.02	5.24	−0.75	−0.63
			CDD	:24.98	:08.78	:03.30	+.18	−0.18	0.03	5.69	−0.30	−0.48
			WT	:23.98	:07.78	:02.45	ok	0.15	0.04	5.37	−0.62	−0.77
			SC	:31.46	:15.26	:01.83	−7.93	−0.25	−0.03	5.47	−0.52	−0.77
			FM	:25.35	:09.15	:03.54	−.07	0.00	0.04	5.98	−0.41	−0.41
8/12/75 14:21:04.7 32.042 N 137.715 E 391 5.7	310	14.5	AIA	:33:24.73	12:20.03	12:16.83	ok		—	3.20	~	~
			CC	:25.30	:20.60	:17.66	ok	0.12	0.03	2.97	−0.23	−0.11
			SC	:25.74	:21.04	:17.76	ok	−0.25	−0.04	3.24	0.04	−0.21
			MY	:24.92	:20.22	:18.87	+1.01	0.08	0.03	2.99	−0.21	−0.13
			FM	:26.16	:21.46	:18.36	−.04	0.00	0.05	3.11	−0.09	−0.03

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Date / Origin time / Latitude / Longitude / Focal Depth / Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
9/21/77			AIQ	:44:	9 :	9: 12.09			—			
10:35:26.6			BG	:43.93	:17.33	:14.00	−.04	0.00	0.05	3.34		
51.371 N			CC	:43.19	:16.59	:13.64	+.06	0.12	0.03	3.04		
178.359 W	311	28.6	RI	:41.13	:14.53	:11.20	−.04	−0.12	0.05	3.34		
30			GDD	:42.24	:15.64	:12.46	−.05	0.04	−0.01	3.12		
4.9			FM	:44.77	:18.14	:14.74	−.23	0.00	0.05	3.22		
			TD	:44.60	:18.00	:14.96	−.05	0.17	0	2.99		
			LAD	:44.63	:18.03	:11.79	−2.85	0.22	0.01	3.40		
8/21/75			AIQ	:33:51.82	9:32.02	9 :29.09	OK		—	2.93	—	—
07:24:19.8			CC	:33:53.49	:33.69	:30.61	OK	0.12	0.03	3.11	0.18	0.30
51.112 N	312	22.7	CM	:54.78	:34.98	:31.69	−.13	−0.18	0.03	3.19	0.26	0.08
177.830 E			WT	arrival	covered							
33			SC	:34:04.01	:44.21	:30.82	−10.00	−0.25	−0.04	3.35	0.42	0.17
5.0			FM	:04.83	:45.03	:31.69	−10.09	0.00	0.05	3.30	0.37	0.37
10/26/77			AIQ	:20:	9:	9: 26.87			~			
15:10:58.8			LPN	:31.14	:32.34	:29.17	−.03	0.21	0.02	3.16		
51.146 N	312	22.9	BG	:31.03	:32.23	:28.81	−.39	0.00	0.05	3.08		
178.327 E			CP	:30.75	:31.75	:28.38	−.02	0.12	0.03	3.38		
33			LAD	:31.44	:32.64	:26.65	−2.19	0.22	0.01	3.31		
5.6												
2/18/76			AIQ	:10:14.00	9:15.40	9:12.00	OK		—	3.40	~	~
08:00:58.6			IC	:16.55	:17.95	:14.28	−.13	−0.14	0.02	3.56	0.16	0.02
51.573 N			WM	:16.39	:17.79	:14.21	−.08	−0.12	0.03	3.55	0.13	0.01
175.676 W	312	23.4	WT	:16.07	:17.47	:14.06	−.02	0.15	0.05	3.44	0.04	0.19
39			SC	:15.98	:17.38	:13.77	OK	−0.25	−0.04	3.57	0.17	−0.08
4.9			CC	:15.48	:16.88	:13.55	OK	0.12	0.03	3.36	−0.04	0.08
			CM	:16.65	:18.05	:14.65	OK	−0.18	0.03	3.48	0.03	−0.15

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied:			Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
							Clock	Station	Elevation			
8/17/77 16:48:31.3 51.867N 175.342W 57 5.4	312	23.7	AIQ	:57:28.30	8:57.20	8:58.53	ok		—	2.64	—	—
			?C	:30.98	:59.68	:56.20	-.18	-0.25	-0.04	3.16	0.52	0.27
			LPN	not	recorded	:						
			LAD	:31.57	9:00.27	:54.35	-2.57	0.22	0.01	3.36	0.72	0.94
			GM	:29.25	8:57.95	:54.95	-.05	0.04	-0.02	2.93	0.29	0.33
			DM	:41.57	9:10.27	:57.12	-10.02	0.06	0.05	3.18	0.54	0.60
			CM	:31.73	:00.43	:57.27	ok	-0.18	0.03	3.19	0.55	0.37
			BG	:30.83	8:59.53	:56.60	+.08	0.00	0.05	3.06	0.42	0.42
10/4/77 15:38:56.6 36.099N 139.743E 66 5.4	313	15.3	AIQ	:51:	12:	12:33.68			—			
			GM	:51:34.16	:37.56	:33.93	-.01	0.04	-0.02	3.60		
			RI	:33.20	:36.60	:33.15	-.04	-0.12	0.05	3.45		
			TD	:35.63	:39.03	:35.63	-.16	0.17	0.0	3.24		
			RG	:34.96	:38.36	:35.00	+.01	0.02	0.06	3.43		
			CC	:34.57	:37.97	:34.71	-.01	0.12	0.03	3.28		
			LAC	:36.71	:40.11	:33.63	-2.95	0.22	0.01	3.59		
			LPN	:35.02	:38.42	:35.24	-.01	0.21	0.02	3.19		
8/20/76 03:56:00.6 43.048N 149.781E 47 5.5	314	18.1	AIQ	04:07:	11:	11:34.33	ok		—			
			SC	:39.90	:39.30	:35.94	-0.14	-0.25	-0.04	3.18		
			WT	:39.71	:39.11	:36.23	-0.05	0.15	0.05	2.88		
			HC	:39.64	:39.04	:35.25	-0.45	-0.12	-0.06	3.28		
			NG	:50.21	:49.61	:36.46	-10.05	-0.13	0.02	3.12		
			FC	:50.43	:49.83	:36.58	-10.05	-0.27	0.00	3.20		
			GM	:39.07	:38.47	:34.90	-0.36	0.04	-0.02	3.19		

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
7/20/77	316	25.9	AIG	32:18.07	7:52.17	7:47.73	ok		—	2.44	—	—
13:24:25.9			SC	:21.74	:54.84	:52.16	−.24	−0.25	−0.03	3.41	0.97	0.72
54.612N			LPN	:21.74	:55.84	:52.56	−.15	0.21	0.02	3.15	0.71	0.92
161.599W			IAD	no phase?		:						
53			SM	:19.97	:54.07	:50.70	−.03	0.04	−0.01	3.33	0.89	0.93
5.3			CM	:32.52	8:06.63	:52.13	−10.03	−0.18	0.03	3.50	1.06	0.88
			CC	:20.95	7:55.05	:51.91	+.03	0.12	0.03	3.20	0.76	0.88
2/21/77	317	25.6	AIG	:09:49.25	7:43.25	7:40.81	OK		—	2.44	—	—
20:02:06.0			WT	:52.55	:46.55	:43.70	OK	0.15	0.05	2.90	0.46	0.61
55.913N			IC	10:03.06	:57.06	:44.02	−10.00	−0.14	0.02	3.06	0.62	0.48
161.894W			CM	:09:53.42	:47.42	:44.42	−.01	−0.18	0.03	3.02	0.58	0.40
167			SC	:52.48	:46.48	:43.46	+.01	−0.25	−0.03	3.00	0.56	0.31
5.0			CC	:51.98	:45.98	:43.14	OK	0.12	0.02	2.87	0.43	0.55
			LPN	not recorded						[illegible]		
7/25/75	317	26.1	AIG	:48:		7:48.61			—			
10:40:25.0			FM	:21.09	7:56.09	7:52.04	−.15	0.00	0.05	3.95		
55.055N			CC	:19.69	7:54.69	:50.81	ok	0.12	0.03	3.91		
160.377W			CM	:21.01	:56.01	:52.12	+.07	−0.18	0.03	3.99		
17			SC	:20.15	:55.15	:51.19	ok	−0.25	−0.03	3.98		
5.8												
8/16/75	318	16.2	AIG	49:33.66	11:53.96	11:50.89	ok		—	3.07	—	—
21:37:39.7			WT	:35.23	:55.53	:52.81	+.09	0.15	0.05	2.86	−0.21	−0.06
43.900N			SC	:35.43	:55.73	:52.66	+.02	−0.25	[illegible]	3.05	−0.02	−0.27
139.263E			CM	:36.04	:56.34	:53.28	−.11	−0.18	0.03	2.98	−0.09	−0.27
230			CC	:35.02	:55.32	:52.45	ok	0.12	0.03	2.90	−0.17	−0.05
5.6			FM	:36.02	:56.32	:53.18	−.07	0.00	0.05	3.12	0.05	0.05

