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# SOURCE-REGION/STATION TIME CORRECTIONS FOR THE EASTERN HIMALAYAN REGION

Jack G. Swanson

Teledyne Geotech

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# SOURCE-REGION/STATION TIME CORRECTIONS FOR THE EASTERN HIMALAYAN REGION

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Source-region/station time corrections are developed for the eastern Himalayan region and 181 stations, including 48 stations of the World Wide Standard Seismograph Network. The study area encompasses the area within about 15 degrees of 30N 95E and includes the Himalayan front, the Tibetan platform and parts of the Central China fold system, the North China-Korean platform, the Burmese arc, the Indochina fold system, and the South China platform. For teleseismic stations, the median standard deviation of station residuals about

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) their corrections ranges from 0.45 second to 0.83 second for different parts of the region. For close-in stations, median station standard deviations range from 0.78 second to 1.30 second. The overall mean depth error (deviation from pP depth) of earthquakes relocated with the corrections applied is about 0 km; the mean of the absolute errors is 6.8 km and the mean 95 percent depth coverage interval is ±16.7 km. A significant depth criterion, based on depth reliability estimates and allowing 5 km for drillable depth, identifies, at the 95 percent level, all calibration earthquakes with pP depth greater than 30 km, 88 percent with pP depth greater than 20 km, and 63 percent with pP depth greater than 10 km. Except for the Burmese arc, focal depths of earthquakes throughout the study area are very shallow, all but 8 of the calibration earthquakes having pP depths of 40 km or less, with a mean value of 18 km. The very shallow focal depths of earthquakes throughout most of this region limit the usefulness of identification techniques based on computed depth. Focal depths of some earthquakes in the study area, previously reported as radiating anomalously weak surface waves, are not great enough to explain the weak surface wave radiation.

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by

Jack G. Swanson

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## REPORT SUMMARY

The capability to determine refined focal depths for earthquakes in the eastern Himalayan region is provided through development of Source-Region/Station Time (SRST) corrections in the region for 181 stations. Use of the SRST corrections permits computation of focal depths, from P-wave arrival times, which do not differ overall from depths based on pP phases. The mean of the absolute differences in depths is about 7 km with 95 percent depth reliability intervals averaging about ±17 km. Of the 242 earthquakes used in the study, 63 percent of those with pP based depths of 10 km or greater are identified as earthquakes at the 95 percent level with a significant depth criterion which allows 5 km for drillable depth. Evaluation of selected earthquakes, which produced anomalously weak surface waves from the region, indicated focal depth was not the cause of the weak radiation.

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# SOURCE-REGION/STATION TIME CORRECTIONS FOR THE EASTERN HIMALAYAN REGION

## 1. INTRODUCTION

This report describes the development of Source-Region/Station Time (SRST) corrections for the eastern Himalayan region and evaluates the usefulness of the corrections for determining focal depth of earthquakes in the region.

In section 2, problems that have been encountered in identifying seismic events in this region and identification techniques that have been utilized or proposed are described. Data used in the study are described in section 3 and the technique used to develop SRSTs is presented in section 4. In section 5, results of the study are given and the reliability of the corrections and the depth reliability of locations made with SRSTs applied are discussed. Tectonic implications of the refined hypocentral locations made possible by the use of SRSTs are also discussed. The effect of depth corrections on $M_s$-$m_b$ values of earthquakes in this region which have previously been described as radiating anomalously weak surface waves is described.

## 2. BACKGROUND

Several areas in the eastern Himalayan region have been identified in which apparently shallow earthquakes produce anomalously weak surface waves (Der, 1972, Kimball and Swanson, 1973, Nuttli and Kim, 1975). Such anomalous earthquakes have been located near the juncture of the Burmese and Himalayan arcs at about 30N 95E. They also occur southwestward from the juncture along the Himalayan arc to about 28N 87E. Isolated anomalous earthquakes have been located in regions of low seismicity on the continental side of the arcs. Such events have occurred near 25N 98E, 29N 104E, 30N 89E, 32N 98E, and 33N 89E. In other regions, the weak surface wave generation of anomalous earthquakes has been attributed to high stress drop in the source region (Thatcher, 1972). Evernden (1975) determined that anomalous $M_s/m_b$ values cannot be caused by high stress drop for $m_b$ less than 5.0. This conclusion was based on Archambeau's (1974) relaxation model of earthquake source mechanism. Evernden also developed corrections to be applied to $M_s$ values based on focal depth and source mechanism. He concluded that anomalous $M_s/m_b$ values can be explained by focal depth and/or source mechanism with strike-slip mechanisms yielding especially weak Rayleigh waves for focal depths of 45 km or greater. Whatever the cause of weak surface wave generation by anomalous earthquakes, without knowledge of focal depth, the $M_s/m_b$ technique of discriminating between earthquakes and explosions is inapplicable to seismic events in the anomalous regions.

Focal depth provides an effective identification criterion if event depth can be determined with adequate reliability. Depths determined from depth phase information (pP-P and sP-P intervals) can yield depths with a reliability of about 5 km or better if clear depth phases are available for a wide distance range. However, depth phases from weak events are difficult to identify, particularly if the events are very shallow (less than 25 km). Accurate focal depths can be determined from P arrival times by means of the commonly used modified Geiger technique (Macelwane and Sohon, 1932) if origin time is known independently. Origin time may be estimated from S and P arrival times at close-in (distance less than about 10 degrees) stations using the S to P travel time ratio technique (Swanson, 1975, Evernden, 1969) if data from enough close-in stations are available. Accurate focal depths can also be determined in all-parameter-free locations using P arrivals with the application of Source-Region/Station Time (SRST) corrections (Veith, 1975a). These corrections are first order adjustments to tabled P-wave travel times from a given source region to individual stations. Estimates of the reliability of the SRSTs are obtained in the course of developing the corrections. They are based on variability of observed residuals about the SRSTs. Accurate relative hypocenters and valid estimates of the relative hypocenter reliability are obtained with application of SRSTs and weighting each station's P arrival time according to the reliability of that station's correction. Because SRSTs are valid for close-in stations as well as for teleseismic stations and because each station's residual is weighted according to that station's reliability for the region, full utilization of the P arrivals for hypocenter determination is achieved. The accurate relative hypocenters obtained have proved to be valuable in resolving tectonic stress patterns in the Kurile arc (Veith, 1974) and in Hindu-Kush region (Veith, 1975b).

# 3. DATA

Earthquakes which occurred between 1964 and 1973 in the area within about 15 degrees of 30N, 95E were considered for use in this study. Calibration events were required to have body wave magnitudes of 4.6 or greater or arrivals reported by at least 50 stations. They were also restricted to those events for which focal depth could be established from pP-P and/or sP-P intervals although this criterion tends to bias data set selection in favor of deeper events. Two hundred and forty-two earthquakes met these criteria. P arrival times reported by 181 stations, including 48 stations of the World Wide Standard Seismograph Network (WWSSN), were used in the study. Arrival times were taken from the bulletins of the International Seismological Centre and the Moscow Academy of Science. The stations used in the study were selected on the basis of the number of P arrivals reported by each station; selection was modified slightly to improve the aximuthal distribution of the stations around the study area.

## 4. DEVELOPMENT OF SOURCE-REGION/STATION TIME CORRECTIONS

The area investigated was divided into four regions for development of SRSTs and 18 subregions to aid in evaluating the results. The regional divisions are shown in figure 1. Region 1 consists of most of the Himalayan foldbelt and the western parts of the Tibetan platform, the Central China fold system, and the North China-Korean platform. Region 2 includes the central part of the Central China fold system and the eastern part of the North China-Korean platform. Region 3 is composed of the Burmese arc and those parts of the Himalayan foldbelt and Tibetan platform near the juncture of the Himalayan and Burmese arcs. Region 4 consists of the Indochina fold system and the western part of the South China platform.

SRST functions were determined separately for each of the four regions. For each region, a reference location was defined and an axis orientation was selected such that the X axis would be approximately perpendicular to the main tectonic trend for the region. Because no clear tectonic trend is evident for region 2, the axis rotation was set to zero (positive X axis oriented northward). Reference locations and axes orientations (azimuth of X axis from north) are listed in table 1.

Table 1. Region coordinate specification

| Region | Reference location: N lat deg | Reference location: E long deg | Azimuth of X axis deg |
|---|---|---|---|
| 1 | 32 | 85 | 17 |
| 2 | 35 | 102 | 0 |
| 3 | 25 | 95 | 103 |
| 4 | 26 | 102 | 80 |

To help assure a smooth transition in SRSTs between regions, arrival time residuals from all calibration earthquakes within 14 degrees of the reference location for a given region were used in determining the SRST functions for that region. The residuals were weighted according to distance from the reference location for the region, as follows: residuals from earthquakes within 7 degrees of the reference location were given unit weight; residuals from earthquakes between 7 and 14 degrees from the reference location were weighted with a $\cos^2$ (distance) taper.

Veith (1975a) has fully described the procedure used to develop SRSTs. A preliminary location of each calibration earthquake was made with depth restrained to pP depth. Stations between 25 and 100 degrees were used with distance and azimuth dependent station corrections applied, and a source term was estimated (Veith, 1975a). The source term was significantly non-zero, with a mean value of -0.11 degree, for earthquakes southeast of 31N 92E, and not significantly different from zero for earthquakes in the

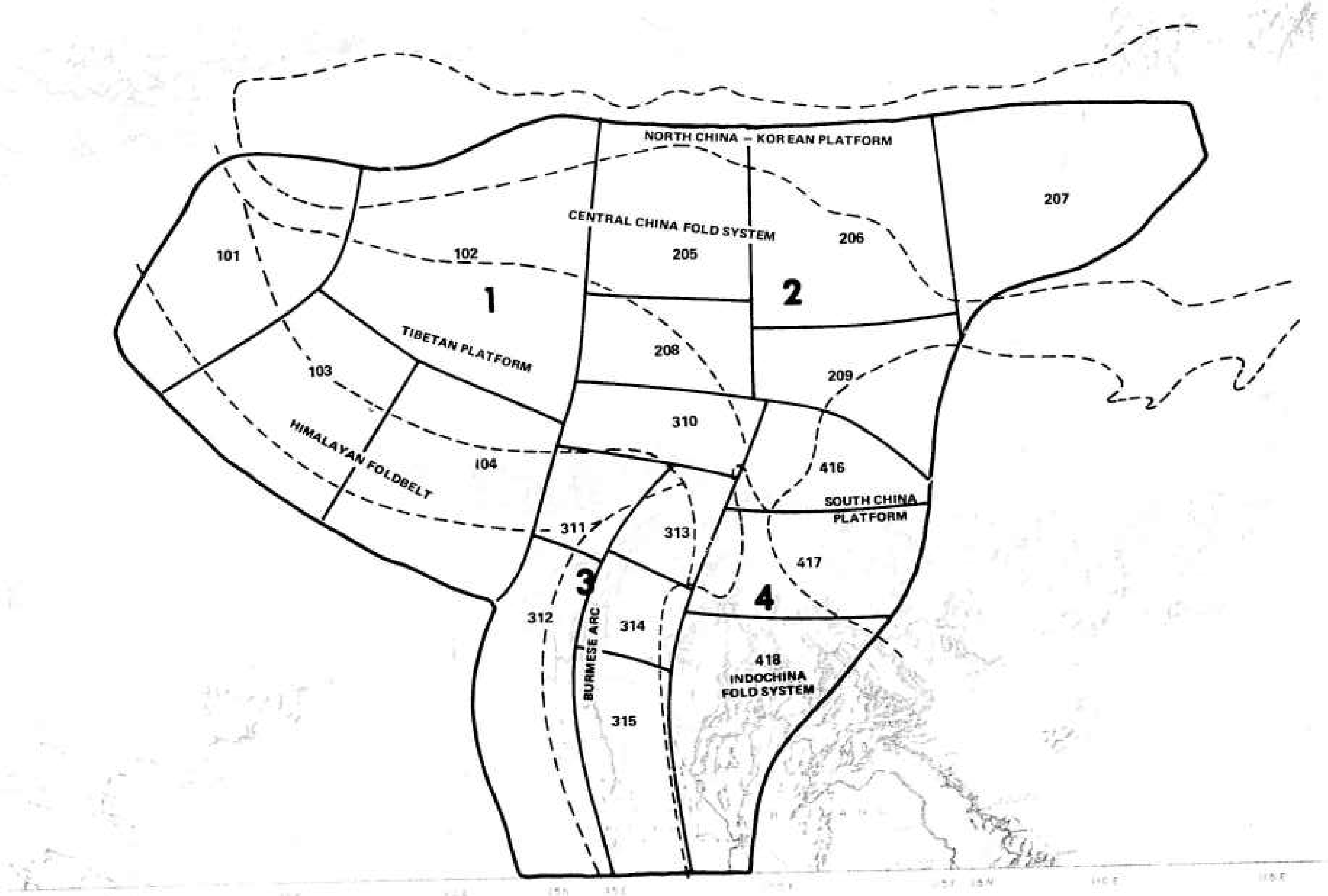


Figure 1. Region and subregion boundaries

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remainder of the area. The earthquakes were then relocated, using a balanced network of stations with distance dependent station corrections, applying a source term of -0.1 degree for calibration earthquakes southeast of 31N 92E. Focal depth was restrained to pP depth and only stations between 25 and 100 degrees were used. SRST corrections were estimated from the uncorrected travel time residuals to these hypocenters for each of the four regions. The calibration earthquakes were then relocated, applying SRSTs for the appropriate region. SRSTs were re-estimated based on the refined locations and the calibration earthquakes were relocated, applying the refined SRST estimates, until four iterations had been completed. Focal depth was restrained to pP depth for all relocation runs. Only stations between 25 and 100 degrees were used on the initial relocation run with SRSTs applied. On the second iteration, stations between 10 and 100 degrees were used, while for the third and fourth relocation runs, stations at all distances less than 100 degrees were used.

On the first and second iterations, the SRST function was restrained to be a linear function of X, Y, and focal depth (h). The depth term was significantly non-zero only for region 3 (the only region with more than one calibration earthquake deeper than 45 km). An examination of the subregion residual patterns after SRSTs had been applied suggested that addition of quadratic terms in X or Y to the SRST function would significantly improve the corrections for all regions. Therefore, provision was made in the SRST estimation process to include quadratic terms in X, Y, or h and to allow the estimation process to select the model with the smallest residual variance, restricting the model selected to four terms, including the constant term. Accordingly, on the third and fourth iterations, model options for regions 1, 2, and 4 included terms in X, Y, $X^2$ or in X, Y, $Y^2$. For region 3, seven model options were available, including terms in XYh, $XYX^2$, $XYY^2$, $hYY^2$, $hYh^2$, $Xhh^2$, or in $XhX^2$.

Locations made with the fourth iteration SRSTs applied and with depth restrained to pP depth were taken to be the final locations of the calibration earthquakes. Standard deviations of station residuals about their SRST corrections for each region were determined from the final earthquake locations and the SRSTs, using only earthquakes within the appropriate region.

Finally, a depth-free relocation run was made with SRSTs applied, using all stations at distances less than 100 degrees and applying station inverse variance weighting. The station variances used for weighting were the station variances about their SRST corrections.

## 5. RESULTS AND DISCUSSION

Final locations of the calibration earthquakes, together with the weighted standard deviation of residuals, the number of locating stations from the depth-restrained relocation run with SRSTs applied, the computed depth [h(SRST)], and the 95 percent depth coverage and confidence intervals from the depth-free relocation run are listed in Appendix 1. Depth coverage intervals were computed using the weighted apriori variance of 1.0 (see section 5.2) and the value of the Chi-square distribution with one degree of freedom. Depth confidence intervals were computed using the observed weighted variance of residuals and the value of the F distribution with one and n-4 degrees of freedom, where n is the number of stations in the locating net.

### 5.1 SOURCE-REGION/STATION TIME CORRECTIONS

Parameters of the SRST functions for the 181 stations are given in Appendix 2 for each of the four regions. In addition, the number of observations (NU) used to estimate the parameters of the SRST functions, the number (NR) of calibration earthquakes in the region that contributed to the estimate of the parameters, and the standard deviation (SD) of the station's residuals about its SRST correction are listed.

Variation of the station standard deviation with distance is shown in figure 2 for each of the four regions. Cumulative frequency distributions of station standard deviation for each of four distance ranges are given in figure 3 for each region. Strong distance dependence of the station standard deviation about the station's SRST correction is evident for all regions. Because of the large variation in standard deviation among the stations, it is important to apply inverse variance weights to each station's residual when locating seismic events in this area. Inverse variance weighting allows full utilization of arrival times from close-in stations, which have most control over focal depth, thereby improving the reliability of estimated depths.

The station standard deviations vary somewhat with region as well as with epicentral distance. Median values of the standard deviation, for distances between 50 and 100 degrees, range from about 0.50 second in region 1 to 0.65 second in region 3. Stations in the distance range 25 to 50 degrees have appreciably lower reliability than stations at greater distance. The median standard deviation for this distance range varies from about 0.60 second in region 1 to 0.85 second in region 3.

These values of median station standard deviation may be compared to the value of 0.79 second obtained by Veith (1975a) for the mean standard deviation about his distance and azimuth dependent stations corrections. Veith's value is based on teleseismic data only, after truncating all values of standard deviation greater than 1.55 seconds. From these results it is clear that the SRSTs have reduced the station standard deviations significantly.