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base, w/o stat. correction	Residual w.r.t. Base w/ stat. correction
10/4/77			AIG	45:		10:45.14			~			
21:34:43.5			CC	:33.83	:50.33	:47.03	-.01	0.12	0.03	3.39		
51.489N			BG	:34.36	:50.86	:47.29	+.02	0.00	0.05	3.64		
156.617E	318	19.9	GM	:33.22	:49.72	:46.15	-.01	0.04	-0.02	3.54		
95			LAD	:35.54	:52.04	:45.33	-295	0.22	0.01	3.77		
?			LPN	:34.67	:51.17	:47.48	-.02	0.21	0.02	3.69		
			RI	:32.08	:48.58	:44.95	-.05	-0.12	0.05	3.63		
			TC	not recorded								
11/4/75			AIG	16:06.54	10:09.54	10:05.79	ok		—	3.75	—	—
12:05:56.9			CC	:08.58	:11.68	:07.34	ok	0.12	0.03	3.87	0.12	0.24
54.355N			WT	:09.16	:12.26	:08.32	ok	0.15	0.05	3.99	0.24	0.39
167.542E	318	21.6	NJ	:10.81	:13.91	:09.95	-.03		0.03	3.96	0.21	
24			CM	:09.83	:12.93	:08.87	ok	-0.18	0.03	4.09	0.34	0.16
5.5			MY	not recorded								
			SC	:09.10	:12.20	:08.12	ok	-0.25	-0.04	4.04	0.29	0.04
8/15/75			AIG	38:29.12	10:10.28	10:06.39	ok		—	3.83	—	—
07:28:18.9			FM	:32.50	:13.60	:08.47	-.13	0.00	0.05	4.05	0.29	0.22
54.877N	318	21.7	WT	:31.85	:12.95	:08.89	ok	0.15	0.05	4.01	0.18	0.33
167.845E			CM	:32.77	:13.87	:08.53	-.15	-0.18	0.03	4.20	0.37	0.19
4			CC	:31.33	:12.43	:08.51	ok	0.12	0.03	3.95	0.12	0.24
6.0			SC	:31.91	:13.01	:08.78	ok	-0.25	-0.04	4.19	0.36	0.11
8/12/76			AIG	:46:37.17	11:28.27	11:25.85	ok		—	2.42	—	—
23:29:08.9			NG	:46:39.58	11:30.68	:28.27	-0.05	-0.13	0.22	2.41	-0.01	-0.14
46.335N	319	17.0	WT	:39.08	:30.18	:27.97	-0.07	0.15	0.05	2.19	-0.23	-0.08
242.200E			HC	:38.73	:29.83	:27.10	-0.05	-0.12	-0.06	2.62	0.20	0.08
301			GM	:38.62	:29.72	:26.77	-0.32	0.04	-0.08	2.61	0.19	0.23
5.0			SC	no record								
			KC	:39.93	:30.93	:28.35	-0.04	-0.27	0.00	2.54	0.12	-0.15

Date / Origin time / Latitude / Longitude / Focal Depth / Magnitude	Azi	Δ_ℓ	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o stat. correction	Residual w.r.t. Base w/ stat. correction
9/21/77			AIQ	12:21.92	10:37.92	10:34.69	ok		—	3.23	—	—
21:01:44.0			TO	:24.58	:40.58	:37.61	−.06	0.17	0.0	2.91	−0.32	−0.15
51.754N			FM	:24.87	:40.87	:37.55	−.30	0.00	0.05	3.07	−0.16	−0.16
155.208E	319	19.6	CC	:23.65	:39.65	:36.62	+.07	0.12	0.03	3.13	−0.10	0.02
231			BG	:24.03	:40.03	:36.93	−.05	0.00	0.05	3.10	−0.13	−0.18
5.6			GM	:23.18	:39.18	:35.75	−.06	0.04	−0.02	3.35	0.12	0.16
			LAO	:25.16	:41.16	:35.00	−2.86	0.22	0.01	3.31	0.08	0.30
			RT	:21.91	:37.91	:34.56	−.05	−0.12	0.05	3.35	0.12	0.00
3/9/77			AIQ	:37:48.00	11:54.40	11:50.92	ok		—	3.48	—	—
14:27:53.6			SC	:50.08	:56.48	:52.76	ok	−0.25	−0.04	3.68	0.20	−0.05
41.606N			WT	:49.92	:56.32	:52.90	+.04	0.15	0.05	3.51	0.03	0.18
130.878E	320	14.7	DM	:49.77	:56.17	:53.09	+.01	0.06	0.05	3.14	−0.34	−0.28
528			GM	:49.48	:55.58	:51.91	−.02	0.04	−0.08	3.63	0.15	0.19
5.9			LPN	:49.84	:56.24	:52.81	−.29	0.21	0.06	3.16	−0.32	−0.11
			CM	:50.52	:56.92	:53.32	−.07	−0.18	0.03	3.56	0.08	−0.10
			LAO	:50.65	:57.05	:51.25	−2.47	0.22	0.01	3.34	−0.14	0.08
8/1/75			AIQ	:05:10.53	10:24.53	10:19.86	ok		—	4.67	—	—
02:14:46.0			CM	:14.02	:28.02	:23.29	+.18	−0.18	0.03	4.94	0.27	−0.09
56.143N			SC	:21.42	:35.42	:22.48	−7.95	−0.25	−0.04	4.95	0.28	0.03
162.918E	320	21.2	WT	:13.31	:27.13	:22.68	+.12	0.15	0.05	4.62	−0.05	0.10
13			CC	:12.89	:26.89	:22.14	−.04	0.12	0.03	4.74	0.07	0.19
5.0			FM	:24.01	:38.01	:22.09	−10.11	0.00	0.05	4.86	0.19	0.19

Date Origin time Latitude Longitude Focal Depth Magnitude	Azi	Δ_i	STA	Arrival time (obs. phase)	travel time (obs.)	travel time (theor.)	Corrections Applied: Clock	Station	Elevation	Absolute Residual	Residual w.r.t. Base w/o Stat. Correction	Residual w.r.t. Base w/ Stat. Correction
9/21/77			AIA	:50:00.67	10: 21.87	10: 18.46	ok		—	3.41	—	—
17: 39: 38.8			RI	:01.23	:22.43	:18.46	−.05	−0.12	0.05	3.97	0.56	0.44
55.734N			GM	:02.38	:23.78	:19.79	−.06	0.17	−0.08	3.91	0.50	0.67
162.316E	321	21.0	BG	:03.49	:24.49	:20.92	−.05	0.00	0.05	3.77	0.36	0.36
48			CC	:03.22	:24.42	:20.72	+.07	0.12	0.03	3.30	0.39	0.51
5.1			FM	:04.45	:25.65	:21.66	−.27	0.00	0.05	3.77	0.36	0.36
			LGD	too small								
			TD	:04.10	:25.30	:21.66	−.05	0.17	0.0	3.59	0.18	0.35
10/19/77			AIA	:23:		7: 15.92			~			
02: 16:02.6			BG	:25.62	:23.02	:19.97	−.04	0.00	0.05	3.06		
62.883N			CC	:25.56	:22.96	:19.80	−.05	0.12	0.03	3.14		
150.559W	330	26.7	GM	:24.83	:22.23	:18.97	−.06	0.04	−0.01	3.19		
102			LPW	:25.66	:23.06	:19.89	−.13	0.21	0.02	3.16		
5.0			RI	:22.80	:20.20	:17.06	−.07	−0.12	0.05	3.12		
			TD	:26.34	:23.74	:20.85	−.20	0.17	0.0	2.99		
			LGD	:26.32	:23.72	:17.39	−3.20	0.22	0.01	3.14		
7/29/76			AIQ	05:13:23.46	13:25.76	13: 21.87	ok		—	3.29	—	—
04:59:57.7			SC	:27.83	:30.13	:26.64	0.24	−0.25	−0.04	3.49	−0.20	−0.45
47.782N			RH	:28.72	:31.02	:27.14	−0.04		−0.04	3.80	−0.09	
48.120E	343	14.5	NG	:28.04	:30.34	:26.73	−0.04	−0.13	0.02	3.59	−0.30	−0.43
O			GM	:27.83	:30.13	:26.13	−0.26	0.04	−0.02	3.67	−0.22	−0.18
5.9			HC	:28.29	:30.59	:26.55	−0.09	−0.12	−0.07	3.88	−0.01	−0.13
UNE			WT	:27.48	:29.78	:26.18	ok	0.15	0.05	3.45	−0.24	−0.09

Appendix 2. Residuals with respect to WT and CC, pp. 80-103.

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
2-16-77	SC	3.93	0.29	0.29	−0.11	−0.08	
00:49:31.2	CC	3.64	0.00	—	−0.03	—	
74	IC	3.85	0.21	0.21	−0.08	−0.05	
19.8	WT	3.64	—	0.00	—	0.03	
	DM	3.71	0.07	0.07	−0.02	0.01	
	CM	3.78	0.14	0.14	−0.19	−0.16	
	LAD	3.43	−0.21	−0.21	−0.14	−0.11	
7-28-77	CC	4.31		—		—	
01:47:32.7	LPN	4.27		−0.04		0.05	
89	SC	4.45		0.14		−0.23	
14.6	GM	4.21		−0.10		−0.18	
	CM						
	BG	4.31		0.00		−0.12	
12-13-77	LPN	4.06		0.15		0.24	
01:14:18.6	CK	4.14		0.23		0.07	
97	BB						
24.4	BG	4.09		0.18		0.06	
	CC	3.91		—		—	
	SL	4.02		0.11		0.07	
	LAD	3.55		−0.36		−0.26	

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
7-15-76	WT	3.95	—		—		
00:07:56.6	SC	3.79	−0.16		−0.56		
100	NG	3.87	−0.08		−0.36		
24.9	GM	3.82	−0.13		−0.24		
	HC	3.97	0.02		−0.25		
	RM	4.04	0.09		−0.30		
7-1-76	SC	4.08	0.20		−0.20		
03:38:12.1	HC	4.22	0.34		0.07		
101	GM	3.83	−0.05		−0.16		
25.5	RM	4.19	0.31		−0.08		
	NG	3.86	−0.02		−0.30		
	WT	3.88	—		—		
9-21-77	RT	4.69	—	0.41		0.17	
16:05:12.7	GM	4.23		−0.05		−0.13	
110	EM	4.45		0.17		0.05	
24.9	BG	4.56		0.28		0.16	
	CC	4.28		—		—	
	LBO	4.33		0.05		0.15	

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
9-1-77	GM	3.86		0.07		−0.01	
17:37:06.8	LAO	4.20		0.41		0.51	
127	NG	3.88		0.09		−0.16	
26.8	SC	4.03		0.24		−0.13	
	CC	3.79		—		—	
	CM	3.74		−0.05		−0.35	
	BG	3.64		−0.15		−0.27	
8-31-77	SC	4.65		0.12		−0.25	
00:42:05.4	NG	4.58		0.05		−0.20	
127	LAO	4.74		0.21		0.31	
26.8	GM	4.69		0.16		0.08	
	CM	4.49		−0.04		−0.34	
	CC	4.53		—		—	
	BG	4.46		−0.07		−0.19	
11-5-75	MY	3.48	−0.14		−0.21		
01:58:54.4	NJ	3.48	−0.14		−0.29		
128	CM	3.63	0.01		−0.32		
26.8	WT	3.62	—		—		
	SC	3.71	0.09		−0.31		

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
8-10-76	WT	4.40	—		—		
00:10:26.9	SC	4.53	0.13		−0.27		
135	HC	4.65	0.25		−0.02		
26.3	NG	4.61	0.21		−0.07		
	FC	4.77	0.37		−0.05		
5-27-76	WT	3.98	—		—		
14:46:10.1	NJ	4.29	0.31		0.16		
137	DM	4.01	0.03		−0.06		
22.3	FR	4.09	0.11		−0.04		
	CM	4.08	0.10		−0.23		
	TA	4.10	0.12		0.02		
6-26-75	SC	3.97		0.05		−0.32	
06:45:17.6	CC	3.92		—		—	
140	FM	3.93		0.01		−0.11	
29.9	CM	3.98		0.06		−0.24	
2-5-76	CC	3.30	0.20	—	0.17	—	
09:53:11.7	DM	3.05	−0.05	−0.25	−0.14	−0.31	
141	SC	3.58	0.48	0.28	0.08	−0.09	
20.2	SH	3.24	0.14	−0.06	−0.01	−0.18	
	WT	3.10	—	−0.20	—	−0.17	

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
8-20-76	GM	3.69	0.35		0.24		
06:54:11.3	EC	3.79	0.45		0.03		
141	NG	3.51	0.17		−0.11		
20.6	HC	3.64	0.30		0.03		
	WT	3.34	—		—		
	SC	3.73	0.39		−0.01		
3-8-77	SC	4.74	0.12		−0.03		
13:08:56.3	WT	4.62	—		—		
141	DM	4.58	−0.04		−0.13		
22.9	GM	4.95	0.33		0.22		
	LPN	4.64	0.02		0.08		
	CM	4.66	0.04		−0.29		
9-20-77	CM	3.55		0.05		−0.03	
16:23:13.3	RT	3.63		0.13		−0.11	
142	BG	3.47		−0.03		−0.15	
19.9	CC	3.50		—		—	
	TD	3.29		−0.21		−0.16	

Date Origin Time Azimuth ∆ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
6-24-75	JC	3.47		0.44		0.07	
00:39:47.4	CC	3.03		—		—	
142	CM	3.28		0.25		−0.05	
20.7	FM	3.17		0.14		0.02	
2-23-77	IC	3.84	0.09	−0.11	−0.20	−0.37	
19:36:05.0	CC	3.95	0.20	—	0.17	—	
142	WT	3.75	—	−0.20	—	−0.17	
32.4	SC	4.05	0.30	0.10	−0.10	−0.27	
	CM	3.93	0.18	−0.02	−0.15	−0.32	
10-28-75	SC	3.24	0.01	0.07	−0.39	−0.30	
06:54:22.4	CC	3.17	−0.06	—	−0.09	—	
143	NJ	3.40	0.17	0.23	0.02	0.11	
20.4	WT	3.23	—	0.06	—	0.09	
	MY	3.17	−0.06	0.00	−0.13	−0.04	
	CM	3.24	0.01	0.07	−0.32	−0.23	
6-7-77	LPU	3.17	0.28		0.34		
13:31:24.3	GM	3.24	0.35		0.24		
145	DM	2.88	−0.01		−0.10		
18.5	WT	2.89	—		—		
	SC	3.09	0.20		−0.20		

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
6-25-75	CC	5.15		—		—	
06:05:13.0	FM	5.24		0.09		−0.03	
145	SC	5.09		−0.06		−0.43	
34.8	CM	5.12		−0.03		−0.33	
12-6-77	CC	3.07		—		—	
17:05:06.4	BG	3.29		0.22		0.10	
146	BB	3.25		0.18		0.03	
18.2	LPN	3.36		0.29		0.38	
	CK	3.47		0.40		0.84	
	SL	3.32		0.25		0.21	
	LBO	3.31		0.24		0.34	
1-17-78	LPN	3.46		−0.26		−0.17	
11:33:13.8	LBO	3.62		−0.10		0.00	
147	CC	3.72		—		—	
18.2	SL	3.85		0.13		0.09	
	BG	3.96		0.24		0.12	
	CK	3.93		0.21		0.05	

Date Origin Time Azimuth ∆ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
10-5-77	TO	3.47		−0.02		0.03	
04:34:09.8	RI	3.80		0.31		0.07	
147	LPN	3.42		−0.07		0.02	
19.1	GM	3.62		0.13		0.05	
	BG	3.65		0.16		0.04	
	CC	3.49		—		—	
	2AD	3.79		0.30		0.40	
2-19-76	WT	4.28	—	−0.13	—	−0.10	
18:31:31.1	CC	4.41	0.13	—	0.10	—	
147	SC	4.50	0.22	0.09	−0.18	−0.28	
35.3	TC	4.41	0.13	0.00	−0.16	−0.26	
	WM	4.26	−0.02	−0.15	−0.29	−0.39	
	CM	4.33	0.05	−0.08	−0.28	−0.38	
1-20-78	CK	2.67		−0.44		−0.60	
04:42:50.3	SL	2.69		−0.42		−0.46	
149	LPN	2.63		−0.48		−0.39	
17.6	BG	2.35		−0.56		−0.68	
	BB	2.99		−0.12		−0.27	
	CC	3.11		—		—	
	2AD	2.98		−0.19		−0.09	

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
5-28-75	SC	2.90		−0.02		−0.39	
13:57:34.5	KM	2.62		−0.30		−0.42	
143	CC	2.92		—		—	
17.3	CM	2.75		−0.17		−0.47	
10-29-75	WT	4.93	—	−0.02	—	0.01	
04:54:00.7	CC	4.95	0.02	—	−0.01	—	
157	SC	5.22	0.29	0.27	−0.11	−0.10	
32.0	CM	5.16	0.23	0.21	−0.10	−0.09	
	MY	4.86	−0.07	−0.09	−0.14	−0.13	
	NJ	5.19	0.26	0.24	0.11	0.12	
6-25-75	CC	4.90		—		—	
05:59:16.2	KM	4.86		−0.04		−0.16	
172	SC	5.04		0.14		−0.23	
40	CM	4.97		0.07		−0.23	
4-13-76	WT	4.47	—		—		
20:17:48.0	SC	4.69	0.22		−0.07		
173	CM	4.62	0.15		−0.18		
40	SC	4.81	0.34		−0.06		
	WM	4.45	−0.02		−0.29		

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
9-21-77	BG	7.04		0.78		0.66	
13:15:57.3	CC	6.26		—		—	
189	RI	6.14		−0.12		−0.36	
55.4 *	GM	6.37		0.11		0.03	
	FM	6.67		0.41		0.29	
	TO	6.25		−0.01		0.04	
	LAO	6.43		0.17		0.27	
1-5-78	LAO	2.78		0.43		0.53	
03:23:26.699	CC	2.35		—		—	
203	SL	2.50		0.15		0.11	
22.2	BG	2.91		0.56		0.44	
	CK	2.63		0.28		0.12	
	BB	2.50		0.15		0.00	
	LPN	2.02		−0.13		−0.03	
3-24-76	FR	3.41	−0.02		−0.17		
04:46:04.4	IC	3.33	−0.10		−0.39		
235	DM	3.31	−0.12		−0.21		
14.6	CM	3.37	−0.06		−0.39		
	WT	3.43	—		—		
	TA	3.23	−0.20		−0.30		

Date Origin Time Azimuth Δ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
6-18-76	GM	3.39	0.15		0.04		
01:45:37.3	SC	3.33	0.09		−0.31		
238	WT	3.24	—		—		
15.0	WM	3.58	0.34		0.07		
	NG	3.28	0.04		−0.24		
	RM	3.65	0.41		0.02		
12-8-77	CK	3.44		0.34		0.18	
06:15:16.2	JL	3.19		0.09		0.05	
239	LPN	3.16		0.06		0.15	
15.0	BB	3.14		0.04		−0.11	
	LAD	2.86		−0.24		−0.14	
	BG	3.30		0.20		0.08	
	CC	3.10	—	—		—	
9-21-77	GM	4.57		0.05		−0.03	
09:27:59.5	TD	4.36		−0.16		−0.11	
239	FM	4.52		0.00		−0.12	
15.0	RT	4.75		0.23		−0.01	
	CC	4.52		—		—	
	BG	4.58		0.06		−0.06	