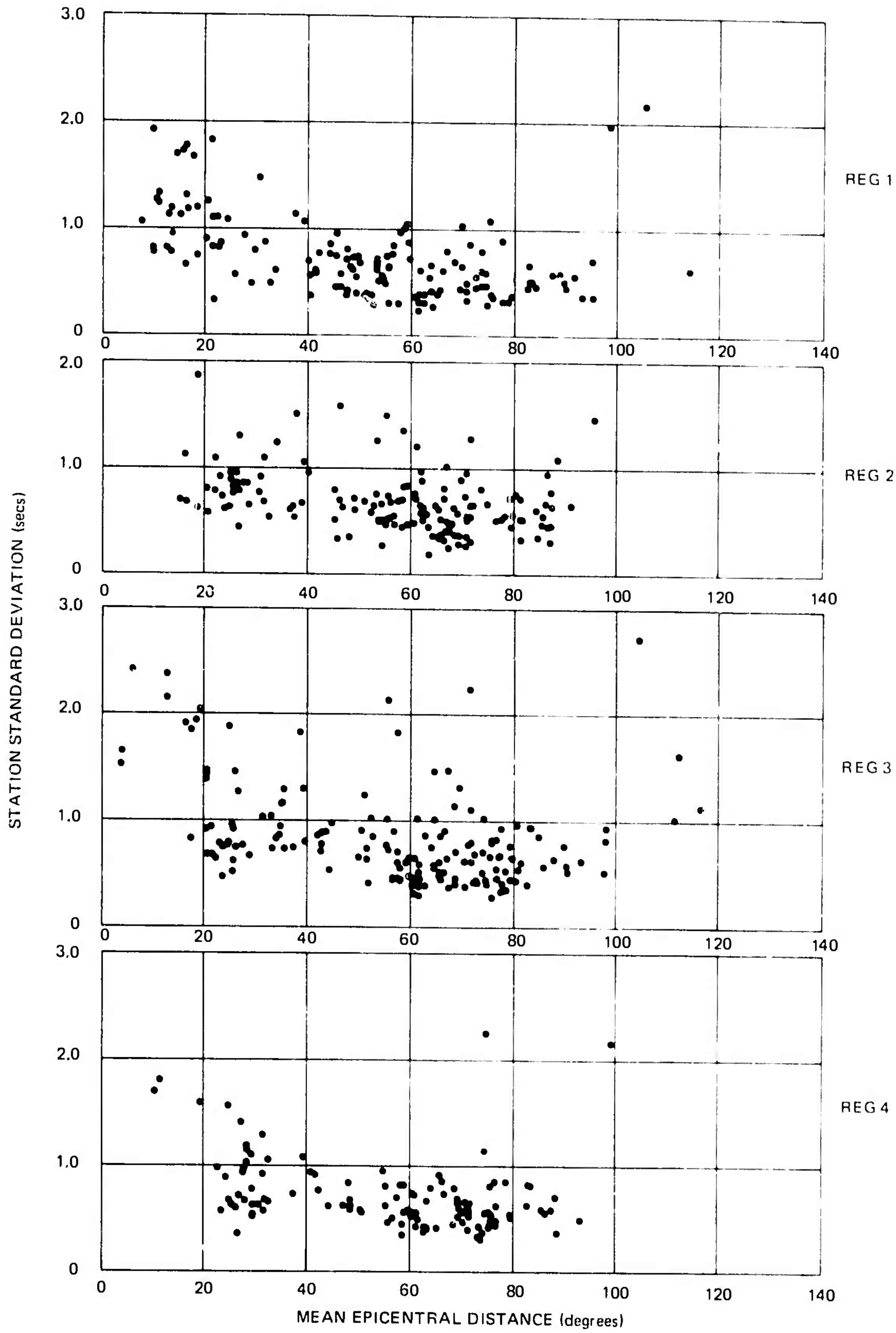


Figure 2. Distance dependence of station standard deviation

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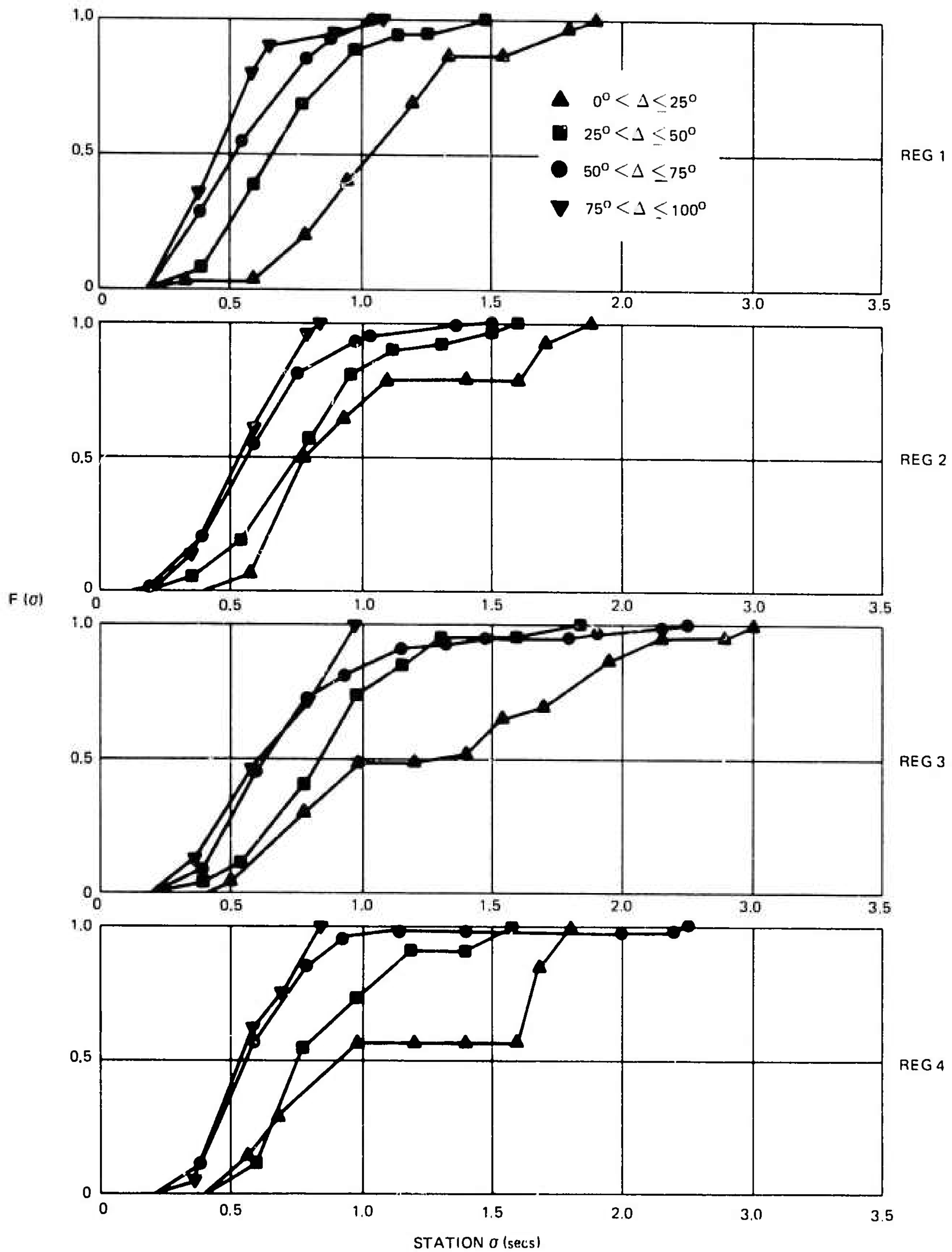


Figure 3. Cumulative frequency distributions [F(σ)] of station standard deviation (σ)

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The reliability of the close-in (distance 25 degrees or less) stations is much poorer than for stations at teleseismic distance. For the close-in distance range, the median station standard deviation ranges from about 0.80 second in region 2 to 1.30 second in region 3. The few stations at distances greater than 100 degrees have standard deviations much larger than stations between 25 and 100 degrees (see figure 2). This indicates the generally poor reliability of the PKP arrival times available from seismic bulletins. Stations at distances greater than 100 degrees were not used in locating earthquakes in this study.

The large station standard deviations at close-in distances (less than 25 degrees) could be reduced either by use of a more complex SRST correction (a higher order adjustment to the travel time tables) or a reduction in the size of the region of application. However, more complex SRST functions would reduce the reliability with which parameters of the SRST functions could be estimated and would require storage of more parameters in applications programs. It is presently not considered feasible to use smaller regions for developing SRSTs for this area because of the limited density of available calibration earthquakes.

SRST corrections are mapped for five close-in stations in figures 4 through 8 and for three teleseismic stations in figures 9 through 11. The SRSTs for region 3 are based on an assumed focal depth of 10 km. Insufficient station data were available to obtain reliable corrections for CHG for regions 2 and 4. SRSTs estimated for some of the close-in stations have discontinuities across the regions boundaries of a few tenths of a second to as large as 1.5 seconds. The large discontinuities usually reflect a lack of data for SRST control near the discontinuity. The discontinuities at the region boundaries were small for the teleseismic stations. In the figures, the corrections have been smoothed across the boundaries where discontinuities existed to give a better estimate of deviations from standard travel times.

The figures show that close-in stations (except ZAK) tend to observe early arrival times. Veith (1975b) also observed this phenomenon in the Hindu-Kush region from shallow earthquakes. He explained the observation as origin time error. The procedure used to develop SRSTs restrains depth to that obtained from pP and sP phases. The origin times are set in the initial relocation run using only teleseismic stations. Close-in station corrections are made to agree with these origin times. Thus, in areas of a thick, slow crust and upper mantle (compared to the Herrin 1968 model), the origin time for an earthquake is set late by the average arrival time delay to the teleseismic stations. This late origin time appears as an early arrival time at close-in stations, in spite of the known slow velocities for the area. In the Hindu-Kush, the origin time delay reaches 1.0 to 1.5 seconds. Figure 4 suggests the origin time error near SHL is also about 1 second. Figure 8 suggests it may be greater near CHG; however, the interference of the Burmese arc structure makes the validity of such an estimate questionable.

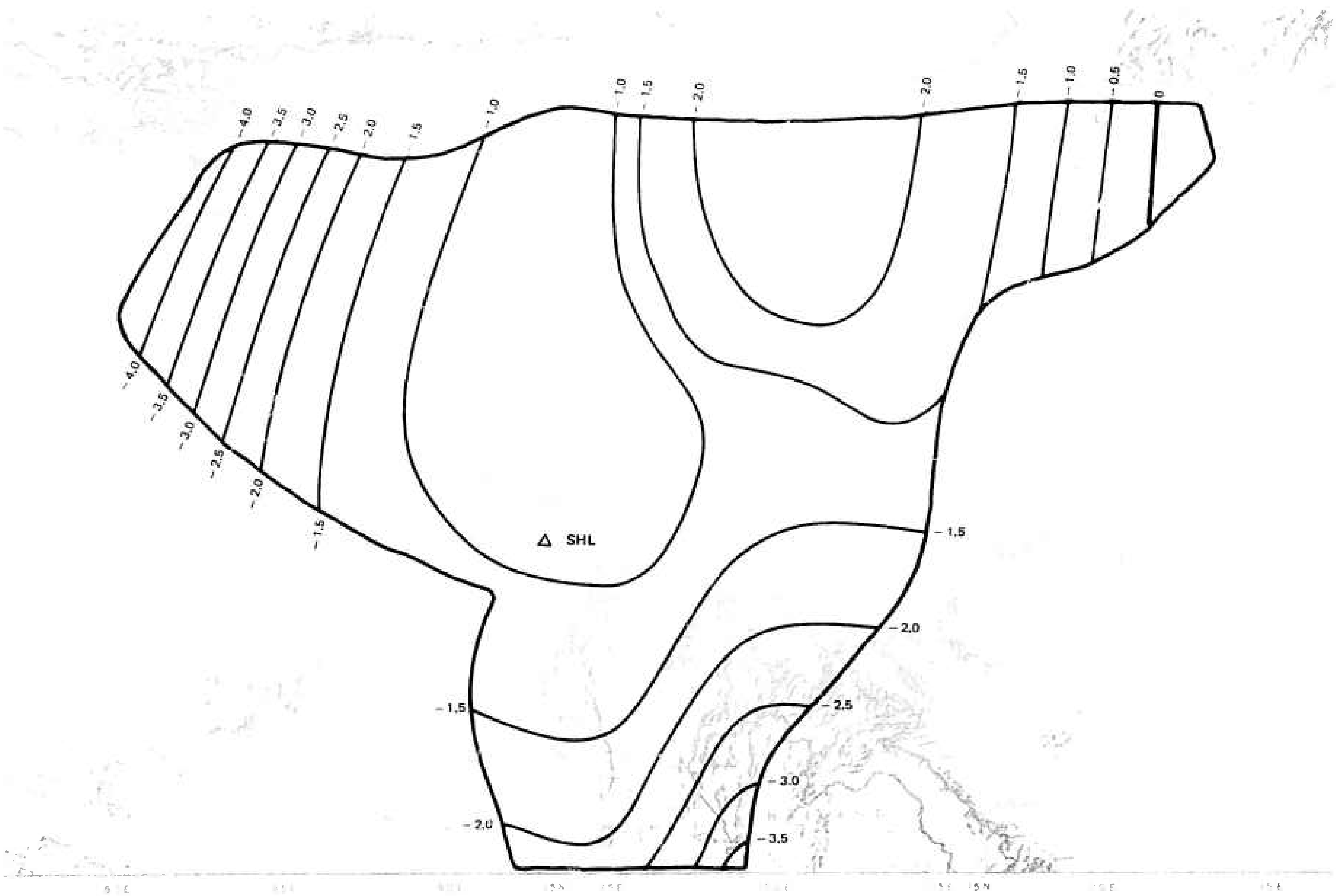


Figure 4. SRST correction for Shillong (SHL)

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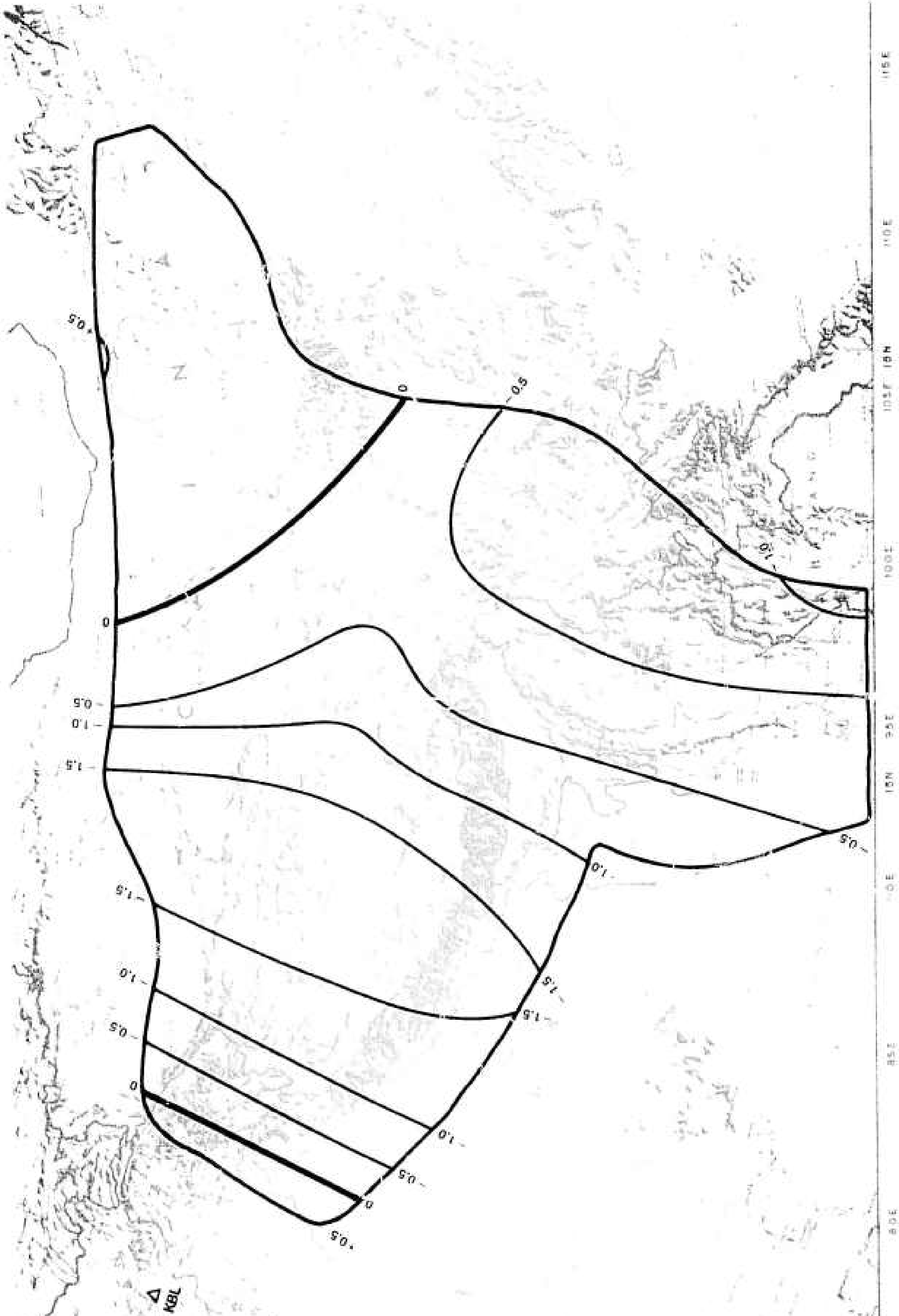


Figure 5. SRST correction for Kabul (KBL)

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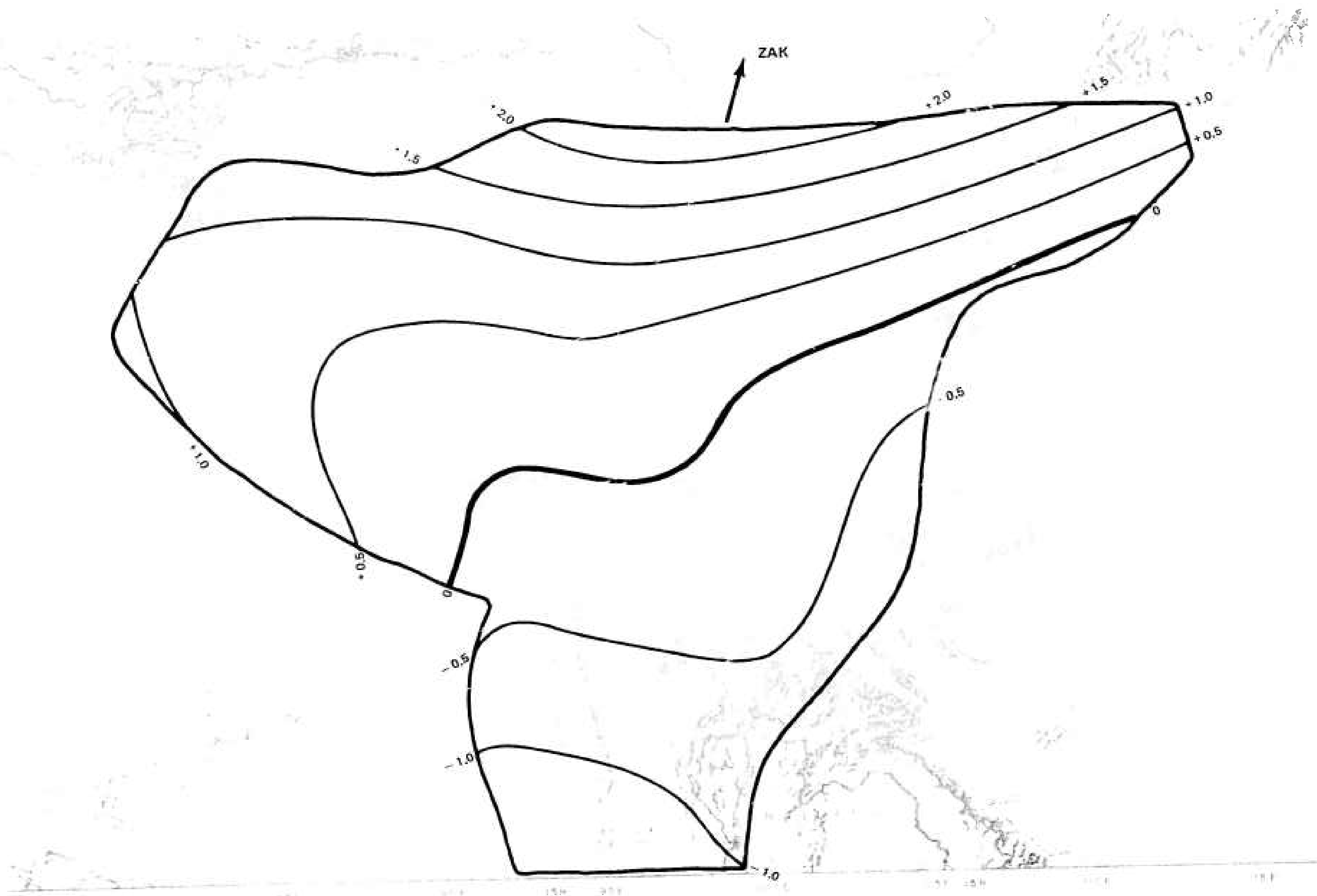


Figure 6. SRST correction for Zakamensk (ZAK)

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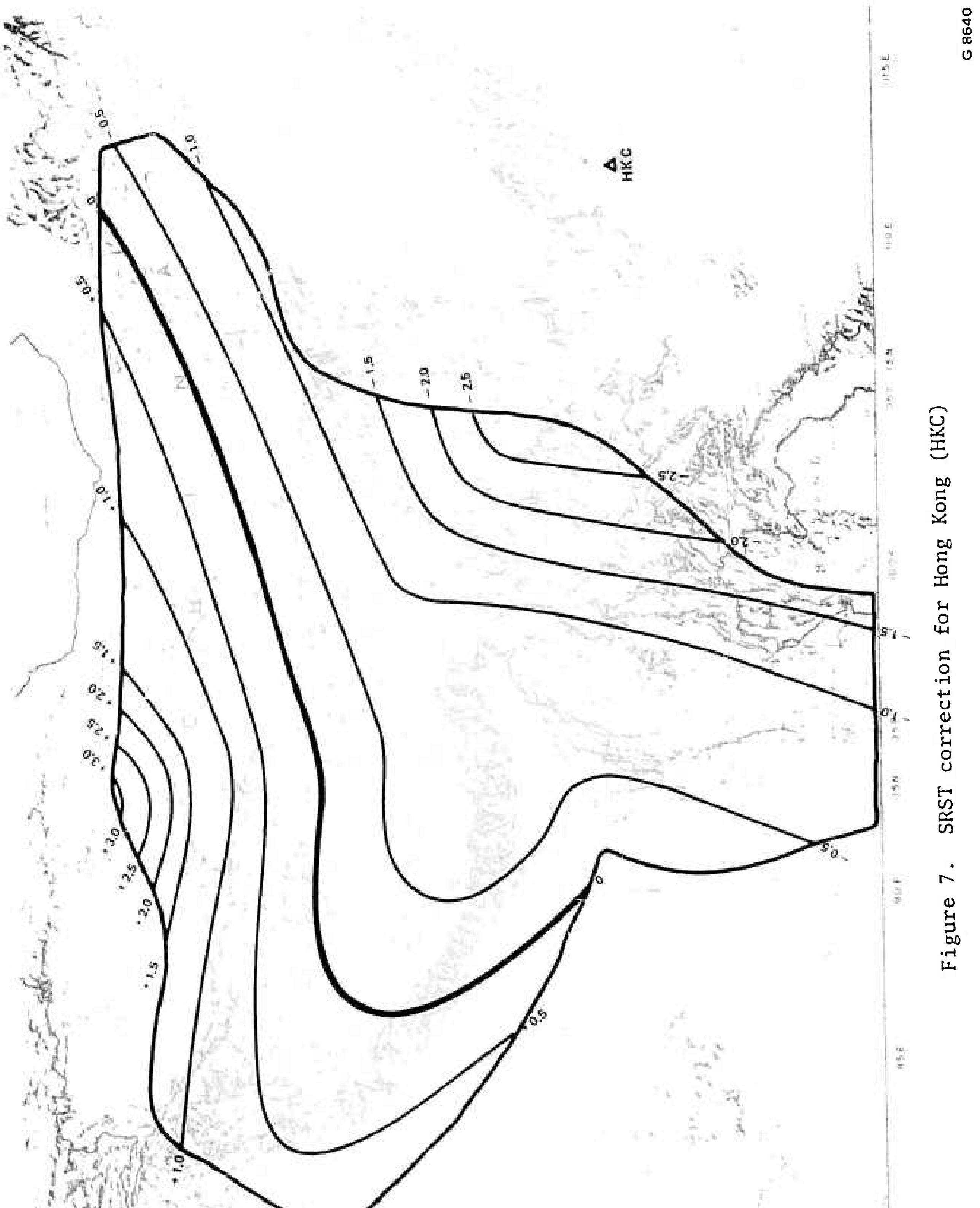