Date Origin Time Azimuth ∆ of Incidence	STN	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
1-20-76	CM	2.94	−0.09		−0.42		
19:16:12.0	DM	3.09	0.06		−0.03		
239	TA	3.15	0.12		0.02		
15.6	WT	3.03	—		—		
2-3-76	CC	2.70	−0.12	—	−0.15	—	
19:27:30.1	DM	2.71	−0.11	0.01	−0.20	−0.05	
240	SC	2.75	−0.07	0.05	−0.47	−0.32	
14.4	SH	2.80	−0.02	0.10	−0.17	−0.02	
	WT	2.82	—	0.12	—	0.15	
5-20-75	FM	3.10		0.03		−0.09	
14:31:50.4	CC	3.07		—		—	
240	SC	3.04		0.17		−0.20	
14.6							
7-24-75	SC	2.85		−0.13		−0.50	
19:01:42.6	CC	2.98		—		—	
241	FM	2.78		−0.20		−0.32	
14.5							

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction
10-17-77	BG	3.13		0.08		−0.10
17:26:40.4	CC	3.11		—		—
242	LAD	3.32		0.21		0.31
14.4	LPN	3.03		−0.08		0.01
	TD	2.85		−0.26		−0.21
5-29-75	SC	3.09		0.04		−0.33
06:42:12.8	CC	3.05		—		—
242	FM	3.08		0.03		−0.09
14.5	CM	3.10		0.05		−0.25
8-12-75	MY	3.47	−0.15	−0.02	−0.22	−0.06
01:12:05.8	FM	3.62	0.00	0.13	−0.15	0.01
242	SC	3.81	0.19	0.32	−0.21	−0.05
15.7	WT	3.62	—	0.13	—	0.16
	CM	3.59	−0.03	0.10	−0.36	−0.20
	CC	3.49	−0.13	—	−0.16	—
8-7-75	FM	2.11	−0.02	0.03	−0.17	−0.09
20:10:15.0	CM	2.11	−0.02	0.03	−0.35	−0.27
243	SC	2.21	0.08	0.13	−0.32	−0.24
14.5	CC	2.08	−0.05	—	−0.08	
	WT	2.13	—	0.05	—	0.08

Date Origin Time Azimuth ∆ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction
2-3-76	WT	3.74	—	0.09	—	0.12
18:03:52.0	JH	3.80	0.06	0.15	−0.09	0.03
243	JC	3.75	0.01	0.10	−0.39	−0.27
16.0	DM	3.82	0.08	0.17	−0.01	0.11
	CC	3.65	−0.09	—	−0.12	—
	CM	3.67	−0.07	0.02	−0.40	−0.28
1-21-77	DM	2.84	0.02	0.15	−0.07	0.09
06:11:05.6	CM	2.77	−0.05	0.08	−0.38	−0.22
245	JC	2.91	0.09	0.22	−0.31	−0.15
15.0	WT	2.82	—	0.13	—	0.16
	CC	2.69	−0.13	—	−0.16	—
	GM	2.88	0.06	0.19	−0.05	0.11
2-6-76	CC	2.73	−0.01	—	−0.04	—
00:02:32.5	CM	2.80	0.06	0.07	−0.27	−0.23
245	DM	2.68	−0.06	−0.05	−0.15	−0.11
15.0	WT	2.74	—	0.01	—	0.04

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
12-14-77	BA	1.92		0.09		−0.06	
15:30:00:169	SL	1.92		0.09		0.05	
289	CC	1.83		—		—	
(NTS) 63.2*	CK	1.90		0.07		−0.09	
	BG	1.97		0.14		0.02	
8-19-77	SC	2.09					
17:55:00.075	GM	1.72					
296							
(NTS) 63.2							
4-27-77	CC	1.72	−0.17	—	−0.20	—	
15:00:00.084	LAO	1.70	−0.19	−0.02	−0.13	0.08	
296	DM	1.90	0.01	0.18	−0.08	0.12	
(NTS) 63.2	GM	1.82	−0.07	0.10	−0.18	0.02	
	WT	1.89	—	0.17	—	0.20	
	CM	2.04	0.15	0.32	−0.18	0.02	
	SC	1.88	−0.01	0.16	−0.41	−0.21	

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
4-5-77	GM	1.77		0.15		0.07	
15:00:00.167	DM	1.93		0.31		0.25	
296	CC	1.62		—		—	
(BITS) 63.2*	CDD	1.99		0.37		0.07	
	SC	1.91		0.29		-0.08	
	LBO	1.64		0.02		0.12	
12-21-77	CK	3.04		0.05		-0.11	
01:00:39.8	LBO	2.59		-0.40		-0.30	
303	BB	3.00		0.01		-0.14	
14.6	SL	2.95		-0.04		-0.08	
	LPN	2.65		-0.34		-0.25	
	CC	2.97		—		—	
	BG	3.01		0.02		-0.10	
9-16-75	NJ	3.06	0.81		0.06		
11:09:07.8	CM	3.05	0.20		-0.13		
305	MG	2.95	0.10		-0.05		
14.5	WT	2.85	—		—		
	HC	3.29	0.44		0.17		

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction
7-28-77	GM	4.67		0.14		0.06
15:22:18.5	SC	4.64		0.11		−0.26
306	LPD	4.42		−0.11		−0.02
32.3	CM	4.54		0.01		−0.29
	CC	4.53		—		—
	BG	4.65		0.12		0.00
8-4-76	NG	2.80	0.30		0.02	
23:01:44.2	SC	2.64	0.14		−0.26	
308	GM	2.78	0.28		0.17	
14.5	FC	207	−0.43		−0.85	
	WT	2.50	—		—	
	HC	2.88	0.38		0.11	
7-29-75	CC	5.24	−0.13	—	−0.16	—
01:48:16.2	CM	5.69	0.32	0.45	−0.01	0.15
309	WT	5.37	—	0.13	—	0.16
38.0	SC	5.47	0.10	0.23	−0.30	−0.14
	FM	5.58	0.22	0.34	0.06	0.22

Date Origin Time Azimuth ∡ of Incidence	STN	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
8-12-75	CC	2.97		—		—	
14:21:04.7	SC	3.24		0.27		−0.10	
310	MY	2.99		0.02		−0.02	
14.5	FM	3.11		0.14		0.02	
9-21-77	BG	3.34		0.30		0.18	
10:35:26.6	CC	3.04		—		—	
311	RI	3.34		0.30		0.06	
28.6	GM	3.12		0.08		0.00	
	FM	3.22		0.18		0.06	
	TO	2.99		−0.05		0.00	
	LAO	3.40		0.36		0.46	
8-21-75	CC	3.11		—		—	
07:24:19.8	CN	3.19		0.08		−0.22	
312	SC	3.35		0.24		−0.13	
227	FM	3.30		0.19		0.07	
10-26-77	LPN	3.16		−0.22		−0.13	
15:10:58.8	BG	3.08		−0.20		−0.42	
312	CC	3.38		—		—	
229	LAO	3.31		−0.07		0.03	

Date Origin Time Azimuth ∡ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
2-18-76	IC	3.36	0.12	0.20	−0.17	−0.06	
08:00:58.6	WM	3.53	0.09	0.17	−0.18	−0.07	
312	WT	3.44	——	0.08	——	0.11	
23.4	SC	3.57	0.13	0.21	−0.27	−0.16	
	CC	3.36	−0.08	——	−0.11	——	
	CM	3.43	−0.01	0.07	−0.34	−0.23	
8-17-77	SC	3.16					
16:48:31.3	LAD	3.36					
312	GM	2.93					
23.7	DM	3.18					
	CM	3.19					
	RG	3.06					
10-4-77	GM	3.60		0.32		0.24	
15:38:56.6	RT	3.45		0.17		−0.07	
313	JO	3.24		−0.04		0.01	
15.3	BG	3.43		0.15		0.03	
	CC	3.28		——		——	
	LAD	3.54		0.26		0.36	
	LPN	3.19		−0.09		0.00	

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
8-20-76	SC	3.18	0.30		0.10		
03:56:00.6	WT	2.88	—		—		
314	HC	3.28	0.40		0.13		
18.1	NG	3.12	0.24		−0.04		
	FC	3.20	0.32		−0.10		
	GM	3.19	0.31		0.20		
7-20-77	SC	3.41		0.21		−0.16	
13:24:25.9	LPN	3.15		−0.05		0.04	
316	GM	3.33		0.13		0.05	
25.9	CM	3.50		0.30		0.00	
	CC	3.20		—		—	
2-21-77	WT	2.90	—	0.52	—	0.06	
20:02:06.0	SC	3.06	0.16	0.19	0.01	−0.07	
317	CM	3.02	0.12	0.15	−0.21	−0.15	
25.6	SC	3.00	0.10	0.13	−0.30	−0.24	
	CC	2.87	−0.03	—	−0.06	—	
	LPN	—					

Date Origin Time Azimuth Δ of Incidence	STN	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction
7-25-75	FM	3.95		0.04		−0.08
10:40:25.0	CC	3.91		—		—
317	CM	3.99		0.08		−0.22
86.1	SC	3.98		0.07		−0.30
8-6-75	WT	2.86	—	−0.04	—	−0.01
21:37:39.7	SC	3.05	0.19	0.15	−0.21	−0.22
318	CM	2.98	0.12	0.08	−0.21	−0.22
14.2	CC	2.90	0.04	—	0.01	—
	FM	3.12	0.26	0.22	0.11	0.10
10-4-77	CC	3.32		—		—
21:34:43.5	BG	3.64		0.32		0.20
318	GM	3.54		0.22		0.14
19.9	LBO	3.77		0.45		0.55
	LPN	3.69		0.37		0.46
	RI	3.63		0.31		0.07
11-4-75	CC	3.87	−0.12	—	−0.15	—
12:05:56.9	WT	3.99	—	0.12	—	0.15
318	NS	3.96	−0.03	0.09	−0.18	−0.03
21.6	CM	4.09	0.10	0.22	−0.23	−0.08
	SC	4.04	0.05	0.17	−0.35	−0.20