Figure 7. SRST correction for Hong Kong (HKC)

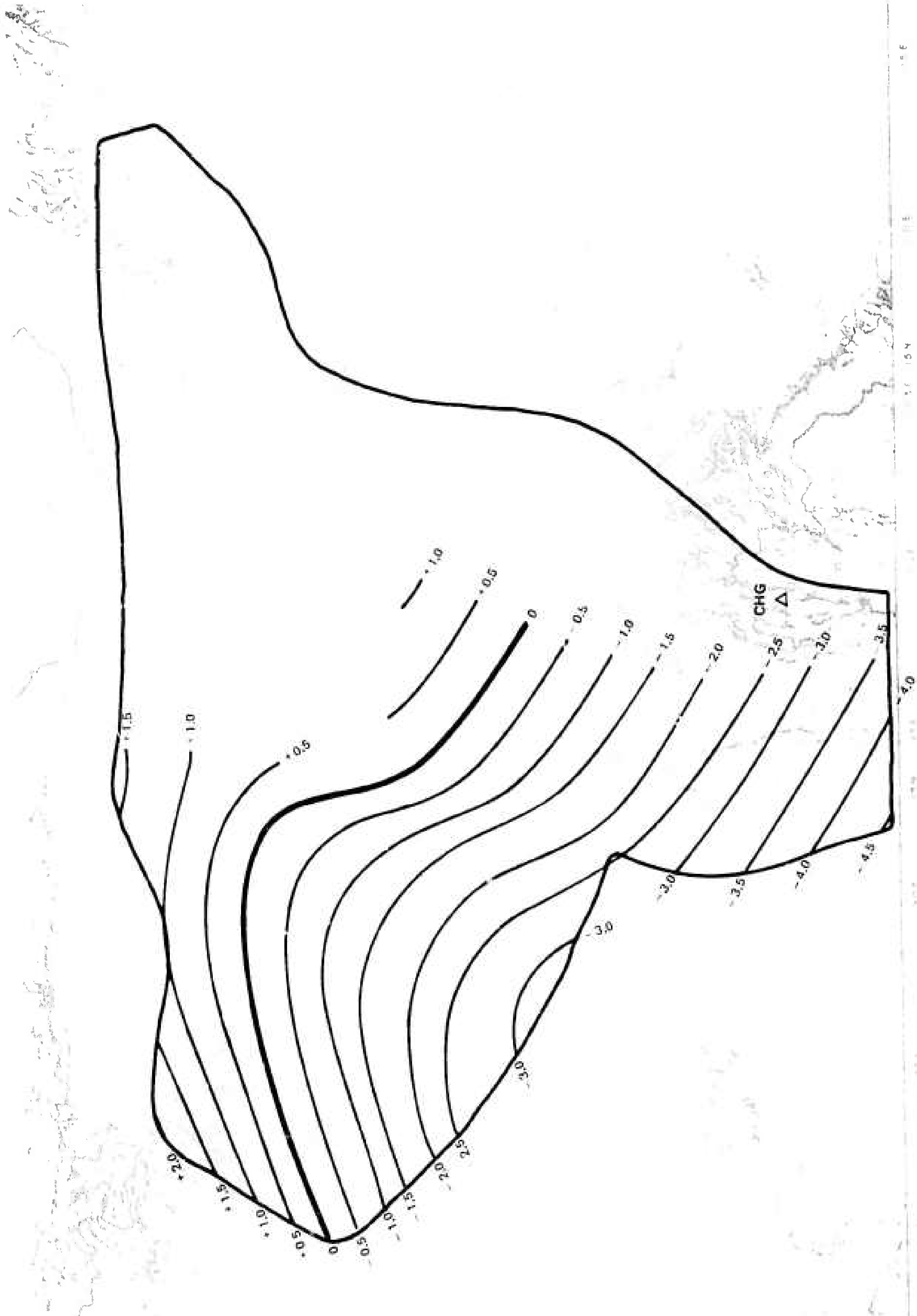


Figure 8. SRST correction for Chiengmai (CHG)

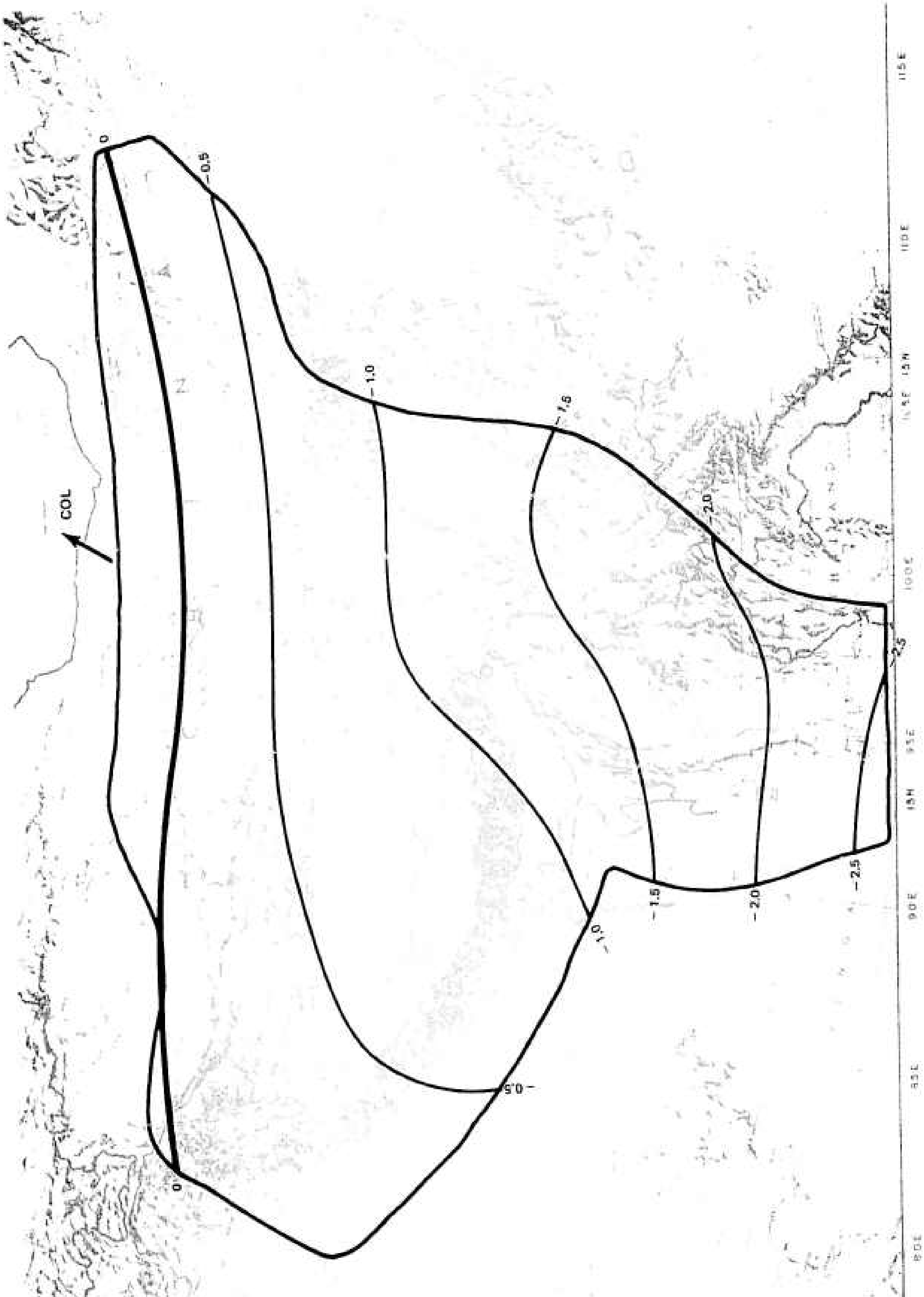


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Figure 9. SRST correction for College Outpost (COL)

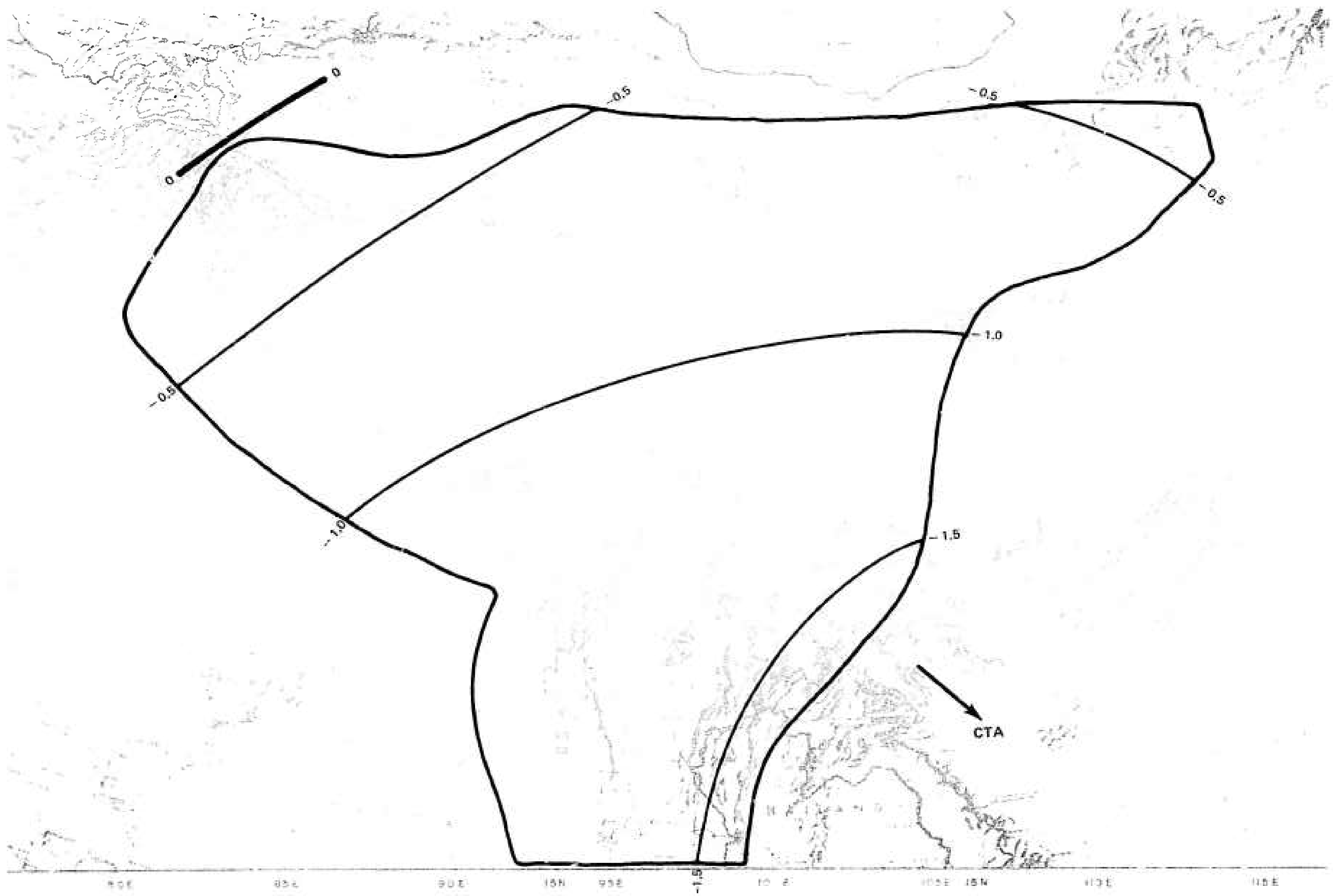


Figure 10. SRST correction for Charters Towers (CTA)

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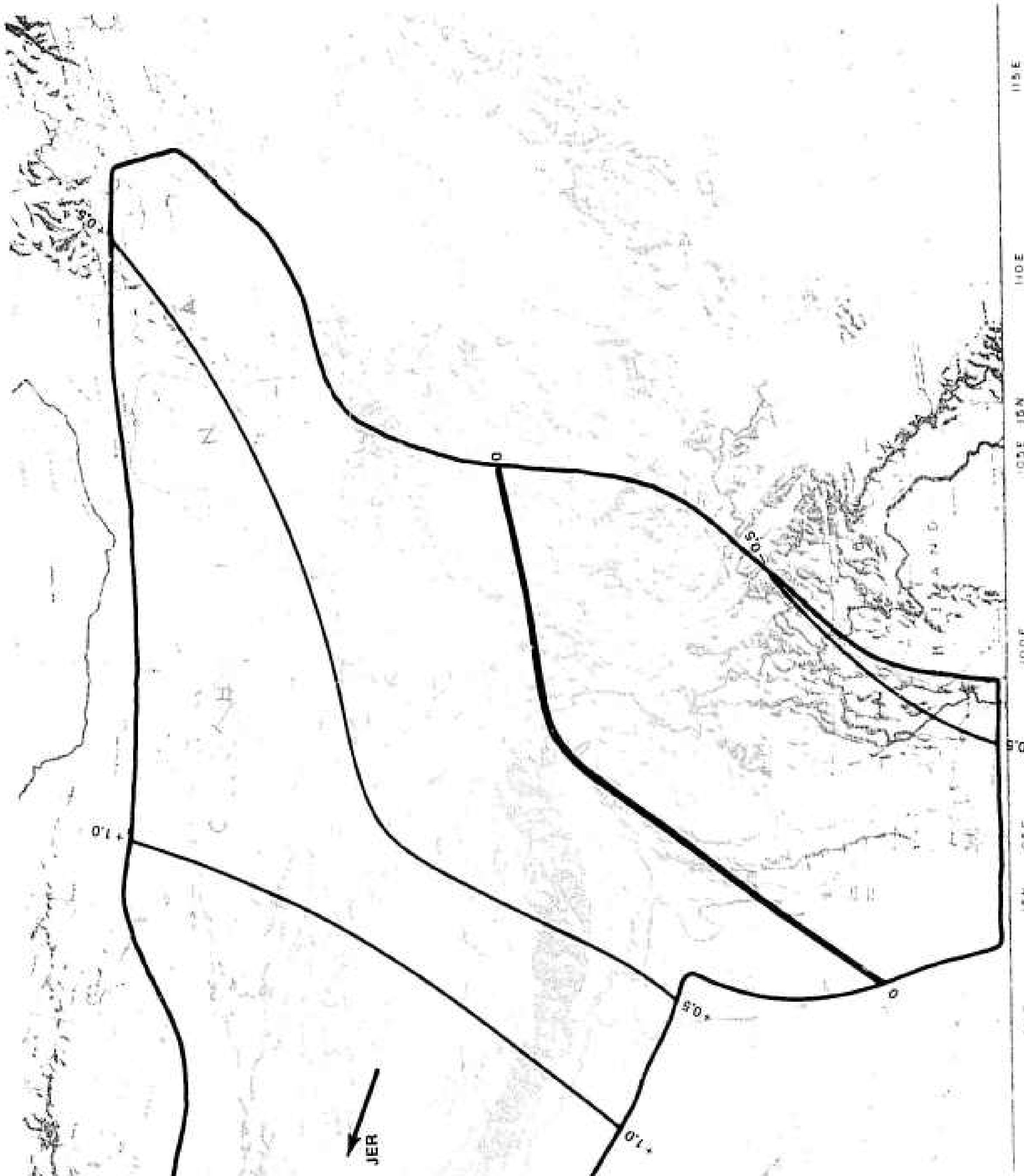


Figure 11. SRST correction for Jerusalem (JER)

Note that all stations have negative corrections for the area of the Burmese arc. Most of the calibration earthquakes in this area occur at subcrustal depths along the arc. Travel times from this part of the region to KBL and JER to the northwest are slower than are travel times to the other stations. This pattern of SRSTs is consistent with the eastward underthrusting of Burma by the oceanic lithosphere of the Indian plate. Thus, travel paths toward the west spend less time in the high velocity underthrusting plate than do paths in other directions.

All the close-in stations except CHG have relatively fast travel times for epicenters along the Himalayan front. The SRSTs for the two closest stations (SHL and KBL) to this area are increasingly negative with increasing distance to about 15 degrees. These SRST patterns are consistent with the existence of a higher than normal velocity medium underlying the Himalayan front, which could result from underthrusting of the Himalayas by the Indian plate.

## 5.2 DEPTH RELIABILITY

A histogram of focal depths of the calibration earthquakes, determined from pP-P and/or sP-P intervals is shown in figure 12. Two-thirds of the calibration earthquakes have pP depths of 25 km or less. All but two of the earthquakes with focal depth greater than 50 km occurred along the Burmese arc. This depth distribution is shown in more detail in figure 13 where histograms of computed depth (h(SRST)) are shown for each of the four regions. Depth distributions are very similar for regions 1 and 2 with very shallow focal depths dominating. There is a rapid fall off in the number of earthquakes with increasing depth. Crustal thickness throughout most of these two regions is greater than 60 km. Ninety-two percent of the calibration earthquakes in region 1 and 83 percent of the earthquakes in region 2 had computed depths of 30 km or less. Only one subcrustal earthquake was observed in either of these regions, at the extreme western end of region 1.

All but four of the calibration earthquakes with computed depth greater than 40 km occurred in region 3, consisting of the Burmese arc and the region near the juncture of the Himalayan and Burmese arcs. The portion of the earthquakes which occurred in the Burmese arc are indicated on the figure. Eighty-four percent of the earthquakes along the Burmese arc had computed depths greater than 40 km, with apparent peaks of activity at depths of about 45, 90 and 110 km. The greatest depth computed for Burmese arc earthquakes was 167 km for the earthquake at 22.5N 94.9E. The region 3 earthquakes west and north of the Burmese arc had computed depths of 30 km or less for 76 percent of the events.

The distribution of computed depths for region 4 exhibits a broad peak with most of the computed depths falling between 15 and 30 km. Eighty-two percent of the computed depths for region 4 were 30 km or less.

Depth error (h(SRST) - h (pP)) statistics and related information are presented in table 2, ordered by region and subregion. Because the station data are weighted by the observed standard deviation of the arrival data about the SRST corrections, the expected value for the weighted event standard deviation is one. The observed values for all regions average very close to this figure.

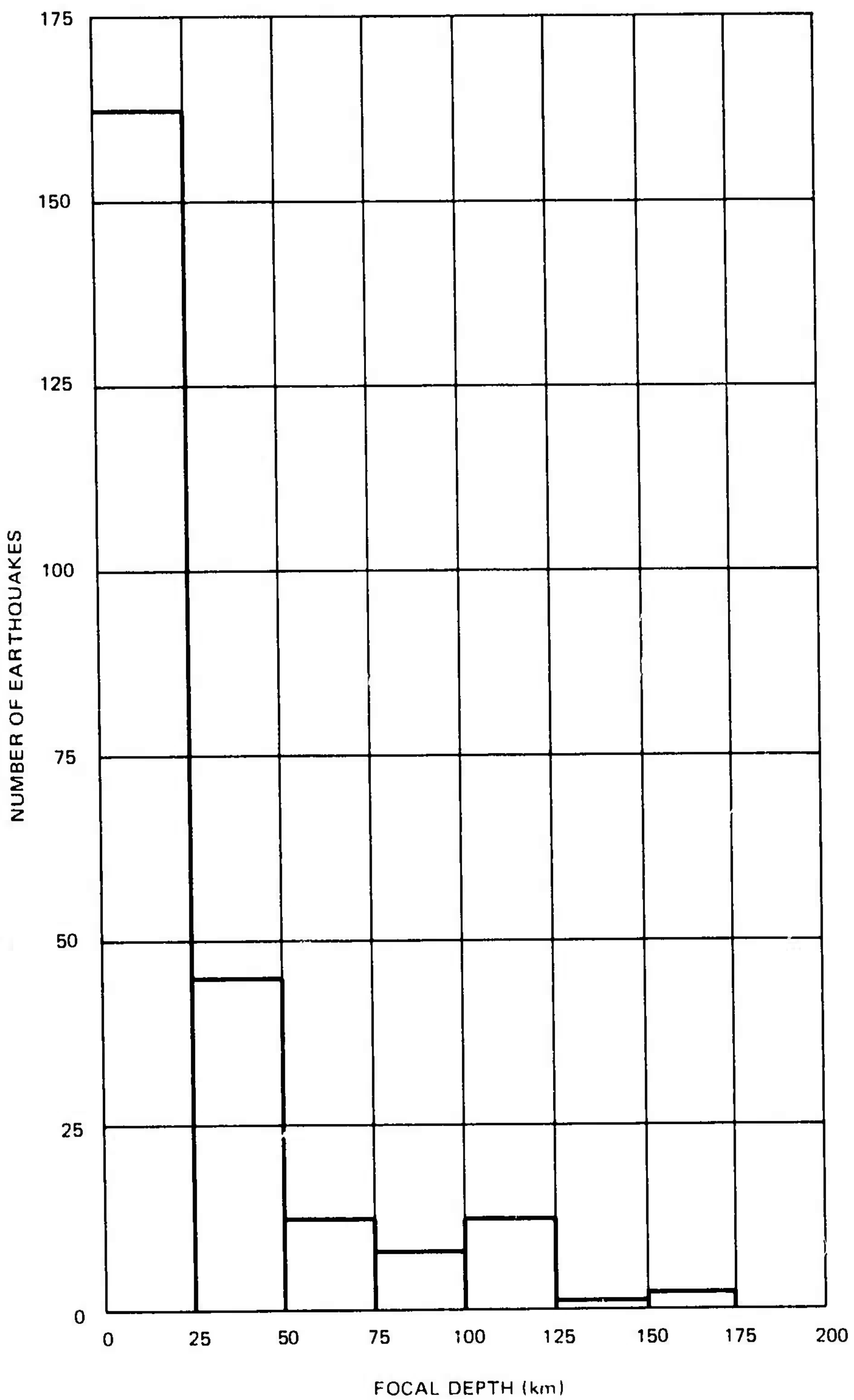


Figure 12. Focal depths of calibration earthquakes.

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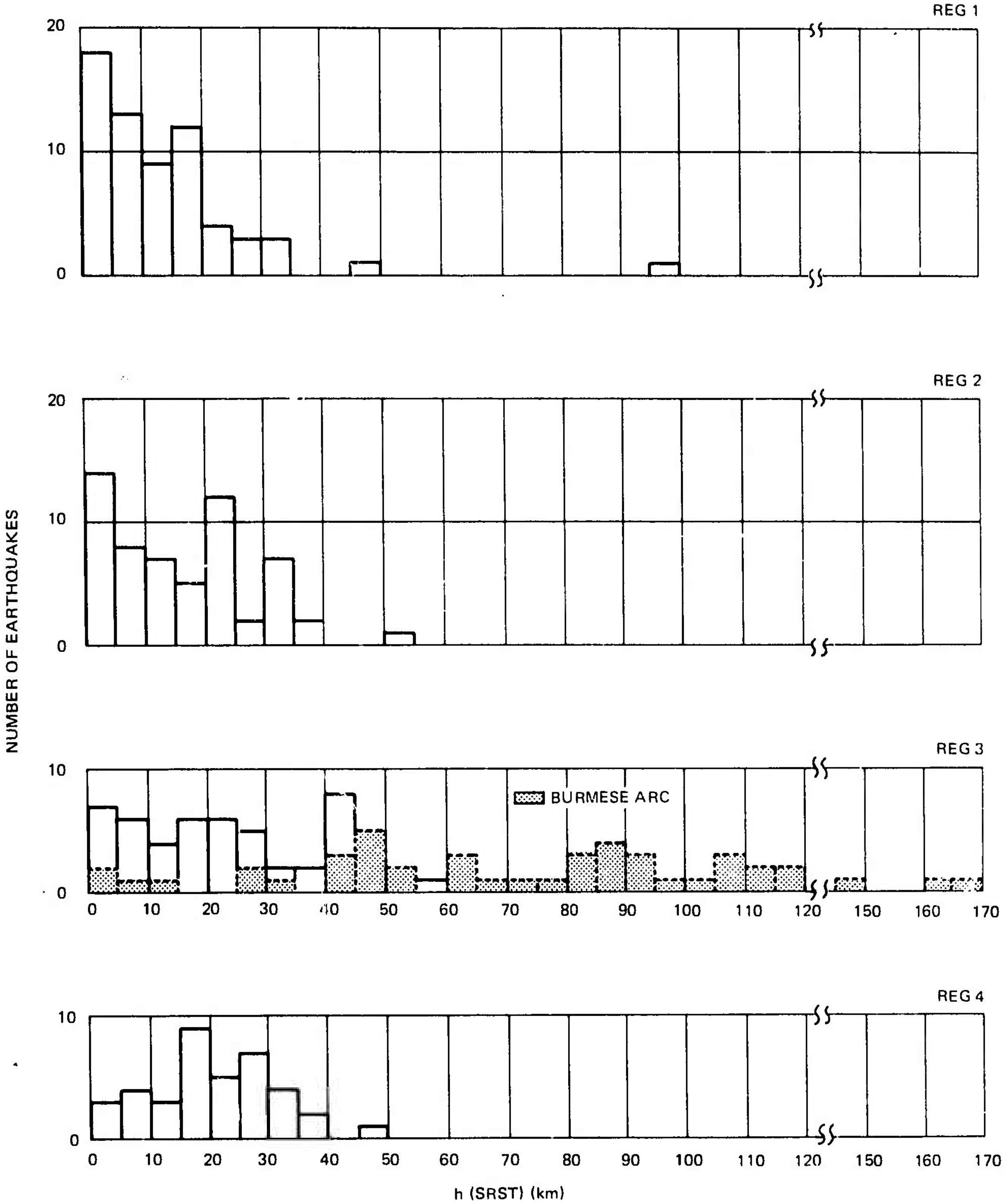


Figure 13. Histograms of computed depth by region

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Table 2. Depth Error Statistics

| Region | No. of Events | No. of Obs. | MEAN EVENT Std.Dev. (wtd) (secs) | MEAN EVENT h(pP) (km) | h(SRST) - h(pP) Mean (km) | h(SRST) - h(pP) Std.Dev. (km) | h(SRST) - h(pP) Absolute Mean (km) | MEAN 95% DEPTH INTERVAL Coverage (km) | MEAN 95% DEPTH INTERVAL Confidence (km) | Number of Coverage Failures Coverage | Number of Coverage Failures Confidence |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 16 | 1143 | 1.03 | 19 | -0.1 | 6.4 | 4.9 | 12.4 | 13.5 | 1 | 1 |
| 102 | 23 | 1652 | 1.05 | 12 | +0.1 | 7.4 | 6.2 | 13.6 | 14.4 | 0 | 1 |
| 103 | 14 | 1354 | 0.99 | 13 | -0.1 | 6.8 | 5.6 | 13.0 | 13.2 | 0 | 0 |
| 104 | 11 | 689 | 1.01 | 18 | -4.1 | 6.4 | 6.3 | 14.3 | 15.4 | 0 | 1 |
| 1 | 64 | 4838 | 1.02 | 15 | -0.7 | 6.9 | 5.8 | 13.3 | 14.1 | 1 | 3 |
| 205 | 6 | 589 | 1.05 | 10 | 0.0 | 6.2 | 5.0 | 14.5 | 14.0 | 0 | 0 |
| 206 | 10 | 744 | 0.95 | 14 | +4.0 | 11.9 | 9.4 | 20.9 | 20.9 | 0 | 1 |
| 207 | 16 | 1327 | 0.98 | 13 | +0.2 | 8.0 | 6.3 | 20.5 | 21.0 | 0 | 1 |
| 208 | 11 | 709 | 1.11 | 19 | -1.0 | 14.6 | 12.8 | 16.0 | 19.4 | 3 | 2 |
| 209 | 15 | 1029 | 1.02 | 19 | +1.1 | 7.6 | 5.9 | 19.5 | 19.6 | 0 | 0 |
| 2 | 58 | 4398 | 1.02 | 15 | +0.8 | 9.8 | 7.8 | 18.8 | 19.6 | 3 | 4 |
| 310 | 18 | 925 | 1.04 | 19 | -1.1 | 4.5 | 3.4 | 21.5 | 22.8 | 0 | 0 |
| 311 | 13 | 1117 | 0.87 | 28 | -4.0 | 8.6 | 6.6 | 15.2 | 14.0 | 1 | 1 |
| 312 | 6 | 440 | 0.74 | 26 | -1.3 | 8.7 | 7.0 | 13.6 | 9.8 | 0 | 2 |
| 313 | 14 | 1212 | 0.90 | 71 | +3.5 | 7.8 | 6.2 | 14.4 | 12.9 | 2 | 3 |
| 314 | 19 | 1478 | 0.99 | 79 | -2.2 | 11.0 | 9.2 | 12.4 | 11.9 | 5 | 6 |
| 315 | 12 | 886 | 0.96 | 66 | +3.4 | 8.9 | 7.3 | 13.3 | 13.7 | 2 | 2 |
| 3 | 82 | 6058 | 0.94 | 51 | -0.4 | 8.7 | 6.6 | 15.4 | 14.9 | 10 | 14 |
| 416 | 20 | 1508 | 0.90 | 21 | +1.4 | 8.2 | 6.4 | 20.9 | 18.9 | 0 | 1 |
| 417 | 13 | 1032 | 1.06 | 18 | +0.7 | 11.6 | 9.8 | 23.4 | 24.1 | 0 | 1 |
| 418 | 5 | 475 | 0.92 | 18 | +3.6 | 5.9 | 5.2 | 20.0 | 18.3 | 0 | 0 |
| 4 | 38 | 3015 | 0.96 | 20 | +0.7 | 10.8 | 8.6 | 21.6 | 20.6 | 0 | 2 |
| All | 242 | 18309 | 0.98 | 28 | +0.1 | 8.6 | 6.8 | 16.7 | 16.8 | 14 | 23 |

The mean depth error ranged from -4.1 km for subregion 104 to +4.0 km for subregion 206. No systematic regional pattern in the mean depth errors is apparent, implying that the SRSTs are removing the systematic deviations from standard travel times. The overall mean absolute depth error is 6.8 km. The standard deviation of depth error varied among the subregions from 4.5 km for subregion 310 to 14.6 km for subregion 208, and the overall depth error standard deviation, for all regions combined, was 8.6 km. The standard deviation of depth error includes the effect of errors in h (pP). The standard deviation of h (pP) for calibration earthquakes used in this study is estimated to be 2 km. This value is based on the mean within-event standard deviation of h (pP) determinations and does not include the effect of possible misidentification of depth phases.

The total depth reliability (TDR) may be estimated (Veith, 1975a) as

$$TDR = [X_1^2 \ \sigma^2(pP) + h^2(cov)]^{1/2} \quad (2)$$

where $\sigma^2(pP)$ ≡ variance of errors in determination of h(pP)

h(cov) ≡ depth coverage interval

$X_1^2$ ≡ value of Chi-square distribution with one degree of freedom

Taking the total depth reliability to be

$$TDR = [X_1^2 \ \sigma^2 \ (h(SRST) - h(pP))]^{1/2}$$

and solving equation (2) for the standard deviation of depth error:

$$\sigma(pP) = [\sigma^2(h(SRST) - h(pP)) - h^2(cov)/X_1^2]^{1/2} \quad (3)$$

Using values of overall depth error standard deviation and mean depth coverage interval from table 2 in equation (3) yields a value of 1.2 km for the standard deviation of h (pP) error. This value is considered to be in good agreement with the value of 2 km based on the mean within-event standard deviation of h (pP).

The 95 percent depth coverage intervals included the pP depth for 94 percent of the earthquakes. Of the 14 earthquakes for which the 95 percent depth coverage interval failed to include the pP depth, half failed by 3 km or less. The relatively large number of failures in subregion 314 (table 2) results from estimated depths being about 20 km too shallow for four events near 24N 094E. All four events are in the mid-depth range (60-110 km) of the subregion. The failures may correspond to the inability of the smoothly varying SRSTs to reflect a sharp structural change in the mid-depth range while maintaining accuracy for shallower and deeper events in the region. The close agreement of the observed coverage percentage with the theoretical value supports the conclusion that the SRSTs are removing systematic deviations from standard travel times.

A significant depth criterion may be developed from the depth reliability estimates, as follows. Define a critical depth ($H_\alpha$) as

$$H_\alpha = N_\alpha \sigma(\hat{h}) + D$$

where $N_\alpha \equiv$ value of standard normal distribution for level $\alpha$

$\sigma(\hat{h}) \equiv$ standard error of depth estimate

$D \equiv$ value assumed for drillable depth

In terms of depth coverage intervals:

$$H_\alpha = N_\alpha h_\alpha(cov)/(X_1^2,\alpha)^{1/2} + D$$

For a confidence level of 95 percent and assuming a value of 5 km for drillable depth:

$$H_{.05} = 0.8393\, h_{.05}(cov) + 5$$

The significant depth criterion then states that, at the 95 percent level, an event is an earthquake if h(SRST) is greater than $H_{.05}$. Results of applying this depth criterion to the calibration earthquakes are shown in table 3, ordered by region and h (pP) range. All calibration earthquakes with h (pP) deeper than 30 km are identified as earthquakes. Of the earthquakes with h (pP) greater than 20 km, 88 percent are identified as earthquakes, and 63 percent of the calibration earthquakes with h (pP) greater than 10 km are identified. Based on the overall mean depth coverage interval (16.7 km - see table 2), 95 percent of the earthquakes with computed depth greater than 19 km should be identified by the significant depth criterion.

The depth reliability of earthquakes located with SRSTs in any region is strongly dependent upon the number of close-in station observations available. This study did not include data from Chinese stations since it has only recently become available. As a result, the depth reliability generally decreases as the earthquake locations move further into China. Development of SRSTs for the Chinese stations and their use in locating earthquakes in the area should provide a significant improvement in the depth reliability obtained.

Table 3. Significant depth criterion statistics

| | DEPTH RANGE (km) | | | |
|---|---|---|---|---|
| | 0-10 | 11-20 | 21-30 | >30 |
| Region 1 | | | | |
| No. Events | 22 | 35 | 3 | 4 |
| No. Identified | 4 | 12 | 3 | 4 |
| % Identified | 18 | 34 | 100 | 100 |
| Region 2 | | | | |
| No. Events | 26 | 18 | 8 | 6 |
| No. Identified | 7 | 7 | 6 | 6 |
| % Identified | 27 | 39 | 75 | 100 |
| Region 3 | | | | |
| No. Events | 7 | 19 | 9 | 47 |
| No. Identified | 0 | 7 | 6 | 47 |
| % Identified | 0 | 37 | 67 | 100 |
| Region 4 | | | | |
| No. Events | 4 | 17 | 15 | 2 |
| No. Identified | 0 | 6 | 9 | 2 |
| % Identified | 0 | 35 | 60 | 100 |
| All Regions | | | | |
| No. Events | 59 | 89 | 35 | 59 |
| No. Identified | 11 | 32 | 24 | 59 |
| % Identified | 19 | 36 | 69 | 100 |

## 5.3 SEISMICITY AND TECTONIC IMPLICATIONS

Final locations of the calibration earthquakes obtained with depth restrained to h(pP) and SRSTs and inverse variance weighting applied are presented in figure 14. The seismicity shown by the final relocated hypocenters is generally consistent with the interpretation of Asian tectonics reported by Molnar and Tapponnier (1975).

Source mechanisms reported by Fitch (1970) and by Tandon and Srivastava (1975) indicate thrust faulting along the Himalayan front. They interpreted these as resulting from underthrusting of the Himalayas by the Indian plate along the Himalayan frontal thrust fault. This fault zone is well defined by shallow earthquakes in figure 14. Tandon and Srivastava (ibid) also observed one earthquake at 27.7N 86.0E that showed apparent strike-slip faulting approximately parallel to the front. Focal depths of all but one of the calibration earthquakes along the Himalayan front were less than 50 km. The one exception was a 58 km earthquake at 26.9N 92.7E.

Seismicity north of the Himalayan front is scattered, showing few clear trends although possible lineations are apparent. For example, there is an east-west trend from about 34N 79E to about 35N 81E and a north-south trend from about 31N 88E to about 35N 86.5E. Neither of these trends correlate with known major faults. A northwest-southeast trend from about 38N 93.5E to about 35.5N 98E occurs in a folded zone in the Tsaidam basin between two major east-west strike-slip faults, the Altyn Tagh fault and the Kunlun fault (Molnar and Tapponier, 1975). Focal depths were less than 40 km for all but two of the calibration earthquakes north of the Himalayan front.

The eastern limit of seismicity within the study area agrees well with tectonic boundaries described by Molnar and Tapponnier: The Red River and Kang Ting strike-slip faults, the Lung Men Shan thrusts, and the eastern boundary of the Shansi graben system. A number of the calibration earthquakes appear to be associated with the Red River, Kang Ting, or Kunlun faults, although these faults are not clearly defined by the calibration events used in this study.

The Burmese arc is well defined by the seismicity. The northeast part of the arc is defined by a very narrow band of earthquakes with focal depths of 47 to 118 km, the deeper hypocenters lying on the southeast side of the band. Tandon and Srivastava (1975) described a focal mechanism for the 94 km calibration earthquake at 26.3N 96.1E as indicating thrust faulting. However, the tensional (T) axis of this mechanism is oriented perpendicular to the trend of the seismic zone, plunging in the direction (SE) of increasing depth shown by the seismicity. Therefore, in view of the depth (94 km) of this earthquake, an alternative interpretation of this source mechanism as indicating down-dip tension in a subducting plate of oceanic lithosphere appears reasonable. The steep plunge of the T axis (66 degrees) is consistent with the narrow seismicity zone.