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
8-15-75	FM	4.05	0.04	0.10	−0.11	−0.02	
07:28:18.9	WT	4.01	—	0.06	—	0.09	
318	CM	4.20	0.19	0.25	−0.14	−0.05	
21.7	CC	3.95	−0.06	—	−0.09	—	
	SC	4.19	0.18	0.24	−0.22	−0.13	
8-12-76	NG	2.41	0.22		−0.06		
23:29:08.9	WT	2.19	—		—		
319	HC	2.62	0.43		0.16		
17.0	GM	2.61	0.42		0.31		
	FC	2.54	0.35		−0.07		
9-21-77	TD	2.91		−0.22		−0.17	
21:01:44.0	FM	3.07		−0.06		−0.18	
319	CC	3.13		—		—	
19.6	BG	3.10		−0.03		−0.15	
	GM	3.35		0.22		0.14	
	LAO	3.31		0.18		0.28	
	RT	3.35		0.22		−0.02	

Date Origin Time Azimuth ∠ of Incidence	STA	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base Wt w/ correction	Residual w.r.t. Base CC w/ correction	
3-9-77	SC	3.68	0.17		−0.23		
14:27:53.6	WT	3.51	—		—		
300	OM	3.14	−0.37		−0.46		
14.7	GM	3.63	0.12		0.01		
	LPM	3.16	−0.35		−0.29		
	CM	3.56	0.05		−0.28		
	LAO	3.34	−0.17		−0.10		
8-1-75	CM	4.94	0.32	0.20	−0.01	−0.10	
08:14:46.0	SC	4.95	0.33	0.21	−0.07	−0.16	
320	WT	4.62	—	−0.12	—	−0.09	
21.2	CC	4.74	0.12	—	0.09	—	
	FM	4.86	0.26	0.12	0.09	0.00	
9-21-77	RI	3.97		0.17		−0.07	
17:39:38.8	CM	3.91		0.11		0.03	
321	BG	3.77		−0.03		−0.15	
21.0	CC	3.80		—		—	
	FM	3.77		−0.03		−0.15	
	TO	3.59		−0.21		−0.16	

Date Origin Time Azimuth ∡ of Incidence	STn	Absolute Residual	Residual w.r.t. Base WT w/o correction	Residual w.r.t. Base CC w/o correction	Residual w.r.t. Base WT w/ correction	Residual w.r.t. Base CC w/ correction	
10-19-77	BG	3.06		−0.08		−0.20	
02:16:02.6	CC	3.14		—		—	
330	GM	3.19		0.05		−0.03	
26.7	LPN	3.06		−0.08		0.01	
	RT	3.12		−0.02		−0.26	
	TO	2.99		−0.15		−0.10	
	LAO	3.34		0.00		0.10	
7-29-76	SC	3.69	0.04		−0.36		
04:59:57.7	RH	3.80	0.15		0.00		
343	NG	3.59	−0.06		−0.34		
(UNE) 14.5	GM	3.67	0.02		−0.09		
	HC	3.88	0.23		−0.04		
	WT	3.65	—		—		

Pages 104-107. Error Analysis (for round-off of distance to nearest 0.01°)

Event 2/19/76 18:31:31.1 147° Azi. $\angle i$ = 35.3° SE Quad

Refer to Figure III-A.

STA	Distance Schlue's Program	MY Calculations (see Figure III-A)
WT	20.99°	———
CC	21.06°	0.80 in. = 8.333 Km. = +0.075° = 21.065°
SC	21.00°	0.105 in. = 1.094 Km. = +0.010° = 21.000°
WM	20.96°	0.33 in. = 3.438 Km. = −0.031° = 20.959°
IC	20.99°	0.545 in. = 5.677 Km. = −0.051° = 20.939°
CM	20.89°	1.110 in = 11.563 Km = −0.104° = 20.886°

Event 2/3/76 18:03:52.0 243° Azi $\angle i$ = 16.0° SW Quad

		(see Figure III-B)
WT	82.97°	———
SH	83.13°	1.71 in. = 17.813 Km. = +0.160° = 83.130°
SC	82.84°	1.44 in = 15.000 Km. = −0.135° = 82.835°
DM	83.09°	1.24 in. = 12.917 Km. = +0.116° = 83.086°
CC	82.98°	0.08 in. = 0.833 Km. = +0.007° = 82.987°
CM	82.91°	0.69 in. = 7.188 Km. = −0.065° = 82.905°

Event 4/27/77 15:00:00.084 296° Azi. $\angle i$ 63.2° NW Quad

		(see Figure III-E)
WT	7.99°	———
CC	7.93°	0.62 in = 6.458 Km = −0.058° = 7.932°
LAD	7.77°	2.55 in = 26.563 km = −0.239° = 7.751°
DM	8.08°	0.93 in = 9.688 Km = +0.087° = 8.077°
GM	7.74°	2.60 in = 27.083 Km = −0.244° = 7.746°
CM	8.03	0.48 in = 5.000 Km = +0.045° = 8.035°
SC	7.91	0.85 in = 8.854 Km = −0.080° = 7.910°

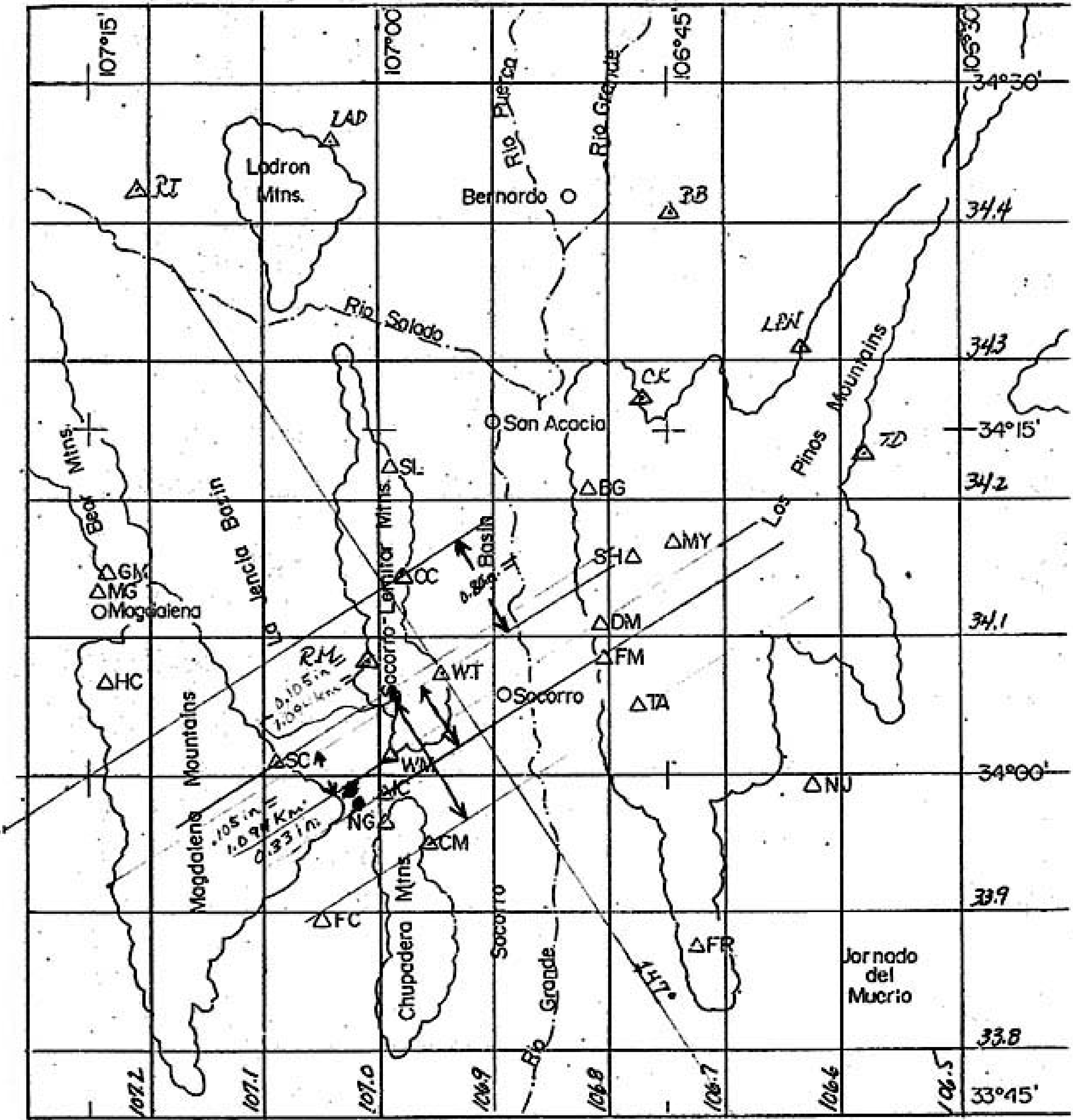


Figure II-A.