The seismic zone follows the Burmese arc southwestward to about 25N, then southward and southeastward along the arc. The seismic zone widens in the area from about 25N to about 22N. Focal depths of the calibration earthquakes in this zone range from 19 km to 160 km, with focal depth increasing from west

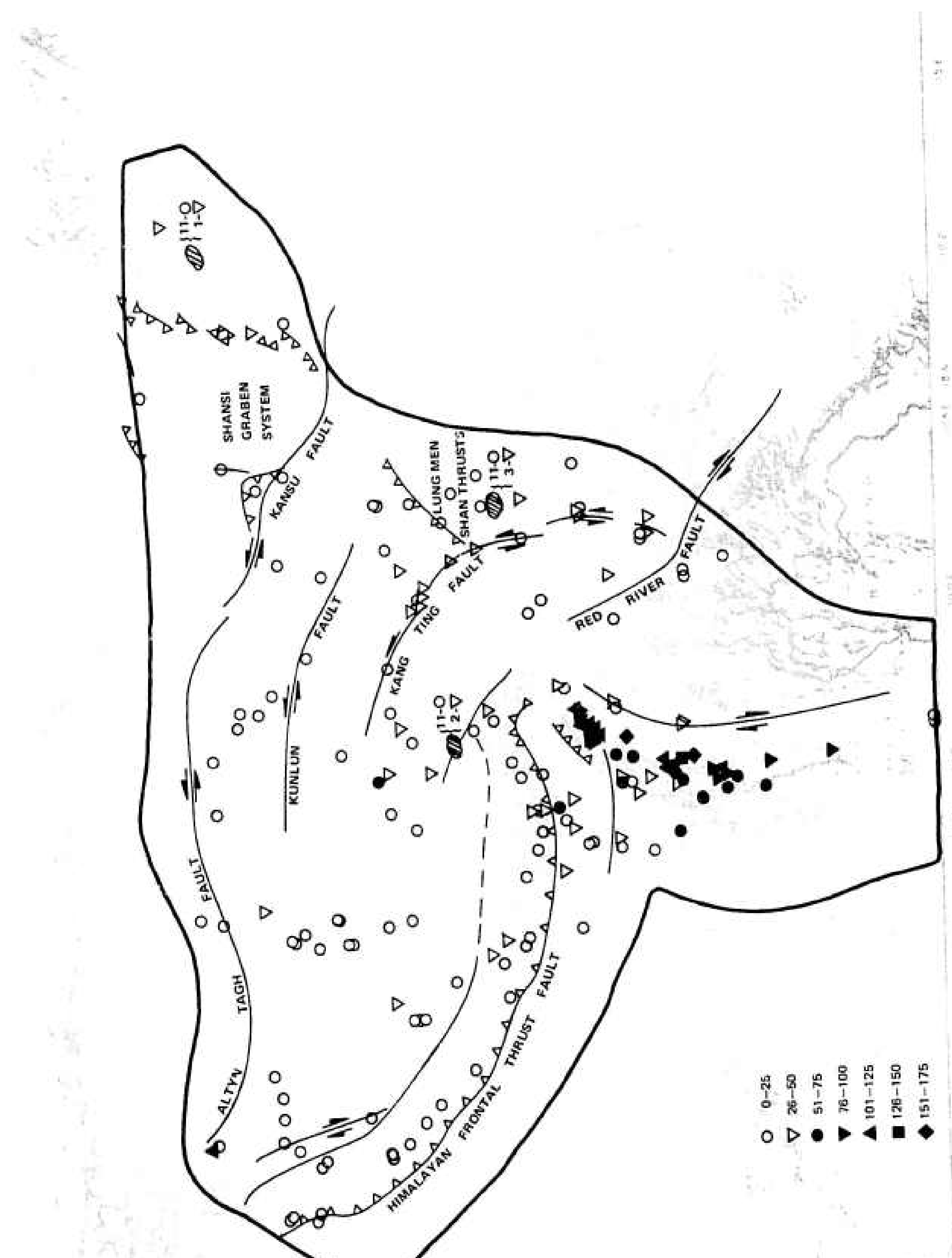


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Figure 14. Final locations of calibration earthquakes.

to east across the arc. Tandon and Srivastava (1975) described a focal mechanism for the 51 km calibration earthquake at 25.1N 94.7E. They interpreted it as indicating normal faulting with a fault strike of 28 degrees, approximately parallel to the trend of the seismic zone in this part of the arc.

Fitch (1970) interpreted a focal mechanism for the 102 km calibration earthquake at 21.7N 94.5E as indicating down-dip tension in the subducting plate. The T axis had a strike of 90 degrees and plunge of 40 degrees. Several calibration earthquakes occurred along a major right-lateral strike-slip fault (Molnar and Tapponnier, 1975) paralleling the Burmese arc to the east. Focal depths of calibration earthquakes in this zone range from 11 km to 48 km. Tandon and Srivastava (1975) reported focal mechanisms for two of the calibration earthquakes in this zone; the 43 km earthquake at 23.0N 95.9E and the 48 km earthquake at 23.1N 95.9E. Both mechanisms were interpreted as indicating strike-slip faulting with T axes approximately parallel to the seismic zone and P axes approximately perpendicular to the zone.

A short arc of shallow earthquakes, with focal depths of 6 to 48 km, extends from the Himalayan arc at about 27N 93E southwest and south to about 24N 92E. The 51 km earthquake at 23.0N 92.4E suggests a possible connection of this zone of shallow activity with the Burmese arc to the east. Tectonic implications of this zone of shallow seismicity are not clear. The northern part of the seismic zone may be associated with an east-west trending fault extending from about 26N 91E to about 26.5N 94.5E (Molnar and Tapponnier, 1975). South from 25N the seismic zone is associated with a zone of folding which trends north-south. Tandon and Srivastava (1975) reported a focal mechanism for the 42 km calibration earthquake at 24.8N 91.9E. They interpreted it as the result of easterly underthrusting at a shallow angle.

The main region of reported anomalous earthquakes at about 30N 95E appears to lie on the intersection of two faults. One trends northwest-southeast, which may be an extension of the right-lateral strike-slip Red River fault, and the other trends east-west following the Tsang-Po and Indus valleys. The latter is considered by Molnar and Tapponnier to mark the suture zone of the Indian and Asian plates. Source mechanisms are not available for earthquakes in this region, but strike-slip faulting is at least plausible.

## 5.4 FOCAL DEPTHS OF ANOMALOUS EARTHQUAKES

Eleven of the earthquakes reported by Der (1972) as anomalous and three of the anomalous earthquakes reported by Nuttli and Kim (1975) are among the calibration earthquakes used in the present study. Locations of these earthquakes and both pP depths and SRST depths determined in the present study, together with $m_b$ and $M_s$ values reported by Der or by Nuttli and Kim are listed in table 4. In addition, values of $M_s$-$m_b$, with $M_s$ corrected for depth by means of Evernden's (1975) correction factors, both for an average source mechanism and for a vertical strike-slip mechanism, are given in the table.

Ten of the eleven anomalous earthquakes reported by Der remain anomalous after application of the average correction factors to the $M_s$ values, with $M_s$-$m_b$ values of -0.9 to -1.2. Nine of these earthquakes were members of a series

Table 4. $M_S - m_b$ for anomalous earthquakes

| SUBREGION | YR | MO | DA | N LAT (DEG) | E LONG (DEG) | h(pP) (km) | h(SRST) (km) | $m_b$ | $M_s$ | $M_s-m_b$ UNCORRECTED | $M_s-m_b$ AVERAGE MECHANISM CORRECTED FOR h(pP) | $M_s-m_b$ AVERAGE MECHANISM CORRECTED FOR h(SRST) | $M_s-m_b$ VERTICAL STRIKE-SLIP CORRECTED FOR h(pP) | $M_s-m_b$ VERTICAL STRIKE-SLIP CORRECTED FOR h(SRST) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| from Der (1972) | | | | | | | | | | | | | | |
| 311 | 65 | 12 | 09 | 27.31 | 92.51 | 40 | 43 | 5.31 | 4.29 | -1.02 | -0.49 | -0.42 | -0.22 | -0.17 |
| 310 | 68 | 06 | 28 | 30.34 | 94.84 | 6 | 10 | 4.77 | 3.19 | -1.58 | -1.25 | -1.03 | -1.04 | -0.68 |
| 310 | 68 | 07 | 04 | 30.26 | 94.84 | 14 | 14 | 4.87 | 3.19 | -1.68 | -1.18 | -1.18 | -0.84 | -0.84 |
| 310 | 68 | 07 | 14 | 30.27 | 94.81 | 15 | 16 | 4.72 | 3.36 | -1.36 | -0.87 | -0.89 | -0.54 | -0.55 |
| 310 | 68 | 07 | 16 | 30.28 | 94.78 | 17 | 22 | 4.57 | 3.13 | -1.44 | -0.98 | -1.04 | -0.65 | -0.72 |
| 310 | 68 | 07 | 23 | 30.30 | 94.80 | 39 | 32 | 4.57 | 3.19 | -1.38 | -0.87 | -1.04 | -0.60 | -0.74 |
| 310 | 68 | 08 | 23 | 30.26 | 94.85 | 23 | 22 | 4.62 | 3.19 | -1.43 | -1.04 | -1.03 | -0.73 | -0.71 |
| 310 | 68 | 08 | 29 | 30.30 | 94.84 | 15 | 15 | 4.55 | 3.21 | -1.34 | -0.85 | -0.85 | -0.52 | -0.52 |
| 310 | 68 | 09 | 01 | 30.26 | 94.86 | 5 | 0 | 4.56 | 3.43 | -1.13 | -0.86 | -1.13 | -0.69 | -1.13 |
| 310 | 68 | 09 | 03 | 30.29 | 94.76 | 19 | 25 | 4.52 | 3.22 | -1.30 | -0.86 | -0.94 | -0.54 | -0.63 |
| 310 | 69 | 08 | 15 | 30.33 | 94.81 | 15 | 18 | 4.87 | 3.30 | -1.57 | -1.08 | -1.12 | -0.75 | -0.79 |
| from Nuttli and Kim (1975) | | | | | | | | | | | | | | |
| 416 | 71 | 08 | 16 | 28.86 | 103.65 | 22 | 22 | 5.7 | 4.8 | -0.9 | -0.5 | -0.5 | -0.2 | -0.2 |
| 104 | 71 | 10 | 24 | 28.39 | 87.30 | 44 | 47 | 4.8 | 2.9 | -1.9 | -1.3 | -1.2 | -1.0 | -1.0 |
| 104 | 71 | 12 | 04 | 27.99 | 87.94 | 37 | 33 | 4.9 | 3.2 | -1.7 | -1.2 | -1.3 | -1.0 | -1.0 |

that occurred from June to September 1968 in a localized area at 30.3N 94.8E (subregion 310). The remaining anomalous earthquake was a member of a series that occurred from June to September 1969 in the same area. Source mechanisms for these earthquakes are unknown, but strike-slip faulting seems at least possible for this area. Six of the calibration earthquakes in this area remain anomalous ($M_s$-$m_b$ less than -0.7) after applying depth correction factors for a vertical strike-slip fault to the $M_s$ values reported by Der.

Of the three anomalous earthquakes reported by Nuttli and Kim that are included in the present study, two remain anomalous after applying the average correction factors to the $M_s$ values. Both of these earthquakes are located along the front of the Himalayan arc at about 28N 87E. Tandon and Srivastava (1975) reported a focal mechanism for an earthquake very close to these anomalous earthquakes at 27.7N 86.0E. They interpreted it as indicating strike-slip faulting parallel to the Himalayan arc (section 5.3). Therefore, even though thrust faulting is expected along the Himalayan arc, the possibility of strike-slip mechanisms for these two anomalous earthquakes cannot be discounted. However, both of these earthquakes remain anomalous after applying depth correction factors for a vertical strike-slip mechanism to the $M_s$ values reported by Nuttli and Kim. Their $M_s$-$m_b$ values are about -1.0.

Both of the anomalous earthquakes along the Himalayan front reported by Nuttli and Kim and three of the anomalous earthquakes reported by Der are identified as earthquakes by the significant depth criterion at the 95 percent probability level (section 5.2).

# 6. CONCLUSIONS

The SRSTs developed in the present study are effective in computing depth estimates by all parameter free locations of earthquakes in the eastern Himalayan region. Computed hypocenters for the calibration events used in this study have a mean depth error near zero with a standard deviation of 8.6 km; the mean absolute depth error is 6.8 km. The 95% level depth reliability intervals average about ±17 km and include the proper percent of the events. To assure maximum reliability of estimated depths, inverse variance weighting should be applied when locating with SRSTs, the weights being based on the variance of each station's residuals about its SRST correction.

Focal depths of earthquakes in this region which have been reported as anomalous are not deep enough to explain the weak surface waves observed from these earthquakes.

The very shallow focal depths of earthquakes in this region with the exception of the Burmese arc, limit the usefulness of identification techniques based on computed depth.

## 7. RECOMMENDATIONS

We recommend that the SRSTs developed in the present study be used to locate seismic events in the Eastern Himalayan region. Inverse variance weighting should be applied when locating with SRSTs.

SRSTs should be developed for Chinese stations in and near this region to improve the depth reliability obtainable for seismic events in this region.

Propagation characteristics of both surface and compressional waves for shallow crustal earthquakes in this region should be investigated intensively, to help resolve the anomalous earthquake problem.

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APPENDIX 1 to TECHNICAL REPORT 75-12

FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

Final locations of the 242 calibration earthquakes are listed in this appendix, ordered by region and by subregion within each region. Included in the list are date, origin time, north latitude, east longitude, pP depth [H(.P)], observed weighted standard deviation (SD) of residuals, number (NP) of stations input, and number (NU) of stations used from the location restrained to h(pP), and computed depth [H(SRST)] and 95 percent depth coverage (HCOV) and confidence (HCNF) intervals from the depth-free location with SRST corrections applied.

FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN HR | MIN | TIME SEC | N LAT DEG | E LONG DEG | NP | NU | SC SEC | H(.P) KM | H(SRST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 65 | 5 | 31 | 2 | 4 | 43.1 | 32.52 | 78.16 | 108 | 83 | .81 | 18 | 18 | 13 | 11 |
| 101 | 65 | 6 | 22 | 5 | 49 | 30.8 | 36.28 | 77.60 | 92 | 77 | 1.08 | 111 | 96 | 7 | 7 |
| 101 | 66 | 10 | 20 | 0 | 53 | 37.7 | 33.51 | 78.57 | 93 | 80 | 2.60 | 4 | 7 | 14 | 14 |
| 101 | 67 | 5 | 27 | 19 | 5 | 46.5 | 36.09 | 77.76 | 149 | 129 | 1.08 | 6 | 13 | 12 | 12 |
| 101 | 68 | 2 | 10 | 17 | 3 | 2.6 | 34.12 | 78.65 | 79 | 76 | 1.86 | 11 | 14 | 15 | 14 |
| 101 | 68 | 2 | 11 | 20 | 38 | 27.6 | 34.14 | 78.66 | 120 | 106 | 1.35 | 12 | 14 | 14 | 12 |
| 101 | 70 | 3 | 5 | 18 | 34 | 21.7 | 32.32 | 76.49 | 73 | 67 | 1.79 | 14 | 5 | 13 | 11 |
| 101 | 70 | 8 | 11 | 1 | 6 | 18.5 | 34.31 | 79.59 | 53 | 52 | 2.35 | 10 | 7 | 18 | 45 |
| 101 | 70 | 10 | 14 | 0 | 30 | 33.6 | 31.38 | 74.58 | 47 | 43 | 1.19 | 10 | 17 | 10 | 12 |
| 101 | 72 | 2 | 20 | 3 | 2 | 13.0 | 34.51 | 80.40 | 59 | 53 | 2.05 | 11 | 5 | 15 | 15 |
| 101 | 72 | 4 | 21 | 21 | 19 | 29.1 | 35.01 | 81.17 | 77 | 72 | .76 | 11 | 20 | 10 | 8 |
| 101 | 72 | 9 | 6 | 2 | 51 | 31.0 | 32.55 | 78.43 | 83 | 76 | 1.75 | 16 | 22 | 10 | 10 |
| 101 | 73 | 1 | 16 | 21 | 31 | 25.6 | 33.29 | 75.85 | 86 | 78 | 1.81 | 19 | 20 | 12 | 10 |
| 101 | 73 | 10 | 24 | 5 | 23 | 51.5 | 33.14 | 76.01 | 106 | 98 | 1.12 | 20 | 17 | 10 | 9 |
| 101 | 73 | 10 | 24 | 19 | 57 | 16.5 | 33.13 | 76.01 | 68 | 64 | 2.23 | 20 | 18 | 11 | 11 |
| 101 | 73 | 12 | 16 | 9 | 16 | 13.5 | 32.35 | 76.18 | 60 | 54 | 2.05 | 11 | 9 | 14 | 17 |
| 102 | 65 | 1 | 21 | 13 | 31 | 30.2 | 34.51 | 86.94 | 63 | 60 | 4.03 | 13 | 14 | 16 | 16 |
| 102 | 65 | 6 | 14 | 13 | 17 | 1.7 | 32.03 | 87.72 | 89 | 80 | 2.38 | 12 | 20 | 12 | 13 |
| 102 | 65 | 6 | 16 | 23 | 49 | 3.7 | 32.01 | 87.72 | 46 | 38 | 1.13 | 13 | 18 | 21 | 26 |
| 102 | 65 | 6 | 17 | 20 | 14 | 52.4 | 32.01 | 87.74 | 113 | 105 | 2.21 | 14 | 0 | 14 | 17 |
| 102 | 65 | 6 | 18 | 1 | 18 | 37.2 | 31.99 | 87.75 | 82 | 78 | 1.62 | 12 | 23 | 12 | 13 |
| 102 | 66 | 10 | 14 | 1 | 4 | 44.1 | 36.40 | 87.46 | 126 | 101 | .95 | 28 | 34 | 11 | 11 |
| 102 | 67 | 12 | 14 | 19 | 15 | 20.5 | 38.17 | 91.27 | 57 | 52 | .87 | 12 | 13 | 18 | 16 |
| 102 | 68 | 2 | 21 | 23 | 32 | 37.5 | 38.24 | 86.81 | 42 | 35 | .69 | 9 | 10 | 21 | 15 |
| 102 | 71 | 5 | 22 | 20 | 3 | 31.0 | 32.37 | 92.07 | 124 | 106 | 1.10 | 8 | 5 | 12 | 13 |
| 102 | 71 | 10 | 29 | 17 | 16 | 51.2 | 34.20 | 86.49 | 71 | 63 | 1.16 | 8 | 19 | 11 | 13 |
| 102 | 72 | 7 | 22 | 16 | 41 | 4.6 | 31.43 | 91.50 | 149 | 128 | 1.20 | 15 | 4 | 12 | 12 |
| 102 | 72 | 12 | 30 | 13 | 29 | 35.0 | 33.71 | 87.73 | 44 | 36 | .88 | 14 | 21 | 12 | 13 |
| 102 | 72 | 12 | 30 | 23 | 54 | 6.4 | 33.63 | 87.74 | 72 | 65 | 1.40 | 14 | 7 | 13 | 20 |
| 102 | 73 | 1 | 2 | 22 | 25 | 56.0 | 31.24 | 88.14 | 67 | 61 | 1.04 | 9 | 4 | 14 | 15 |
| 102 | 73 | 1 | 23 | 11 | 31 | 47.5 | 40.38 | 91.15 | 47 | 43 | .91 | 10 | 2 | 13 | 11 |
| 102 | 73 | 2 | 23 | 10 | 43 | 6.1 | 37.50 | 85.73 | 52 | 46 | 1.15 | 16 | 14 | 13 | 15 |
| 102 | 73 | 7 | 14 | 4 | 51 | 20.8 | 35.12 | 86.47 | 137 | 119 | .93 | 15 | 13 | 12 | 12 |
| 102 | 73 | 7 | 14 | 13 | 39 | 28.9 | 35.21 | 86.60 | 126 | 114 | .73 | 8 | 16 | 10 | 7 |
| 102 | 73 | 7 | 16 | 19 | 45 | 40.3 | 35.09 | 86.53 | 93 | 85 | 1.14 | 9 | 17 | 11 | 13 |

## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

Final locations of the 242 calibration earthquakes are listed in this appendix, ordered by region and by subregion within each region. Included in the list are date, origin time, north latitude, east longitude, pP depth [H(.P)], observed weighted standard deviation (SD) of residuals, number (NP) of stations input, and number (NU) of stations used from the location restrained to h(pP), and computed depth [H(SRST)] and 95 percent depth coverage (HCOV) and confidence (HCNF) intervals from the depth-free location with SRST corrections applied.

## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NP | NU | SD SEC | H(.P) KM | H(SRST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 102 | 73 | 7 | 21 | 19 | 50 | 5.8 | 35.19 | 86.55 | 64 | 57 | 1.24 | 8 | 8 | 14 | 13 |
| 102 | 73 | 8 | 16 | 8 | 2 | 54.2 | 33.21 | 86.85 | 84 | 79 | 1.66 | 11 | 7 | 13 | 14 |
| 102 | 73 | 9 | 8 | 7 | 25 | 43.4 | 33.22 | 86.82 | 100 | 91 | 1.12 | 12 | 0 | 13 | 12 |
| 102 | 73 | 11 | 27 | 9 | 31 | 10.5 | 33.15 | 86.87 | 55 | 52 | 1.74 | 7 | 9 | 14 | 22 |
| 103 | 66 | 3 | 6 | 2 | 10 | 56.2 | 31.47 | 80.53 | 105 | 89 | .82 | 13 | 7 | 18 | 16 |
| 103 | 66 | 3 | 6 | 2 | 15 | 55.7 | 31.49 | 80.52 | 133 | 119 | 1.08 | 20 | 26 | 13 | 14 |
| 103 | 66 | 6 | 27 | 10 | 41 | 7.1 | 29.60 | 80.91 | 151 | 136 | .99 | 9 | 4 | 12 | 11 |
| 103 | 66 | 6 | 27 | 13 | 55 | 51.5 | 29.59 | 80.89 | 109 | 101 | .88 | 13 | 13 | 14 | 12 |
| 103 | 66 | 12 | 16 | 20 | 52 | 17.5 | 29.65 | 80.88 | 160 | 141 | 1.59 | 11 | 5 | 11 | 13 |
| 103 | 68 | 1 | 5 | 6 | 42 | 50.0 | 30.46 | 79.28 | 65 | 60 | 1.16 | 21 | 30 | 13 | 17 |
| 103 | 69 | 3 | 3 | 6 | 20 | 21.8 | 30.05 | 79.96 | 115 | 106 | 2.75 | 5 | 9 | 12 | 11 |
| 103 | 69 | 6 | 22 | 1 | 33 | 25.5 | 30.21 | 79.41 | 130 | 127 | 2.12 | 15 | 10 | 12 | 10 |
| 103 | 70 | 2 | 12 | 1 | 51 | 48.6 | 29.26 | 80.67 | 113 | 98 | .92 | 5 | 13 | 12 | 12 |
| 103 | 71 | 5 | 3 | 0 | 33 | 23.5 | 30.70 | 84.47 | 101 | 90 | 1.09 | 4 | 0 | 13 | 25 |
| 103 | 72 | 2 | 4 | 14 | 8 | 23.4 | 30.35 | 84.59 | 80 | 76 | 1.52 | 10 | 6 | 14 | 16 |
| 103 | 72 | 3 | 15 | 6 | 0 | 33.8 | 30.53 | 84.48 | 101 | 95 | 1.65 | 15 | 20 | 12 | 11 |
| 103 | 72 | 4 | 28 | 0 | 53 | .5 | 31.33 | 84.92 | 93 | 87 | 2.96 | 35 | 35 | 10 | 14 |
| 103 | 73 | 10 | 16 | 9 | 50 | 43.3 | 28.36 | 83.15 | 74 | 67 | 1.51 | 8 | 0 | 15 | 15 |
| 104 | 64 | 2 | 18 | 3 | 48 | 36.6 | 27.35 | 91.24 | 69 | 59 | 1.23 | 18 | 8 | 16 | 15 |
| 104 | 64 | 11 | 9 | 16 | 12 | 51.3 | 29.47 | 86.18 | 59 | 54 | 2.44 | 11 | 3 | 16 | 21 |
| 104 | 65 | 1 | 12 | 13 | 55 | 21.6 | 27.41 | 87.84 | 63 | 53 | 1.09 | 17 | 5 | 18 | 21 |
| 104 | 68 | 8 | 18 | 14 | 19 | 2.4 | 26.42 | 90.63 | 77 | 73 | .81 | 30 | 29 | 12 | 10 |
| 104 | 69 | 11 | 5 | 20 | 25 | 17.1 | 27.65 | 90.29 | 71 | 67 | .74 | 13 | 22 | 13 | 10 |
| 104 | 70 | 2 | 26 | 19 | 30 | 8.0 | 27.69 | 85.97 | 129 | 122 | 1.26 | 11 | 0 | 12 | 10 |
| 104 | 70 | 7 | 25 | 1 | 35 | 27.6 | 25.71 | 88.72 | 111 | 89 | .99 | 4 | 1 | 14 | 15 |
| 104 | 71 | 10 | 24 | 8 | 59 | 6.9 | 28.39 | 87.30 | 55 | 48 | 1.02 | 44 | 47 | 9 | 10 |
| 104 | 71 | 12 | 4 | 8 | 38 | 4.4 | 27.59 | 87.94 | 49 | 45 | .88 | 37 | 33 | 14 | 12 |
| 104 | 72 | 8 | 21 | 14 | 4 | 36.9 | 27.30 | 88.15 | 57 | 56 | 2.01 | 5 | 4 | 14 | 19 |
| 104 | 73 | 3 | 22 | 1 | 6 | 59.0 | 28.04 | 87.11 | 45 | 42 | 1.47 | 7 | 0 | 19 | 25 |
| 205 | 71 | 3 | 24 | 13 | 54 | 19.0 | 35.40 | 98.03 | 164 | 144 | 1.45 | 4 | 0 | 13 | 19 |
| 205 | 72 | 8 | 30 | 15 | 14 | 10.3 | 36.29 | 96.37 | 152 | 126 | 1.10 | 4 | 0 | 14 | 15 |
| 205 | 72 | 8 | 30 | 18 | 47 | 43.9 | 36.26 | 96.38 | 150 | 132 | .74 | 6 | 6 | 12 | 9 |
| 205 | 72 | 8 | 30 | 18 | 51 | 35.4 | 36.34 | 96.36 | 85 | 71 | .66 | 21 | 31 | 21 | 16 |

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## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NP | NU | SD SEC | H(.P) KM | H(SRST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 205 | 73 | 3 | 12 | 14 | 21 | 29.4 | 38.40 | 93.55 | 40 | 32 | .83 | 14 | 19 | 14 | 12 |
| 205 | 73 | 6 | 16 | 7 | 22 | 47.9 | 37.64 | 95.64 | 83 | 75 | .88 | 13 | 12 | 14 | 13 |
| 206 | 65 | 1 | 10 | 14 | 53 | 59.0 | 35.04 | 111.67 | 37 | 33 | 1.27 | 9 | 36 | 30 | 39 |
| 206 | 65 | 10 | 21 | 18 | 47 | 54.7 | 40.64 | 109.52 | 31 | 29 | .98 | 21 | 35 | 37 | 39 |
| 206 | 67 | 10 | 15 | 21 | 43 | 54.3 | 36.80 | 105.05 | 69 | 65 | .93 | 10 | 0 | 28 | 27 |
| 206 | 67 | 12 | 18 | 14 | 7 | 44.2 | 36.40 | 111.46 | 81 | 65 | .81 | 39 | 54 | 16 | 14 |
| 206 | 68 | 12 | 22 | 9 | 6 | 36.0 | 36.61 | 101.82 | 145 | 130 | .81 | 10 | 9 | 18 | 14 |
| 206 | 70 | 1 | 27 | 10 | 49 | 30.4 | 34.60 | 101.31 | 77 | 70 | .68 | 7 | 2 | 16 | 11 |
| 206 | 70 | 12 | 2 | 19 | 12 | 53.3 | 35.66 | 105.56 | 113 | 95 | .80 | 6 | 1 | 14 | 12 |
| 206 | 71 | 6 | 28 | 5 | 1 | 48.6 | 37.66 | 106.12 | 109 | 90 | .80 | 12 | 22 | 14 | 11 |
| 206 | 73 | 5 | 8 | 10 | 1 | 38.9 | 32.69 | 103.97 | 58 | 50 | .95 | 17 | 11 | 22 | 23 |
| 206 | 73 | 8 | 11 | 7 | 15 | 38.4 | 32.64 | 104.00 | 121 | 113 | 1.28 | 6 | 7 | 14 | 19 |
| 207 | 66 | 3 | 22 | 8 | 11 | 35.7 | 37.47 | 115.04 | 143 | 134 | 1.98 | 4 | 0 | 17 | 15 |
| 207 | 66 | 3 | 22 | 8 | 19 | 32.5 | 37.30 | 115.20 | 125 | 109 | 1.32 | 6 | 0 | 26 | 33 |
| 207 | 66 | 3 | 22 | 8 | 45 | 53.7 | 37.35 | 115.16 | 51 | 41 | 1.05 | 27 | 40 | 20 | 20 |
| 207 | 66 | 3 | 22 | 11 | 8 | 37.3 | 37.53 | 115.08 | 82 | 77 | .74 | 11 | 7 | 27 | 20 |
| 207 | 66 | 3 | 23 | 17 | 28 | .9 | 37.44 | 114.97 | 67 | 60 | 2.35 | 10 | 18 | 20 | 16 |
| 207 | 66 | 3 | 26 | 15 | 19 | 2.2 | 37.62 | 115.15 | 128 | 117 | 1.02 | 9 | 0 | 17 | 17 |
| 207 | 66 | 3 | 26 | 18 | 14 | 20.9 | 37.63 | 115.12 | 86 | 81 | 2.02 | 8 | 7 | 21 | 27 |
| 207 | 66 | 3 | 29 | 6 | 11 | 59.1 | 37.38 | 114.98 | 105 | 101 | 1.77 | 9 | 22 | 16 | 12 |
| 207 | 67 | 3 | 27 | 8 | 58 | 23.8 | 38.41 | 116.59 | 142 | 130 | 1.22 | 27 | 32 | 15 | 11 |
| 207 | 67 | 12 | 2 | 20 | 5 | 55.0 | 37.69 | 115.19 | 99 | 90 | 1.39 | 11 | 24 | 13 | 19 |
| 207 | 68 | 1 | 7 | 4 | 5 | 37.9 | 37.35 | 114.98 | 49 | 43 | 1.08 | 10 | 1 | 29 | 33 |
| 207 | 68 | 1 | 15 | 19 | 33 | 58.2 | 37.67 | 115.36 | 75 | 68 | 1.10 | 11 | 11 | 23 | 26 |
| 207 | 68 | 5 | 14 | 19 | 47 | 3.4 | 37.64 | 114.80 | 54 | 49 | 1.36 | 10 | 0 | 24 | 34 |
| 207 | 69 | 7 | 18 | 5 | 24 | 48.3 | 38.64 | 119.50 | 163 | 148 | 1.63 | 21 | 21 | 13 | 9 |
| 207 | 69 | 7 | 18 | 13 | 33 | 50.1 | 38.02 | 119.36 | 87 | 70 | .80 | 11 | 10 | 17 | 14 |
| 207 | 69 | 7 | 19 | 1 | 52 | 7.1 | 38.13 | 119.45 | 43 | 38 | .82 | 20 | 15 | 30 | 30 |
| 208 | 64 | 3 | 16 | 1 | 5 | 18.8 | 37.02 | 95.65 | 107 | 96 | .82 | 7 | 0 | 17 | 13 |
| 208 | 65 | 7 | 31 | 17 | 7 | 51.3 | 32.72 | 93.16 | 63 | 51 | 1.31 | 9 | 3 | 19 | 26 |
| 208 | 65 | 7 | 31 | 19 | 1 | 8.3 | 32.60 | 93.12 | 41 | 37 | 1.34 | 53 | 32 | 16 | 24 |
| 208 | 65 | 7 | 31 | 21 | 44 | 49.1 | 32.76 | 93.18 | 72 | 54 | .83 | 10 | 22 | 16 | 14 |
| 208 | 65 | 8 | 1 | 20 | 9 | 18.0 | 32.70 | 93.18 | 91 | 74 | .87 | 9 | 21 | 14 | 12 |
| 208 | 66 | 3 | 14 | 4 | 42 | 51.0 | 32.31 | 97.52 | 63 | 58 | 1.98 | 14 | 0 | 21 | 43 |
| 208 | 69 | 6 | 14 | 3 | 20 | 29.2 | 31.74 | 94.83 | 70 | 61 | 1.15 | 11 | 35 | 17 | 20 |

## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NF | NU | SD SEC | H(P) KM | H(SRST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 208 | 71 | 6 | 4 | 14 | 10 | 46.5 | 32.17 | 95.26 | 54 | 51 | 1.16 | 39 | 25 | 14 | 16 |
| 208 | 72 | 6 | 2 | 16 | 48 | 55.7 | 34.09 | 94.19 | 31 | 28 | 1.74 | 13 | 20 | 14 | 25 |
| 208 | 72 | 7 | 16 | 2 | 20 | 23.8 | 32.53 | 95.92 | 109 | 101 | .63 | 10 | 20 | 12 | 10 |
| 208 | 72 | 8 | 10 | 21 | 6 | 39.5 | 32.47 | 93.56 | 116 | 107 | 2.07 | 38 | 24 | 13 | 10 |
| 209 | 65 | 4 | 11 | 14 | 27 | 44.6 | 29.37 | 104.78 | 42 | 37 | .87 | 7 | 14 | 27 | 25 |
| 209 | 67 | 1 | 24 | 14 | 45 | 16.7 | 30.24 | 104.22 | 88 | 77 | 1.49 | 11 | 8 | 19 | 18 |
| 209 | 67 | 8 | 30 | 4 | 22 | 6.0 | 31.61 | 100.31 | 164 | 147 | 1.93 | 39 | 35 | 14 | 12 |
| 209 | 67 | 8 | 30 | 4 | 57 | 43.2 | 31.51 | 100.26 | 34 | 32 | .75 | 12 | 15 | 32 | 26 |
| 209 | 67 | 8 | 30 | 11 | 8 | 50.3 | 31.55 | 100.32 | 143 | 128 | 1.73 | 17 | 13 | 17 | 19 |
| 209 | 69 | 9 | 25 | 23 | 10 | 39.3 | 32.58 | 102.21 | 42 | 35 | 1.19 | 17 | 0 | 33 | 37 |
| 209 | 70 | 3 | 14 | 22 | 6 | 22.1 | 30.66 | 103.12 | 55 | 53 | 1.52 | 10 | 22 | 18 | 21 |
| 209 | 70 | 3 | 22 | 10 | 42 | 8.8 | 31.69 | 103.88 | 69 | 65 | .78 | 14 | 21 | 17 | 13 |
| 209 | 70 | 11 | 8 | 9 | 15 | 57.3 | 32.09 | 101.32 | 122 | 96 | .93 | 31 | 31 | 13 | 13 |
| 209 | 73 | 2 | 6 | 10 | 37 | 9.3 | 31.37 | 100.68 | 112 | 103 | 1.91 | 26 | 23 | 13 | 19 |
| 209 | 73 | 2 | 7 | 9 | 20 | 56.1 | 31.33 | 100.81 | 47 | 42 | .67 | 10 | 20 | 17 | 14 |
| 209 | 73 | 2 | 7 | 16 | 6 | 25.6 | 31.45 | 100.30 | 112 | 103 | .91 | 28 | 30 | 13 | 11 |
| 209 | 73 | 2 | 16 | 7 | 29 | 48.1 | 31.79 | 100.01 | 44 | 41 | 1.95 | 9 | 7 | 18 | 38 |
| 209 | 73 | 3 | 23 | 19 | 14 | 55.3 | 31.77 | 99.55 | 30 | 26 | .67 | 27 | 24 | 25 | 18 |
| 209 | 73 | 9 | 9 | 2 | 13 | 40.5 | 31.59 | 99.97 | 89 | 80 | .84 | 19 | 30 | 15 | 19 |
| 310 | 65 | 6 | 15 | 7 | 59 | 23.0 | 29.68 | 95.42 | 80 | 76 | .99 | 6 | 6 | 22 | 23 |
| 310 | 65 | 10 | 6 | 8 | 3 | 9.9 | 29.15 | 96.07 | 44 | 40 | .83 | 48 | 44 | 17 | 14 |
| 310 | 67 | 8 | 15 | 9 | 21 | 2.4 | 31.05 | 93.58 | 129 | 130 | 1.90 | 7 | 0 | 19 | 19 |
| 310 | 68 | 6 | 28 | 20 | 34 | 57.4 | 30.34 | 94.84 | 55 | 48 | 1.10 | 6 | 10 | 23 | 26 |
| 310 | 68 | 7 | 4 | 6 | 46 | 1.0 | 30.26 | 94.84 | 45 | 44 | 1.37 | 14 | 14 | 28 | 38 |
| 310 | 68 | 7 | 14 | 18 | 12 | 46.4 | 30.27 | 94.81 | 54 | 49 | .86 | 15 | 16 | 21 | 17 |
| 310 | 68 | 7 | 16 | 22 | 23 | 9.9 | 30.28 | 94.78 | 53 | 52 | .95 | 17 | 22 | 19 | 19 |
| 310 | 68 | 7 | 19 | 18 | 49 | 3.1 | 30.26 | 94.77 | 54 | 52 | 1.03 | 17 | 19 | 20 | 21 |
| 310 | 68 | 7 | 23 | 20 | 51 | 51.5 | 30.30 | 94.80 | 53 | 48 | .83 | 39 | 32 | 20 | 18 |
| 310 | 68 | 8 | 20 | 9 | 31 | 2.0 | 30.31 | 94.82 | 52 | 49 | 1.35 | 30 | 24 | 22 | 30 |
| 310 | 68 | 8 | 23 | 17 | 1 | 19.0 | 30.26 | 94.85 | 44 | 35 | .64 | 23 | 22 | 22 | 25 |
| 310 | 68 | 8 | 29 | 19 | 51 | 27.7 | 30.30 | 94.84 | 45 | 35 | .67 | 15 | 15 | 26 | 17 |
| 310 | 68 | 9 | 1 | 5 | 59 | 28.0 | 30.26 | 94.86 | 32 | 31 | 1.19 | 5 | 0 | 32 | 39 |
| 310 | 68 | 9 | 3 | 17 | 45 | 56.5 | 30.29 | 94.76 | 30 | 45 | .69 | 19 | 25 | 21 | 17 |

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# FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NP | NU | SD SEC | H(.P) KM | H(SRST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 310 | 69 | 8 | 15 | 7 | 15 | 37.0 | 30.33 | 94.81 | 38 | 36 | .98 | 15 | 18 | 25 | 28 |
| 310 | 70 | 2 | 8 | 19 | 7 | 30.0 | 31.03 | 93.67 | 55 | 52 | 1.52 | 36 | 36 | 16 | 23 |
| 310 | 70 | 6 | 24 | 0 | 43 | 4.5 | 29.02 | 95.75 | 88 | 74 | .91 | 25 | 24 | 17 | 16 |
| 310 | 73 | 12 | 21 | 2 | 8 | 47.9 | 30.34 | 94.80 | 48 | 45 | 1.06 | 10 | 0 | 21 | 22 |
| 311 | 64 | 10 | 21 | 23 | 9 | 20.5 | 28.07 | 93.81 | 108 | 104 | 2.63 | 24 | 0 | 23 | 23 |
| 311 | 65 | 12 | 9 | 20 | 26 | 9.6 | 27.31 | 92.51 | 94 | 85 | 1.56 | 40 | 43 | 11 | 10 |
| 311 | 66 | 9 | 26 | 5 | 10 | 59.4 | 27.46 | 92.60 | 137 | 126 | 2.92 | 21 | 19 | 17 | 13 |
| 311 | 67 | 2 | 25 | 11 | 56 | 11.5 | 27.21 | 92.61 | 30 | 25 | 1.04 | 45 | 41 | 18 | 25 |
| 311 | 67 | 3 | 11 | 16 | 56 | 53.9 | 28.38 | 94.34 | 101 | 88 | .87 | 17 | 3 | 20 | 19 |
| 311 | 67 | 3 | 14 | 6 | 58 | 6.8 | 28.39 | 94.31 | 152 | 142 | 1.32 | 17 | 8 | 17 | 14 |
| 311 | 67 | 9 | 15 | 10 | 32 | 46.1 | 27.27 | 91.94 | 150 | 134 | 1.55 | 19 | 13 | 16 | 12 |
| 311 | 68 | 5 | 2 | 0 | 26 | 4.5 | 26.64 | 92.15 | 47 | 43 | .84 | 37 | 42 | 14 | 12 |
| 311 | 69 | 2 | 22 | 20 | 37 | 5.3 | 26.59 | 92.38 | 54 | 49 | .75 | 11 | 20 | 14 | 11 |
| 311 | 69 | 6 | 30 | 8 | 51 | 56.4 | 26.65 | 92.69 | 75 | 70 | 1.09 | 58 | 57 | 9 | 9 |
| 311 | 70 | 2 | 19 | 7 | 10 | 3.5 | 27.39 | 93.97 | 158 | 151 | 2.17 | 8 | 7 | 14 | 13 |
| 311 | 71 | 7 | 17 | 15 | 0 | 58.2 | 26.38 | 93.16 | 159 | 149 | 1.72 | 45 | 37 | 9 | 6 |
| 311 | 73 | 7 | 4 | 16 | 44 | 14.4 | 27.66 | 92.64 | 47 | 46 | 1.01 | 27 | 27 | 16 | 15 |
| 312 | 68 | 6 | 12 | 4 | 29 | 25.4 | 24.60 | 91.88 | 82 | 71 | .67 | 42 | 30 | 18 | 12 |
| 312 | 69 | 1 | 25 | 23 | 34 | 32.3 | 22.96 | 92.40 | 117 | 106 | 1.83 | 51 | 42 | 9 | 8 |
| 312 | 69 | 6 | 1 | 8 | 35 | 25.5 | 25.69 | 91.72 | 81 | 73 | 1.85 | 20 | 16 | 11 | 5 |
| 312 | 70 | 8 | 28 | 1 | 24 | 9.0 | 24.76 | 91.65 | 65 | 58 | .87 | 6 | 7 | 14 | 12 |
| 312 | 71 | 2 | 2 | 7 | 59 | 56.7 | 23.71 | 91.68 | 122 | 102 | .69 | 19 | 30 | 13 | 9 |
| 312 | 73 | 11 | 2 | 12 | 9 | 58.6 | 25.77 | 91.68 | 57 | 54 | .81 | 18 | 23 | 17 | 14 |
| 313 | 64 | 3 | 27 | 4 | 30 | 38.9 | 25.64 | 95.75 | 72 | 68 | .97 | 114 | 119 | 13 | 13 |
| 313 | 64 | 6 | 3 | 2 | 49 | 20.1 | 25.65 | 95.69 | 90 | 83 | 2.81 | 118 | 118 | 18 | 12 |
| 313 | 68 | 1 | 23 | 3 | 22 | 49.5 | 25.98 | 95.63 | 50 | 46 | .81 | 102 | 108 | 16 | 14 |
| 313 | 69 | 4 | 28 | 12 | 50 | 21.6 | 25.54 | 95.15 | 117 | 106 | 1.39 | 78 | 83 | 11 | 8 |
| 313 | 69 | 8 | 29 | 10 | 2 | 55.4 | 26.28 | 96.07 | 115 | 107 | 1.31 | 94 | 92 | 13 | 9 |
| 313 | 70 | 1 | 19 | 12 | 57 | 30.0 | 26.37 | 97.11 | 63 | 47 | .73 | 30 | 43 | 13 | 11 |
| 313 | 70 | 3 | 10 | 5 | 20 | 11.1 | 26.62 | 97.00 | 111 | 100 | .78 | 13 | 12 | 22 | 17 |
| 313 | 70 | 4 | 8 | 5 | 8 | 2.3 | 26.49 | 96.35 | 105 | 95 | .84 | 88 | 99 | 9 | 8 |
| 313 | 70 | 7 | 29 | 10 | 16 | 21.1 | 25.78 | 95.38 | 100 | 148 | 1.54 | 47 | 68 | 10 | 7 |
| 313 | 70 | 7 | 29 | 10 | 30 | 49.0 | 26.00 | 95.38 | 44 | 38 | .97 | 51 | 46 | 20 | 20 |
| 313 | 71 | 5 | 30 | 15 | 44 | 18.5 | 25.18 | 96.36 | 116 | 107 | 1.52 | 11 | 3 | 22 | 25 |
| 313 | 71 | 5 | 31 | 5 | 14 | 2.2 | 25.24 | 96.51 | 126 | 113 | 1.58 | 28 | 35 | 16 | 25 |

## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NP | NU | SD SEC | H(.P) KM | H(SHST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 313 | 72 | 4 | 17 | 10 | 35 | 49.8 | 25.60 | 95.37 | 94 | 85 | 1.78 | 111 | 110 | 9 | 7 |
| 313 | 72 | 11 | 1 | 21 | 53 | 51.4 | 26.42 | 96.31 | 122 | 109 | .65 | 115 | 113 | 10 | 6 |
| 314 | 64 | 3 | 20 | 19 | 0 | 57.0 | 23.46 | 94.42 | 42 | 34 | .76 | 103 | 89 | 15 | 13 |
| 314 | 64 | 6 | 13 | 17 | 36 | 1.2 | 22.96 | 94.01 | 84 | 74 | 3.38 | 59 | 50 | 14 | 24 |
| 314 | 64 | 7 | 12 | 20 | 16 | 2.7 | 24.91 | 95.40 | 71 | 64 | .99 | 156 | 162 | 12 | 12 |
| 314 | 64 | 7 | 13 | 10 | 58 | 50.1 | 23.55 | 94.72 | 97 | 86 | 1.75 | 108 | 115 | 13 | 11 |
| 314 | 65 | 2 | 25 | 10 | 34 | 11.6 | 23.59 | 94.67 | 83 | 77 | 1.47 | 108 | 93 | 12 | 11 |
| 314 | 65 | 6 | 18 | 8 | 17 | 43.2 | 24.91 | 93.64 | 80 | 69 | .77 | 65 | 46 | 14 | 12 |
| 314 | 65 | 12 | 5 | 22 | 1 | 42.9 | 23.32 | 94.51 | 76 | 64 | 2.02 | 108 | 88 | 13 | 10 |
| 314 | 66 | 10 | 22 | 3 | 3 | 30.9 | 23.04 | 94.29 | 90 | 84 | 2.02 | 101 | 81 | 12 | 10 |
| 314 | 67 | 2 | 8 | 17 | 17 | 50.7 | 23.12 | 93.85 | 68 | 61 | 2.18 | 47 | 41 | 13 | 10 |
| 314 | 67 | 12 | 10 | 18 | 43 | 38.0 | 22.54 | 94.89 | 78 | 75 | 1.35 | 160 | 167 | 12 | 12 |
| 314 | 69 | 10 | 17 | 1 | 25 | 16.2 | 23.04 | 94.71 | 150 | 139 | 2.09 | 144 | 146 | 10 | 11 |
| 314 | 70 | 3 | 13 | 18 | 24 | 55.3 | 24.94 | 93.95 | 63 | 58 | .77 | 49 | 53 | 10 | 8 |
| 314 | 70 | 5 | 29 | 10 | 34 | .8 | 23.96 | 94.09 | 140 | 121 | 1.36 | 38 | 42 | 10 | 9 |
| 314 | 70 | 8 | 13 | 7 | 0 | 41.9 | 24.61 | 93.87 | 85 | 74 | 1.46 | 19 | 29 | 16 | 19 |
| 314 | 71 | 6 | 26 | 2 | 16 | 39.5 | 24.60 | 94.81 | 108 | 101 | 1.37 | 67 | 74 | 10 | 9 |
| 314 | 71 | 10 | 10 | 18 | 25 | 19.8 | 23.00 | 95.90 | 110 | 90 | 1.14 | 43 | 47 | 11 | 14 |
| 314 | 71 | 10 | 14 | 12 | 55 | 25.1 | 23.07 | 95.85 | 130 | 115 | 1.73 | 48 | 62 | 11 | 11 |
| 314 | 71 | 12 | 29 | 22 | 27 | 7.3 | 25.12 | 94.74 | 137 | 113 | .66 | 51 | 46 | 13 | 8 |
| 314 | 73 | 5 | 31 | 23 | 39 | 56.4 | 24.30 | 93.51 | 104 | 92 | .92 | 29 | 30 | 16 | 13 |
| 315 | 64 | 1 | 22 | 15 | 58 | 46.8 | 22.30 | 93.53 | 102 | 95 | 1.20 | 57 | 54 | 11 | 9 |
| 315 | 64 | 2 | 27 | 15 | 10 | 52.2 | 21.65 | 94.45 | 113 | 108 | 2.75 | 102 | 109 | 10 | 9 |
| 315 | 65 | 6 | 1 | 4 | 32 | 52.9 | 20.60 | 94.85 | 87 | 78 | 2.36 | 88 | 89 | 14 | 13 |
| 315 | 65 | 12 | 15 | 4 | 43 | 49.0 | 21.59 | 94.51 | 92 | 79 | .73 | 94 | 101 | 15 | 11 |
| 315 | 66 | 11 | 19 | 7 | 42 | 35.1 | 18.34 | 95.24 | 63 | 56 | .94 | 84 | 90 | 13 | 14 |
| 315 | 66 | 12 | 15 | 2 | 8 | 7.0 | 21.32 | 94.41 | 117 | 102 | 2.02 | 94 | 94 | 11 | 7 |
| 315 | 67 | 2 | 15 | 5 | 57 | 34.4 | 20.36 | 94.06 | 115 | 106 | 2.07 | 54 | 64 | 11 | 10 |
| 315 | 70 | 10 | 14 | 16 | 51 | 42.2 | 21.66 | 94.20 | 62 | 52 | .91 | 78 | 76 | 12 | 11 |
| 315 | 71 | 9 | 11 | 5 | 49 | 24.8 | 15.61 | 96.39 | 64 | 54 | 1.38 | 13 | 8 | 21 | 31 |
| 315 | 71 | 9 | 11 | 6 | 28 | 13.0 | 15.18 | 96.33 | 93 | 71 | 1.33 | 13 | 0 | 21 | 30 |
| 315 | 71 | 11 | 11 | 4 | 41 | 1.1 | 21.33 | 93.89 | 68 | 59 | .88 | 51 | 64 | 11 | 10 |
| 315 | 72 | 12 | 10 | 11 | 20 | 34.5 | 21.67 | 94.29 | 67 | 57 | 1.18 | 64 | 84 | 9 | 10 |

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## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NP | NU | SC SEC | H(.P) KM | H(SRST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 416 | 66 | 1 | 31 | 2 | 35 | 6.2 | 27.30 | 99.67 | 67 | 64 | 1.28 | 12 | 19 | 24 | 24 |
| 416 | 66 | 10 | 11 | 10 | 6 | 23.9 | 27.99 | 103.73 | 81 | 66 | 1.31 | 32 | 27 | 23 | 31 |
| 416 | 67 | 5 | 5 | 0 | 8 | 8.1 | 29.27 | 103.63 | 56 | 45 | .68 | 10 | 6 | 35 | 25 |
| 416 | 70 | 7 | 31 | 13 | 10 | 48.9 | 28.61 | 103.61 | 136 | 121 | .92 | 12 | 25 | 17 | 14 |
| 416 | 71 | 8 | 16 | 4 | 58 | .8 | 28.56 | 103.65 | 150 | 140 | 1.45 | 22 | 22 | 17 | 15 |
| 416 | 71 | 8 | 16 | 13 | 29 | 26.5 | 28.52 | 103.69 | 46 | 43 | 1.04 | 19 | 22 | 23 | 25 |
| 416 | 71 | 8 | 16 | 18 | 53 | 56.2 | 28.92 | 103.76 | 143 | 130 | 1.20 | 20 | 0 | 21 | 21 |
| 416 | 71 | 8 | 16 | 22 | 37 | 34.8 | 28.63 | 103.62 | 134 | 125 | .84 | 18 | 23 | 17 | 13 |
| 416 | 71 | 8 | 17 | 9 | 36 | 17.1 | 28.73 | 103.74 | 79 | 68 | .73 | 17 | 20 | 20 | 16 |
| 416 | 71 | 8 | 17 | 17 | 7 | 43.1 | 28.61 | 103.70 | 77 | 66 | .80 | 28 | 34 | 19 | 16 |
| 416 | 71 | 8 | 23 | 5 | 36 | 14.4 | 28.50 | 103.69 | 94 | 87 | 2.46 | 28 | 18 | 20 | 26 |
| 416 | 71 | 8 | 23 | 5 | 46 | 27.9 | 28.63 | 103.69 | 56 | 50 | .89 | 29 | 33 | 22 | 20 |
| 416 | 71 | 9 | 4 | 1 | 10 | 35.6 | 28.54 | 103.79 | 40 | 36 | .83 | 23 | 19 | 22 | 20 |
| 416 | 71 | 11 | 4 | 20 | 12 | 24.8 | 28.64 | 103.59 | 60 | 55 | 1.01 | 23 | 19 | 19 | 20 |
| 416 | 72 | 4 | 8 | 9 | 33 | 43.5 | 29.51 | 101.83 | 126 | 122 | 1.29 | 39 | 49 | 14 | 11 |
| 416 | 72 | 5 | 6 | 22 | 5 | 22.1 | 28.02 | 102.39 | 56 | 53 | 1.16 | 13 | 18 | 23 | 28 |
| 416 | 72 | 9 | 27 | 0 | 8 | 32.9 | 30.35 | 101.62 | 108 | 81 | .67 | 29 | 28 | 19 | 10 |
| 416 | 73 | 6 | 28 | 21 | 58 | 2.7 | 28.92 | 103.63 | 53 | 47 | .65 | 12 | 17 | 24 | 16 |
| 416 | 73 | 6 | 28 | 21 | 59 | 30.3 | 28.56 | 103.60 | 73 | 61 | .56 | 11 | 28 | 21 | 12 |
| 416 | 73 | 6 | 29 | 17 | 52 | 3.0 | 28.69 | 103.62 | 74 | 71 | .84 | 22 | 20 | 19 | 16 |
| 417 | 66 | 2 | 5 | 15 | 12 | 36.3 | 26.18 | 103.15 | 152 | 130 | 1.27 | 15 | 12 | 21 | 24 |
| 417 | 66 | 2 | 6 | 9 | 13 | 25.0 | 26.26 | 103.14 | 65 | 60 | 2.51 | 15 | 27 | 27 | 19 |
| 417 | 66 | 2 | 13 | 10 | 44 | 40.9 | 26.18 | 103.28 | 138 | 127 | 2.06 | 8 | 14 | 22 | 25 |
| 417 | 66 | 2 | 18 | 3 | 45 | 17.4 | 26.23 | 103.21 | 54 | 47 | 1.22 | 27 | 38 | 26 | 24 |
| 417 | 68 | 3 | 16 | 12 | 26 | 40.5 | 25.34 | 100.98 | 58 | 54 | 1.55 | 29 | 20 | 28 | 25 |
| 417 | 70 | 1 | 4 | 17 | 32 | 43.4 | 24.20 | 102.40 | 55 | 48 | .79 | 30 | 36 | 29 | 24 |
| 417 | 70 | 1 | 4 | 21 | 44 | 36.1 | 24.19 | 102.40 | 104 | 98 | 2.08 | 27 | 32 | 19 | 17 |
| 417 | 70 | 1 | 14 | 10 | 14 | 21.9 | 24.28 | 102.37 | 88 | 81 | 1.90 | 12 | 6 | 24 | 20 |
| 417 | 70 | 2 | 5 | 3 | 40 | 4.3 | 24.28 | 102.24 | 140 | 129 | 1.65 | 17 | 26 | 16 | 16 |
| 417 | 70 | 3 | 11 | 1 | 37 | 24.5 | 23.94 | 102.88 | 54 | 51 | 1.57 | 30 | 7 | 28 | 31 |
| 417 | 70 | 3 | 24 | 23 | 47 | 4.4 | 26.24 | 104.92 | 81 | 74 | 1.13 | 8 | 0 | 23 | 26 |
| 417 | 70 | 6 | 17 | 11 | 50 | 7.3 | 24.25 | 102.38 | 68 | 66 | 2.18 | 10 | 0 | 23 | 43 |
| 417 | 71 | 2 | 5 | 9 | 10 | 36.3 | 25.23 | 99.41 | 119 | 109 | 1.67 | 11 | 30 | 19 | 18 |
| 418 | 66 | 9 | 28 | 14 | 0 | 24.0 | 27.47 | 100.14 | 158 | 136 | 2.02 | 22 | 31 | 17 | 17 |
| 418 | 69 | 2 | 9 | 15 | 34 | 46.9 | 21.71 | 101.38 | 65 | 62 | 2.50 | 19 | 29 | 24 | 21 |

## FINAL LOCATIONS OF CALIBRATION EARTHQUAKES

| REGION | DATE YR | MO | DA | ORIGIN TIME HR | MIN | SEC | N LAT DEG | E LONG DEG | NP | NU | SD SEC | H(.P) KM | H(SHST) KM | HCOV KM | HCNF KM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 418 | 70 | 2 | 6 | 22 | 32 | 43.4 | 22.95 | 100.78 | 72 | 69 | .91 | 24 | 25 | 21 | 19 |
| 418 | 71 | 4 | 28 | 15 | 32 | 4.0 | 22.94 | 101.03 | 159 | 141 | .98 | 11 | 7 | 20 | 20 |
| 418 | 73 | 8 | 16 | 3 | 58 | 11.4 | 22.98 | 101.02 | 111 | 99 | 1.22 | 13 | 13 | 18 | 15 |

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APPENDIX 2 TO TECHNICAL REPORT 75-12

SOURCE-REGION/STATION TIME CORRECTIONS

## SOURCE-REGION/STATION TIME CORRECTIONS

Parameters of the SRST corrections for the 181 stations are listed in this appendix, ordered by region. Coordinates of the reference location and azimuth of the X axis are given for each region. The X and Y coordinates of an epicentral location are given by

$$X = (\theta-\theta_o) \cos Z - (\phi-\phi_o) \sin \theta \sin Z$$

$$Y = (\theta-\theta_o) \sin Z + (\phi-\phi_o) \sin \theta \cos Z$$

where $\theta \equiv$ colatitude of epicenter for which correction is to be computed.

$\phi \equiv$ East longitude of epicenter for which correction is to be computed.

$\theta_o \equiv$ colatitude of reference location for the region.

$\phi_o \equiv$ East longitude of reference location for the region.

$Z \equiv$ azimuth of X axis.

The corrections correspond to one of seven types, according to the following definitions.

| Correction type | SRST Correction |
|---|---|
| 1 | $A + BX + CY + Dh$ |
| 2 | $A + BX + CY + DX^2$ |
| 3 | $A + BX + CY + DY^2$ |
| 4 | $A + Bh + CY + DY^2$ |
| 5 | $A + Bh + CY + Dh^2$ |
| 6 | $A + BX + Ch + Dh^2$ |
| 7 | $A + BX + Ch + DX^2$ |

Included in the table are the number of observations (NU) used to determine the correction, the number of earthquakes (NR) in the appropriate region that contributed to determination of the correction, and the standard deviation (SD) of the station's residuals about its SRST correction. The standard deviation is based on the calibration earthquakes within the appropriate region only. Parameter values in the table are for X and Y in radians and focal depth (h) in km.

The SRSTs are to be subtracted from the station's observed P arrival time or added to the travel time taken from the Herrin (1968) travel time tables.