0 1 2 3 4 5 6 7 8 9

S-P INTERVAL (secs) V_p = 5.8 km/sec V_s = 3.35 km/sec

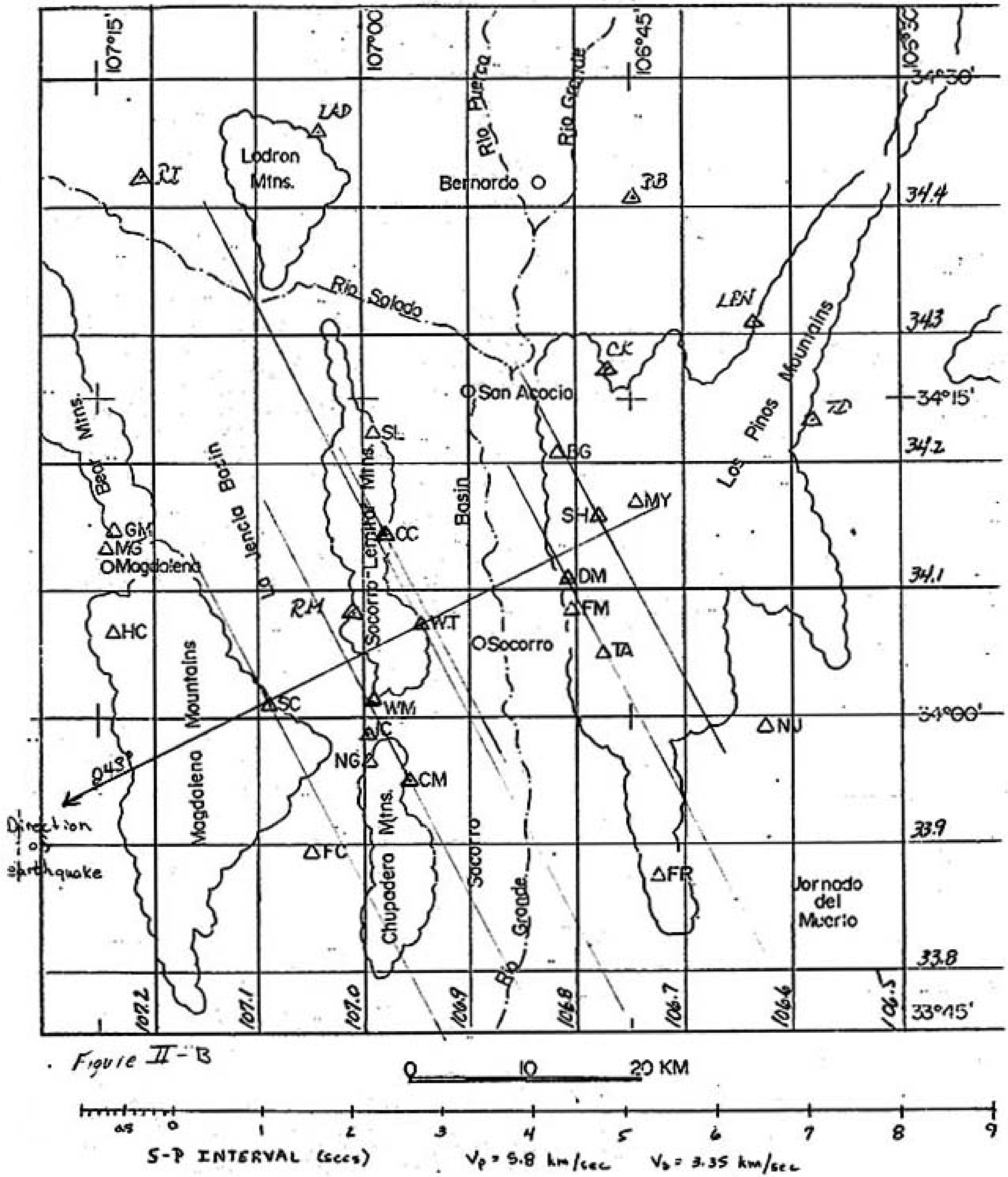

107°15'
107°00'
106°45'
34°30'
34°15'
34°00'
33°45'
34.4
34.3
34.2
34.1
33.9
33.8
107.2
107.1
107.0
106.9
106.8
106.7
106.6
106.5
Ladron Mtns.
Bernardo
Rio Puerco
Rio Grande
Rio Salado
San Acacio
Los Pinos Mountains
Bear Mtns.
La Jencia Basin
Socorro-Lemitar Mtns.
Basin
Magdalena
Socorro
Magdalena Mountains
Chupadero Mtns.
Socorro
Rio Grande
Jornado del Muerto
SL
BG
SH
MY
GM
MG
CC
DM
FM
HC
WT
TA
SC
WM
NU
NG
CM
FC
FR
045°
Direction of earthquake
0 10 20 KM
.05 0 1 2 3 4 5 6 7 8 9
S-P INTERVAL (secs)
Vp = 5.8 km/sec
Vs = 3.35 km/sec

Figure II-B

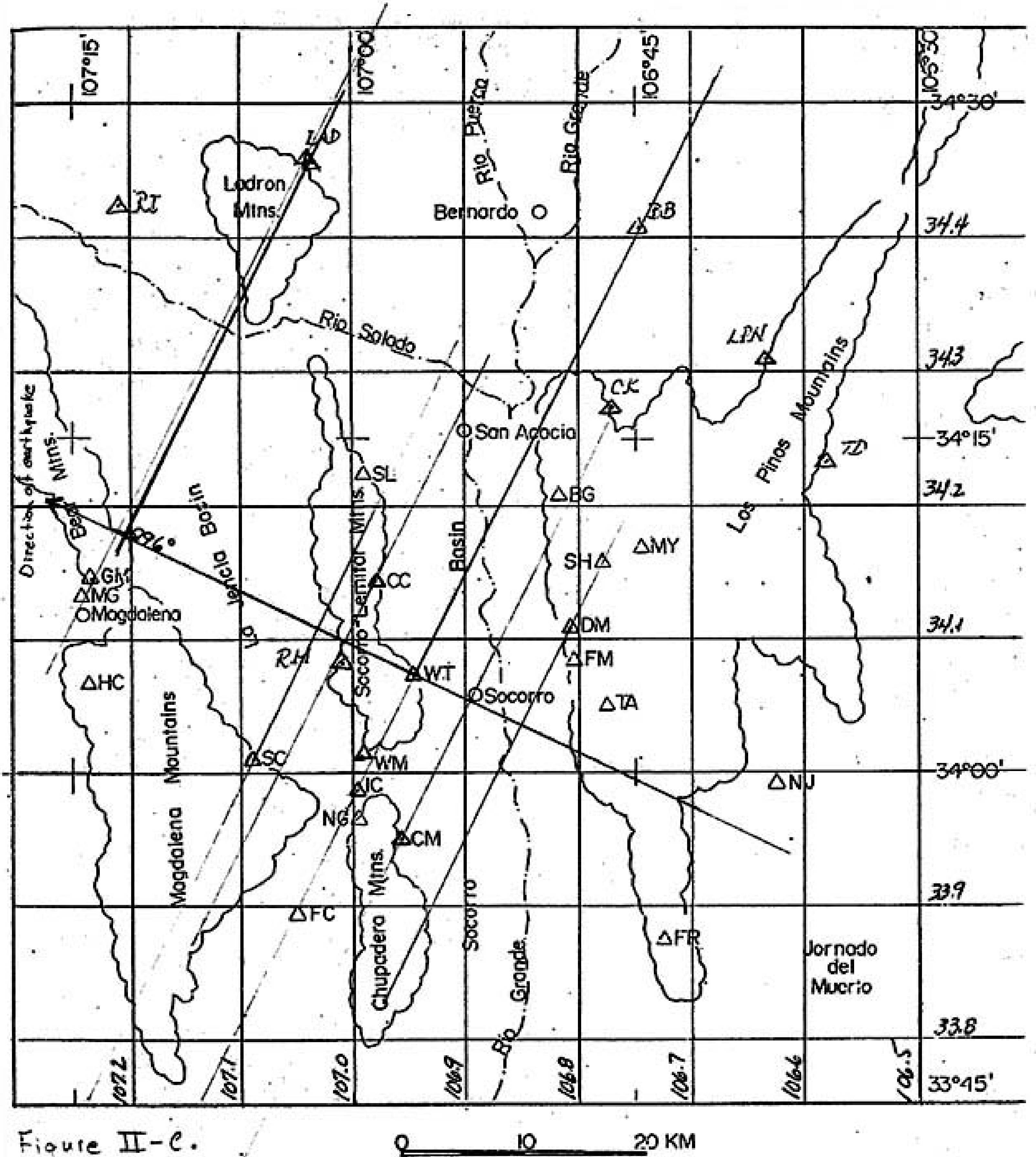

107°15'
107°00'
106°45'
106°30'
34°30'
34.4
34.3
34°15'
34.2
34.1
34°00'
33.9
33.8
33°45'
107.2
107.1
107.0
106.9
106.8
106.7
106.6
106.5
Ladron
Mtns.
Bernardo
Rio Puerco
Rio Grande
Rio Salado
San Acacia
Los Pinos Mountains
Direction of earthquake
Bear Mtns.
296°
La Jencia Basin
Socorro - Lemitar Mtns.
Basin
Magdalena
Magdalena Mountains
Socorro
Chupadera Mtns.
Socorro
Rio Grande
Jornado del Muerto
LD
RI
BB
LPN
CK
TD
SL
BG
MY
SH
GM
MG
CC
DM
FM
RH
WT
TA
HC
SC
WM
IC
NJ
NG
CM
FC
FR
0 10 20 KM

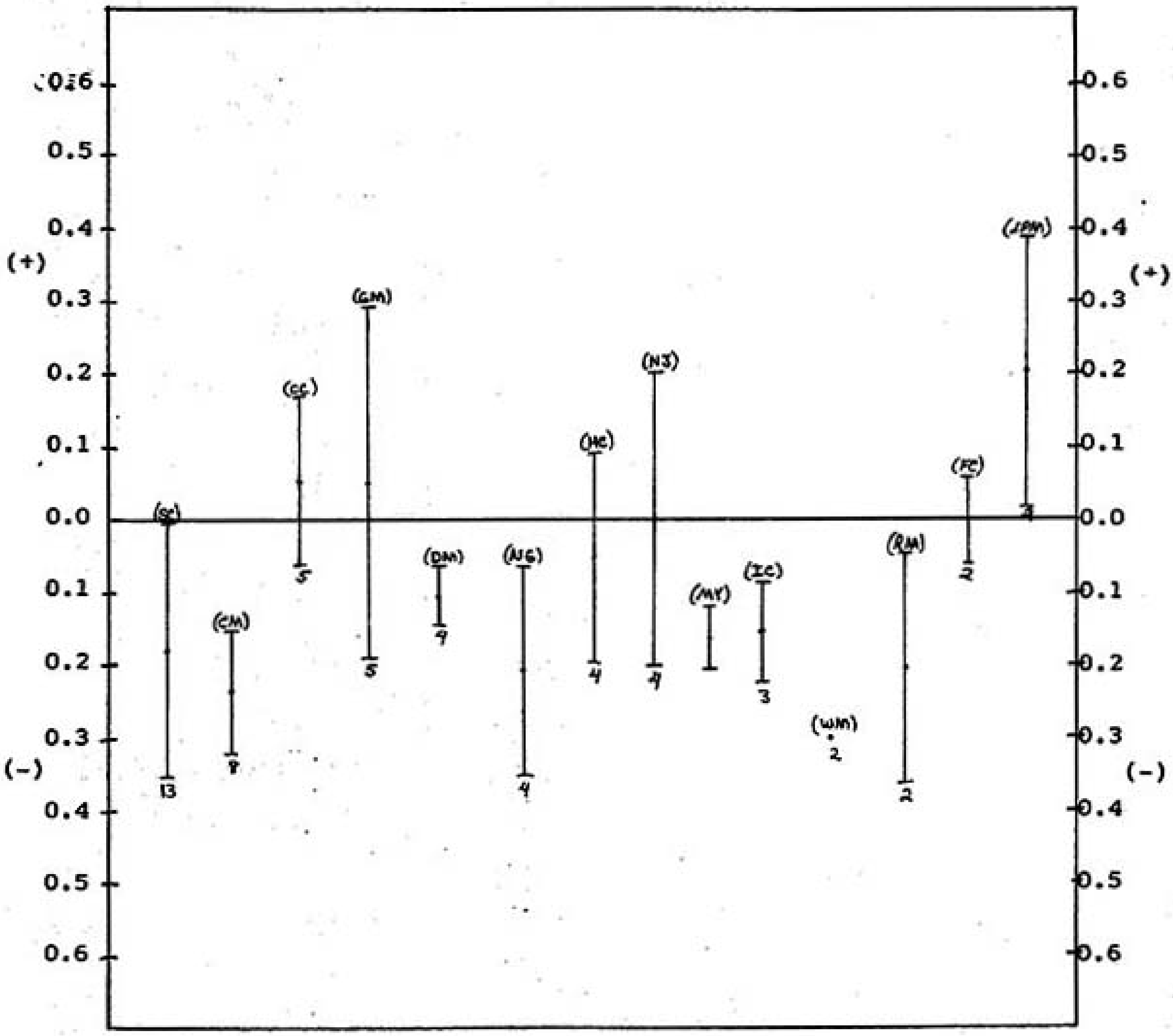
Figure II-C.

.05 0 1 2 3 4 5 6 7 8 9
S-P INTERVAL (secs)
Vp = 5.8 km/sec Vs = 3.35 km/sec

Appendix 4. Relative residuals with error bars, pp. 108-113.

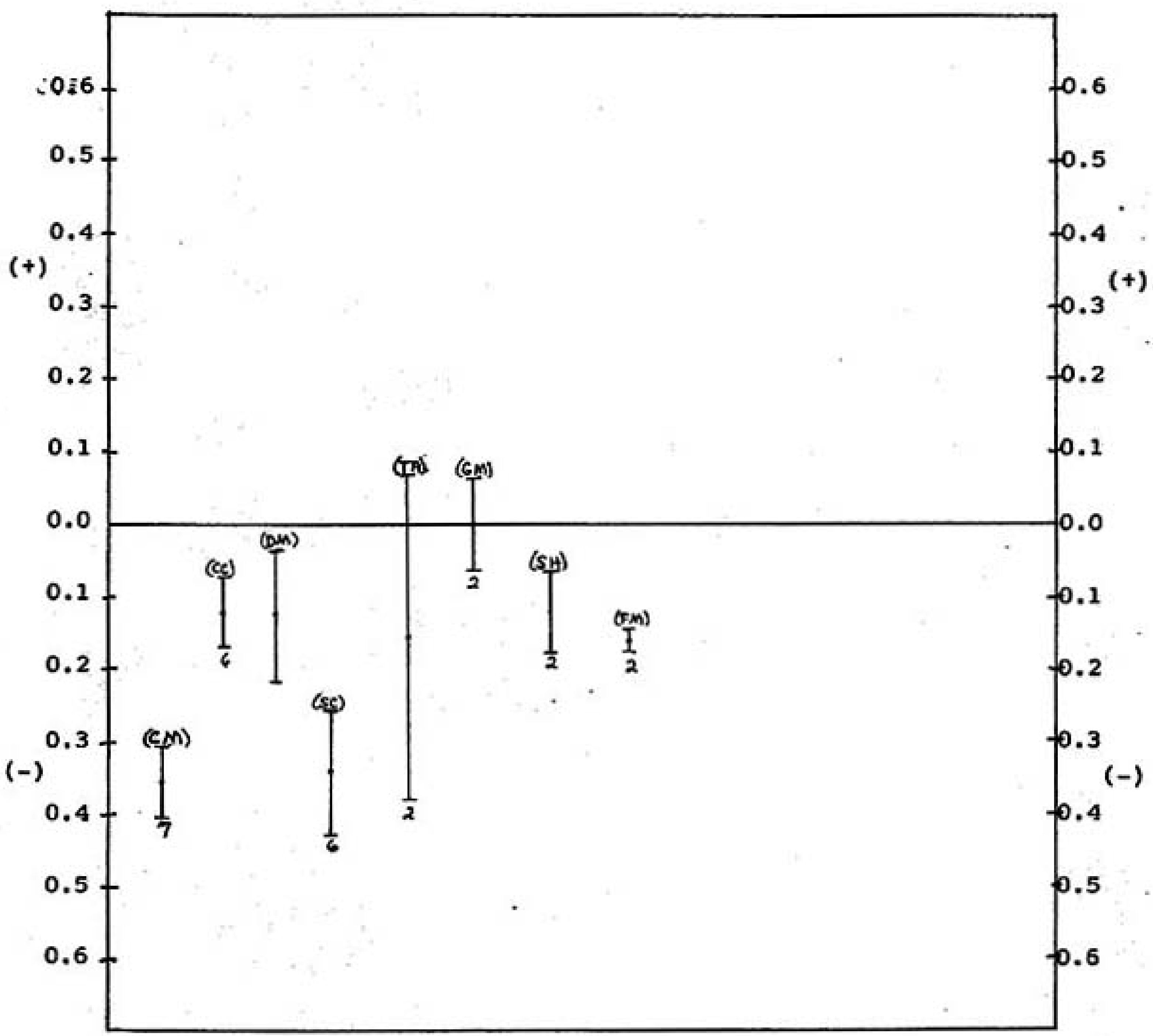
RESIDUALS WITH RESPECT TO WT

SE QUADRANT



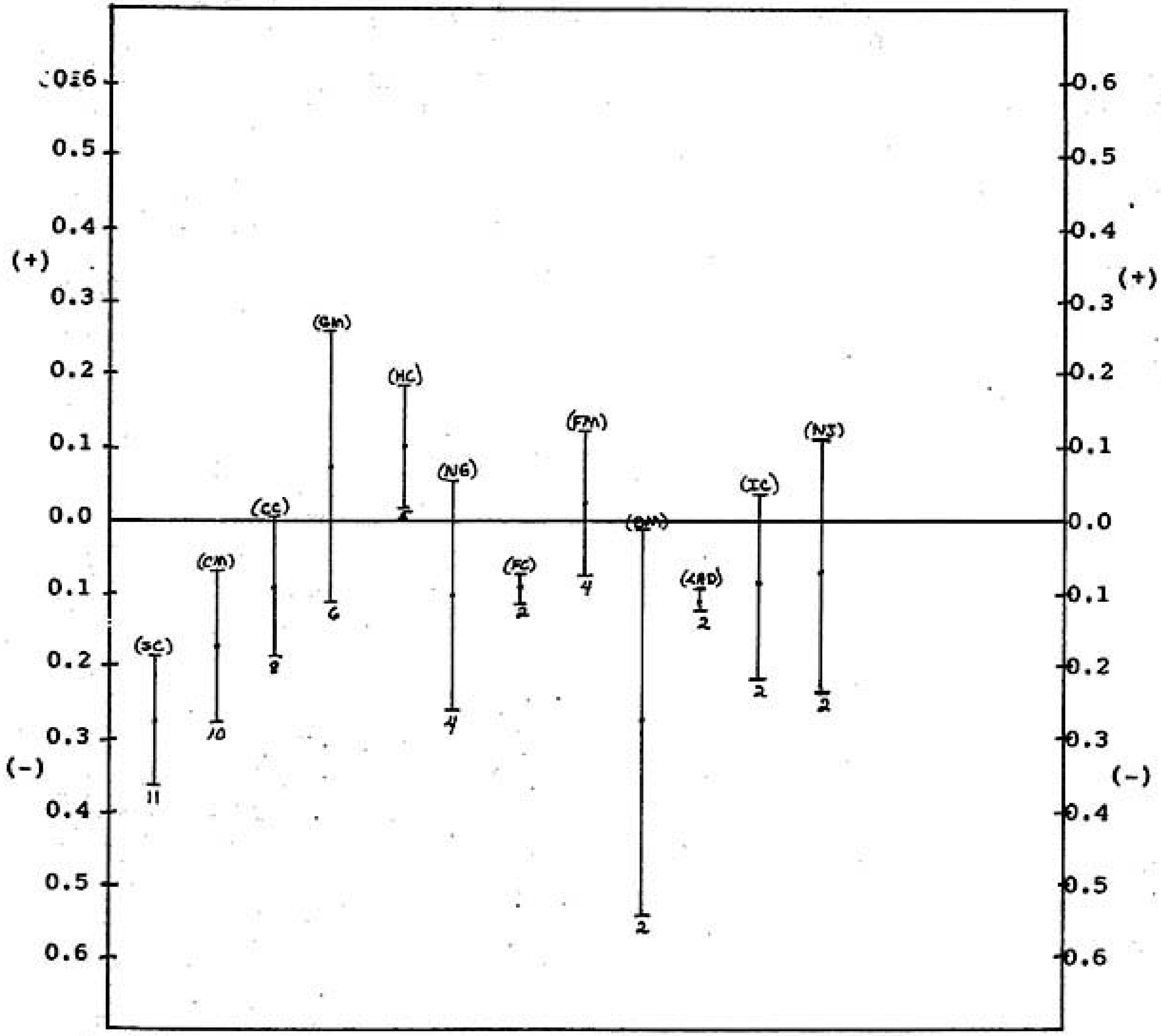
RESIDUALS WITH RESPECT TO WT

SW QUADRANT



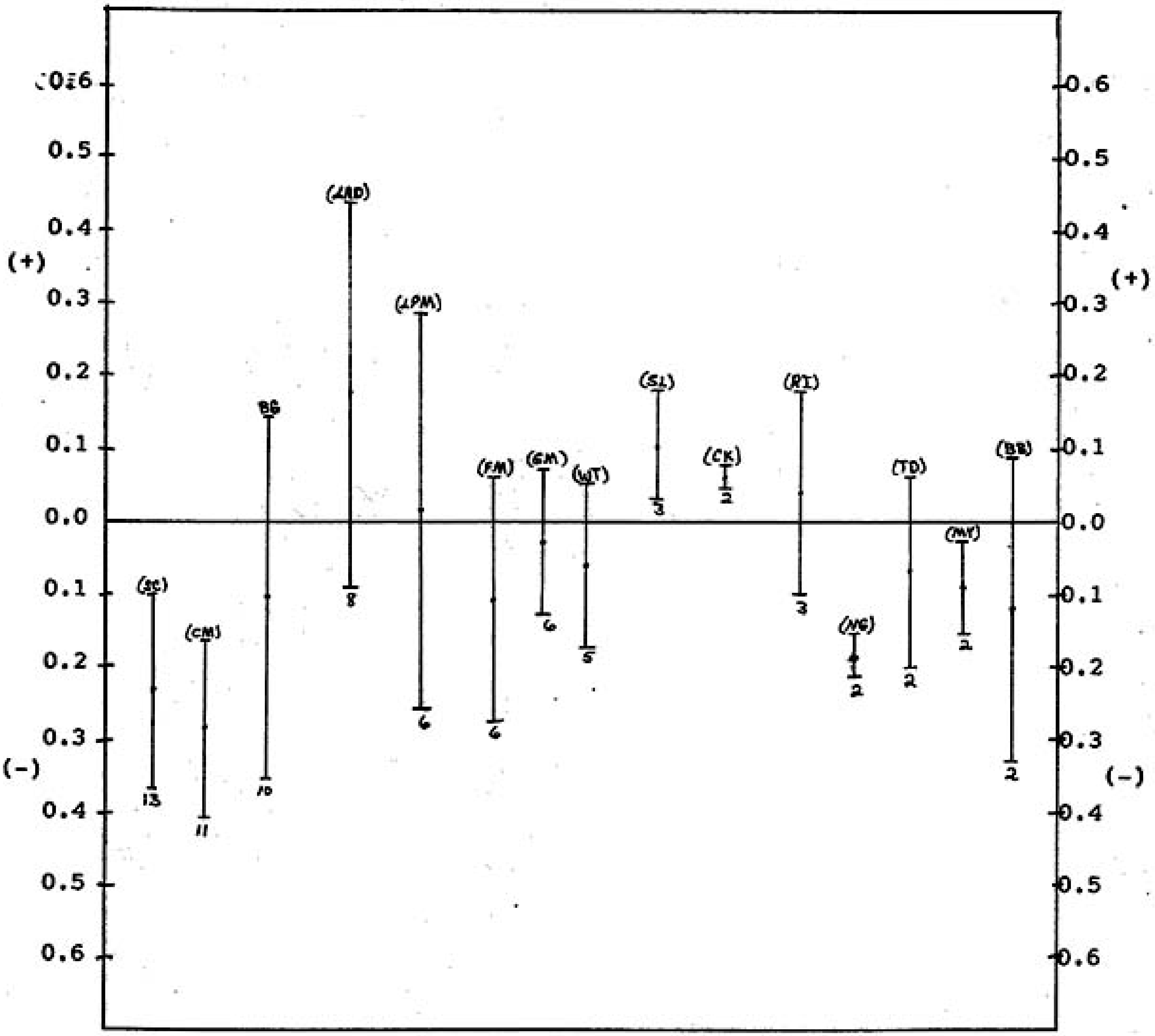
RESIDUALS WITH RESPECT TO WT

NW QUADRANT



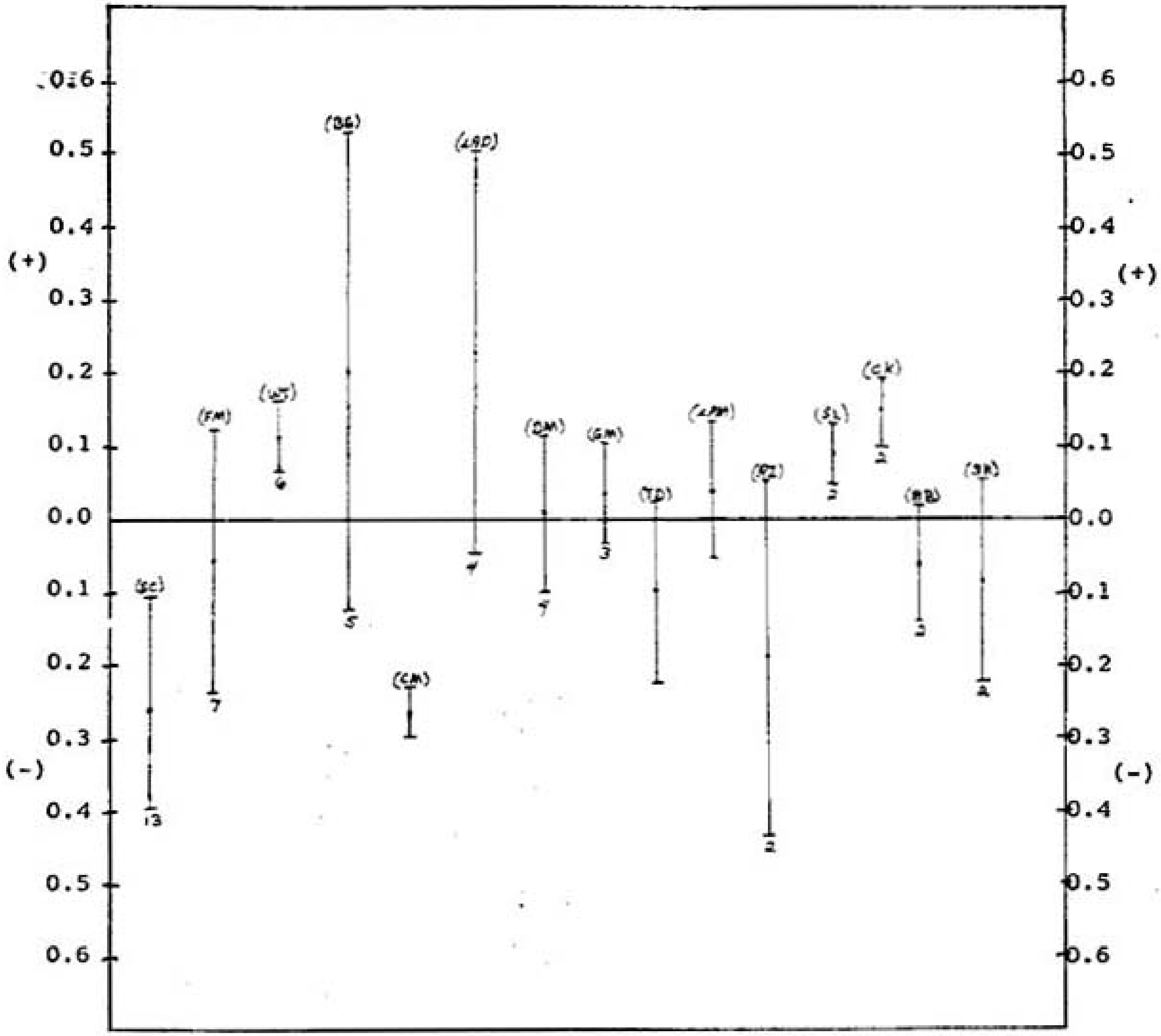
RESIDUALS WITH RESPECT TO CC

SE QUADRANT



RESIDUALS WITH RESPECT TO CC

SW QUADRANT



RESIDUALS WITH RESPECT TO CC

NW QUADRANT