TABLE 1 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 1

REF LAT = 32.00 N REF LONG = 85.00 E X AZI = 17 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| AAB | 1.051 | -3.45 | .69 | 19.38 | 1.14 | 143 | 45 | 3 |
| AAE | 1.914 | 5.56 | -2.06 | 34.65 | .81 | 40 | 14 | 2 |
| ADE | -0.398 | 1.16 | -3.42 | 15.14 | .51 | 59 | 10 | 2 |
| ALE | -1.315 | -5.11 | -7.01 | 46.75 | .44 | 93 | 29 | 3 |
| APA | -0.665 | -4.59 | -2.10 | 65.55 | .57 | 66 | 17 | 2 |
| ASH | .663 | -10.31 | 3.47 | -2.71 | 1.84 | 48 | 27 | 2 |
| ASP | -0.678 | -0.64 | -2.30 | 8.72 | .45 | 46 | 21 | 3 |
| AVE | -0.134 | -8.19 | -2.10 | -18.89 | 1.09 | 49 | 17 | 3 |
| BAG | 1.390 | -6.31 | -3.45 | -53.10 | 1.14 | 56 | 14 | 3 |
| BER | .222 | -4.54 | -1.03 | 12.50 | .63 | 38 | 11 | 2 |
| BHA | -1.354 | -0.30 | -3.53 | 27.56 | 1.04 | 84 | 15 | 3 |
| BKR | 1.661 | -3.00 | -4.46 | -9.19 | .61 | 115 | 35 | 2 |
| BLC | -1.573 | -2.54 | -6.51 | 25.31 | .51 | 46 | 18 | 3 |
| BMO | .855 | 11.42 | -1.09 | -45.94 | 1.99 | 68 | 17 | 3 |
| BNG | -2.077 | -0.35 | -0.61 | -3.06 | .80 | 103 | 40 | 3 |
| BNS | .826 | -4.37 | -6.25 | -27.92 | 1.01 | 36 | 10 | 2 |
| BOD | -0.863 | 1.71 | -1.57 | 5.36 | .50 | 98 | 38 | 2 |
| BOM | .849 | -19.35 | 1.74 | 15.22 | 1.78 | 39 | 8 | 3 |
| BRS | -0.450 | -1.29 | -0.55 | -10.98 | .59 | 73 | 17 | 3 |
| BRW | .021 | -12.31 | 1.22 | 33.16 | .44 | 30 | 8 | 2 |
| BUL | -1.483 | 1.38 | -1.69 | 14.12 | .48 | 132 | 40 | 3 |
| CAL | 1.339 | -7.97 | 13.21 | -27.06 | 1.92 | 34 | 8 | 3 |
| CAN | .039 | -0.09 | -2.11 | -24.63 | .58 | 73 | 14 | 3 |
| CHG | -1.187 | -17.84 | -5.56 | 86.70 | 1.20 | 69 | 16 | 3 |
| CHT | .324 | 2.05 | -9.70 | 30.30 | 1.26 | 42 | 10 | 3 |
| CIN | -0.373 | -4.04 | 4.13 | -63.36 | .98 | 27 | 6 | 3 |
| CIR | -0.412 | -2.66 | -1.44 | -35.95 | .48 | 52 | 9 | 3 |
| CLK | -0.965 | -2.57 | -2.67 | 74.15 | .60 | 84 | 17 | 2 |
| CLL | -0.109 | -5.07 | -3.10 | -19.49 | .56 | 127 | 46 | 2 |
| CMP | .685 | -10.67 | -2.17 | -53.22 | .92 | 40 | 13 | 2 |
| COL | -0.542 | -2.36 | -3.28 | 19.09 | .29 | 157 | 51 | 2 |
| COP | .336 | 1.58 | -2.71 | 67.70 | .30 | 38 | 10 | 2 |
| CTA | -0.722 | -1.86 | -3.37 | 7.69 | .33 | 104 | 35 | 3 |
| DAV | 2.401 | -17.47 | -12.59 | 65.72 | .77 | 35 | 6 | 2 |
| DOJ | 1.000 | 2.63 | -8.00 | 15.09 | 1.05 | 47 | 16 | 2 |
| DSH | -1.128 | -7.68 | 2.24 | 87.80 | 1.70 | 108 | 37 | 2 |
| EDM | -0.462 | -4.77 | -1.69 | -57.52 | .39 | 69 | 23 | 2 |
| EIL | -0.046 | -3.24 | -7.79 | 41.32 | .71 | 34 | 8 | 2 |
| EKA | -0.537 | -2.70 | -0.95 | 39.08 | .55 | 68 | 19 | 2 |
| ELT | -0.834 | 1.04 | 1.11 | 63.67 | .84 | 87 | 30 | 2 |
| ESK | -0.047 | -6.32 | -0.86 | -12.14 | .23 | 51 | 15 | 3 |
| EUR | 1.088 | 7.13 | -3.48 | .75 | 1.00 | 25 | 5 | 3 |
| FBC | -1.338 | -2.33 | -0.24 | -33.56 | .67 | 66 | 18 | 2 |
| FFC | -1.321 | -3.06 | -3.51 | 5.19 | .57 | 71 | 33 | 3 |
| FLN | -1.105 | -1.60 | -5.29 | 65.36 | .67 | 59 | 18 | 3 |
| FRJ | 1.488 | -3.22 | -2.77 | -54.47 | .95 | 106 | 39 | 2 |
| FSJ | -0.297 | -4.41 | -2.79 | 26.40 | .46 | 43 | 15 | 3 |
| FUR | .453 | -6.28 | -3.26 | -15.80 | .77 | 75 | 25 | 3 |
| GAR | -2.398 | 1.21 | 3.73 | 35.81 | 1.19 | 108 | 30 | 2 |
| GBA | -0.539 | -6.57 | -2.18 | 53.69 | .91 | 54 | 18 | 3 |

TABLE 1 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 1

REF LAT = 32.00 N REF LONG = 85.00 E X AZI = 17 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| GDH | -0.639 | 1.86 | -5.03 | 18.36 | .28 | 39 | 9 | 3 |
| GIL | -0.676 | -0.16 | -2.80 | 20.22 | .36 | 94 | 36 | 2 |
| GRF | .671 | -2.15 | -3.37 | -10.73 | .65 | 71 | 29 | 2 |
| GRR | -0.739 | -4.13 | -2.09 | 3.35 | .27 | 64 | 22 | 3 |
| GRS | .718 | -1.43 | -1.49 | -37.21 | .81 | 72 | 24 | 3 |
| HFS | -0.183 | -6.07 | -0.73 | -34.76 | .73 | 77 | 34 | 2 |
| HKC | -0.062 | -5.73 | -5.74 | 98.51 | .94 | 62 | 11 | 2 |
| HYB | -2.527 | -14.35 | 5.16 | 26.79 | .67 | 76 | 31 | 3 |
| IFR | -0.367 | 1.43 | -3.72 | 10.14 | .47 | 108 | 33 | 3 |
| ILT | -0.257 | -2.79 | -6.92 | -6.35 | .30 | 70 | 26 | 2 |
| INK | -0.707 | -2.65 | -4.09 | 6.56 | .39 | 65 | 20 | 3 |
| IRK | 1.238 | -2.34 | -14.35 | 60.61 | .87 | 71 | 27 | 3 |
| ISK | .237 | -1.12 | -2.23 | -34.75 | .45 | 34 | 7 | 3 |
| ISO | -0.233 | -8.04 | -2.42 | -8.17 | .67 | 42 | 9 | 3 |
| JER | 1.204 | -0.76 | -1.44 | -35.53 | .60 | 77 | 21 | 3 |
| KAR | -0.992 | 22.20 | 4.90 | 42.69 | 1.31 | 25 | 10 | 3 |
| KAS | .312 | -2.36 | -4.08 | -5.41 | .59 | 75 | 21 | 2 |
| KBL | -1.623 | .70 | -3.63 | 69.98 | .77 | 83 | 26 | 3 |
| KDC | -0.324 | -0.77 | -6.86 | -7.68 | .38 | 42 | 12 | 3 |
| KEV | .153 | -1.56 | -3.07 | -1.24 | .39 | 109 | 32 | 2 |
| KHC | .119 | -7.20 | -3.04 | -6.65 | .54 | 140 | 46 | 2 |
| KHE | .878 | -2.27 | -2.14 | -18.64 | .75 | 91 | 26 | 3 |
| KIR | -0.429 | -2.68 | -4.21 | 8.82 | .35 | 126 | 37 | 3 |
| KJN | -0.425 | -1.75 | -2.36 | 22.66 | .38 | 117 | 27 | 2 |
| KLG | -1.820 | -3.26 | .16 | 26.01 | .56 | 51 | 18 | 3 |
| KOD | 1.136 | 3.20 | -0.52 | -8.25 | 1.11 | 73 | 24 | 3 |
| KON | -0.176 | -2.91 | -0.99 | -22.96 | .75 | 80 | 27 | 2 |
| KRA | -0.097 | -6.43 | -3.92 | -12.40 | .56 | 78 | 24 | 2 |
| KRK | .298 | .52 | -1.19 | -11.18 | .71 | 36 | 12 | 2 |
| KRR | -1.764 | 2.03 | -5.26 | 23.95 | .86 | 71 | 13 | 3 |
| KRV | -0.173 | -2.44 | -2.86 | -24.68 | .88 | 92 | 37 | 2 |
| KTG | .719 | -7.13 | -3.81 | 2.75 | .40 | 45 | 15 | 3 |
| LAH | .002 | -13.97 | -16.92 | -59.86 | 1.06 | 54 | 23 | 2 |
| LHN | -0.594 | -2.18 | -1.50 | -0.58 | .70 | 42 | 18 | 3 |
| LUJ | -0.308 | -3.49 | -4.50 | 26.41 | .62 | 69 | 16 | 3 |
| LNS | -0.966 | -1.89 | -2.52 | 21.13 | .72 | 67 | 24 | 2 |
| LOR | -0.843 | -7.46 | -1.56 | 6.40 | .40 | 92 | 30 | 3 |
| LWI | -0.556 | 3.58 | -6.55 | 50.02 | .63 | 62 | 17 | 3 |
| MAG | .106 | -10.29 | -1.45 | -64.76 | .74 | 39 | 12 | 2 |
| MAT | -1.049 | -3.56 | -6.46 | -4.25 | .86 | 97 | 32 | 3 |
| MBC | -0.650 | -3.64 | -3.28 | -16.75 | .43 | 144 | 48 | 2 |
| MNL | .986 | -10.30 | -9.34 | 60.24 | .72 | 29 | 12 | 2 |
| MOS | .134 | -1.94 | .51 | -25.65 | .69 | 106 | 42 | 3 |
| MOX | -0.130 | -5.06 | -2.96 | 3.48 | .48 | 141 | 47 | 3 |
| MOY | .840 | -8.59 | -5.35 | 61.61 | .82 | 61 | 25 | 2 |
| MSH | 1.077 | -4.46 | 3.63 | -18.77 | 1.25 | 49 | 24 | 3 |
| MUN | -1.418 | -5.81 | -1.95 | 12.84 | .32 | 77 | 17 | 3 |
| NAI | .299 | 1.02 | -5.24 | 50.04 | .86 | 53 | 15 | 3 |
| NEW | -0.449 | 5.89 | 3.72 | 42.29 | .36 | 30 | 11 | 2 |
| NIE | .490 | -2.90 | -4.20 | 37.62 | .69 | 77 | 25 | 2 |

TABLE 1 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 1

REF LAT = 32.00 N REF LONG = 85.00 E X AZI = 17 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| NIL | -1.937 | -7.91 | -16.36 | 74.92 | .79 | 33 | 14 | 3 |
| NP- | -0.636 | -4.18 | -1.25 | -14.39 | .18 | 28 | 8 | 2 |
| NOR | -0.304 | -3.67 | -7.39 | -24.68 | .30 | 72 | 19 | 2 |
| NUR | -0.200 | -4.28 | -2.17 | -16.62 | .44 | 153 | 51 | 2 |
| ORN | -0.423 | -1.66 | -2.49 | -11.37 | .38 | 69 | 29 | 3 |
| OUL | -0.742 | 1.88 | -2.19 | 14.57 | .37 | 66 | 9 | 3 |
| PBA | 2.764 | -6.67 | -22.24 | 15.25 | 1.00 | 22 | 6 | 3 |
| PMG | -0.045 | 1.72 | -1.15 | -13.87 | .61 | 81 | 20 | 3 |
| PMR | -1.031 | -0.08 | -4.08 | 26.18 | .33 | 95 | 30 | 2 |
| PNT | -0.533 | 5.87 | 1.28 | 60.64 | .72 | 40 | 13 | 2 |
| POO | -1.613 | -13.66 | 6.79 | 42.22 | 1.19 | 108 | 40 | 3 |
| PRA | .625 | -2.81 | -3.85 | -12.87 | .69 | 52 | 18 | 3 |
| PRE | -0.774 | -0.55 | -0.54 | -4.01 | .90 | 54 | 16 | 3 |
| PRJ | .292 | -3.84 | -4.08 | 8.15 | .51 | 146 | 49 | 2 |
| PRZ | .434 | -2.47 | -6.49 | 43.54 | 1.25 | 61 | 24 | 3 |
| PUL | .114 | -2.25 | .75 | -38.09 | .74 | 69 | 25 | 3 |
| QUE | -1.733 | -4.77 | 3.07 | 50.73 | 1.13 | 143 | 51 | 3 |
| RAB | .695 | -2.12 | -1.52 | -17.13 | .80 | 41 | 10 | 2 |
| RES | -0.994 | -1.57 | -0.59 | 9.87 | .60 | 77 | 20 | 3 |
| RSL | -0.392 | -6.72 | .07 | -17.54 | .88 | 66 | 19 | 2 |
| SAM | -1.065 | 1.27 | 5.10 | 58.04 | 1.67 | 68 | 25 | 3 |
| SDB | -0.274 | -1.12 | -1.84 | 30.68 | .46 | 44 | 21 | 3 |
| SEH | -2.086 | 12.98 | -16.30 | 91.86 | 1.60 | 24 | 9 | 3 |
| SEM | -1.070 | 3.43 | -0.86 | -87.64 | .76 | 94 | 31 | 2 |
| SHI | -0.534 | 1.74 | -5.08 | -9.23 | .58 | 107 | 31 | 3 |
| SHK | -0.503 | -5.74 | -12.31 | -12.42 | .52 | 25 | 9 | 2 |
| SHL | -1.090 | -2.22 | 11.46 | -70.91 | .81 | 132 | 36 | 3 |
| SIM | .340 | -8.34 | -0.01 | -51.28 | .57 | 50 | 18 | 3 |
| SKA | -0.192 | -3.33 | -4.72 | 1.98 | .35 | 38 | 4 | 2 |
| SOD | -0.273 | -2.48 | -2.65 | 3.15 | .63 | 153 | 42 | 2 |
| SSC | -0.484 | -3.70 | -2.46 | -7.46 | .41 | 70 | 24 | 3 |
| SSF | -0.[illegible]45 | -5.24 | -1.52 | -0.23 | .39 | 96 | 27 | 2 |
| STR | [illegible]20 | -5.16 | .19 | -27.01 | 1.00 | 42 | 14 | 3 |
| STJ | -0.075 | -5.24 | -2.54 | -10.68 | .31 | 51 | 15 | 3 |
| SVE | .161 | -1.20 | -3.36 | -10.43 | .50 | 114 | 40 | 2 |
| TAB | 2.235 | -7.72 | -11.64 | -39.04 | 1.48 | 54 | 17 | 2 |
| TAM | -1.103 | -0.11 | .10 | 6.79 | .70 | 47 | 15 | 2 |
| TAS | -1.601 | -6.26 | 3.73 | 50.38 | 1.73 | 111 | 40 | 3 |
| TEH | .895 | -8.05 | -3.04 | -34.37 | 1.09 | 58 | 22 | 3 |
| TFO | 1.685 | -5.46 | -4.46 | -81.89 | .63 | 52 | 16 | 2 |
| TIK | -1.386 | -0.57 | -3.98 | -19.04 | .45 | 116 | 42 | 2 |
| TOL | -0.415 | -4.19 | .40 | -6.60 | .56 | 40 | 12 | 2 |
| TOO | .153 | .29 | -0.38 | -37.81 | .52 | 69 | 20 | 3 |
| TRI | -0.667 | 1.46 | -4.97 | 29.10 | .31 | 43 | 13 | 2 |
| TRO | -0.203 | -2.80 | -2.98 | 2.38 | .39 | 112 | 32 | 3 |
| UBO | .328 | -16.22 | 7.19 | -82.99 | 2.16 | 63 | 14 | 2 |
| UME | -0.473 | -1.94 | -3.29 | 8.96 | .38 | 125 | 34 | 3 |
| UPP | -0.559 | -4.62 | -1.68 | -32.52 | .40 | 160 | 49 | 2 |
| UZH | .053 | -0.58 | -4.69 | 45.71 | .65 | 117 | 40 | 2 |
| VAN | .208 | -6.42 | 14.53 | -97.37 | 1.11 | 90 | 32 | 3 |

TABLE 1 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 1

REF LAT = 32.00 N REF LONG = 85.00 E X AZI = 17 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| VLA | .498 | -0.56 | -5.98 | -36.54 | 1.08 | 74 | 25 | 3 |
| VRI | .032 | 2.59 | -3.35 | 45.00 | .62 | 27 | 6 | 2 |
| WIT | 1.331 | -8.17 | .88 | -85.23 | 1.22 | 30 | 8 | 2 |
| WLS | .062 | -7.14 | -12.20 | 39.08 | .35 | 40 | 13 | 3 |
| WRA | -0.791 | -1.85 | -1.95 | 24.15 | .50 | 91 | 34 | 2 |
| WRS | -1.792 | -10.65 | -9.53 | 55.89 | 1.34 | 87 | 30 | 3 |
| YAK | -0.528 | .37 | -5.35 | -16.79 | .78 | 97 | 32 | 3 |
| YKC | -1.295 | -1.11 | -1.79 | 4.15 | .47 | 90 | 37 | 3 |
| YSS | .527 | -3.14 | -5.52 | -40.80 | .46 | 65 | 18 | 2 |
| ZAK | .454 | -3.51 | -4.23 | 45.98 | .34 | 68 | 27 | 2 |

TABLE 2 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 2

REF LAT = 35.00 N REF LONG = 102.00 E X AZ = 0 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| AAB | 1.416 | 2.62 | -1.30 | -38.03 | .74 | 156 | 41 | 2 |
| ADE | -0.683 | -3.76 | -2.25 | 12.51 | .51 | 66 | 15 | 3 |
| ALE | -0.410 | -4.04 | 3.10 | -10.98 | .64 | 106 | 29 | 3 |
| ANP | 2.404 | -8.04 | -5.71 | 13.78 | 1.88 | 35 | 13 | 3 |
| APA | .205 | -9.80 | -0.93 | -6.96 | .70 | 77 | 22 | 3 |
| ASH | .752 | 11.64 | 5.64 | -52.62 | 1.01 | 44 | 9 | 2 |
| ASP | -0.971 | -1.74 | .84 | 22.09 | .26 | 56 | 13 | 3 |
| AVE | .036 | -5.53 | -1.30 | -1.10 | .97 | 44 | 12 | 2 |
| BAG | 1.364 | -3.88 | 7.19 | -49.48 | .93 | 83 | 25 | 3 |
| BER | -0.001 | -3.10 | -4.59 | 15.86 | .79 | 36 | 9 | 3 |
| BHA | -1.690 | -5.38 | -3.99 | 25.03 | .55 | 95 | 22 | 2 |
| BKR | 1.194 | -3.18 | -1.67 | -14.63 | .64 | 134 | 39 | 2 |
| BLC | -2.001 | -3.00 | -2.06 | 21.39 | .57 | 59 | 25 | 2 |
| BMO | -0.612 | -0.17 | -0.06 | 33.60 | .67 | 96 | 43 | 2 |
| BNG | -1.894 | -6.95 | -4.55 | -35.25 | .76 | 104 | 19 | 3 |
| BNS | .095 | -8.22 | -1.64 | 44.07 | .82 | 38 | 13 | 2 |
| BOD | -0.800 | .43 | 1.28 | -24.34 | .61 | 112 | 34 | 2 |
| BRA | .486 | -6.75 | -0.69 | -24.25 | 1.21 | 43 | 10 | 3 |
| BRS | -0.600 | -5.26 | 1.14 | 36.54 | 1.00 | 81 | 20 | 3 |
| BRW | 1.041 | -11.62 | -5.60 | -29.71 | .47 | 42 | 11 | 3 |
| BUL | -1.393 | -4.99 | -4.12 | -16.99 | .65 | 149 | 34 | 3 |
| CAN | -0.264 | -3.58 | 1.76 | 10.23 | .52 | 85 | 19 | 3 |
| CIN | -0.003 | -7.61 | .03 | -29.28 | .96 | 28 | 7 | 3 |
| CIR | -1.029 | -4.76 | 1.20 | -12.50 | .68 | 61 | 10 | 3 |
| CLK | -1.088 | -7.37 | -3.92 | -8.02 | .72 | 92 | 17 | 2 |
| CLL | -0.538 | -3.75 | -2.37 | 3.30 | .37 | 146 | 42 | 3 |
| CMC | -1.786 | 5.16 | -5.85 | -52.93 | .27 | 35 | 12 | 2 |
| CMP | 1.528 | -0.81 | .99 | -46.95 | 1.36 | 42 | 12 | 3 |
| COL | -0.526 | -7.97 | -0.27 | 12.41 | .35 | 182 | 54 | 2 |
| COP | 1.005 | -2.07 | -0.18 | -4.28 | .89 | 41 | 13 | 3 |
| CTA | -0.875 | -3.31 | -0.39 | 7.06 | .43 | 115 | 25 | 3 |
| DAR | -1.317 | -6.16 | -11.67 | 23.22 | .91 | 45 | 9 | 3 |
| DAV | 1.701 | -4.97 | -4.02 | -26.08 | 1.12 | 47 | 14 | 3 |
| DDI | -1.602 | -3.72 | 7.52 | 44.65 | .32 | 31 | 4 | 3 |
| DSH | .660 | -8.60 | -1.52 | -51.39 | 1.31 | 106 | 29 | 3 |
| EDM | -0.321 | -1.71 | .19 | -18.31 | .48 | 98 | 37 | 3 |
| EIL | -0.968 | -12.28 | -3.26 | 53.15 | .51 | 44 | 15 | 2 |
| EKA | .100 | -6.73 | -3.19 | -20.32 | .90 | 63 | 12 | 3 |
| ELT | -0.765 | -3.53 | -6.05 | 24.13 | .78 | 98 | 26 | 3 |
| ESK | -0.057 | -7.37 | -3.90 | 10.17 | .96 | 48 | 17 | 3 |
| FBC | -1.828 | -2.49 | -1.14 | 3.60 | .57 | 61 | 15 | 3 |
| FFC | -1.728 | -4.90 | -2.85 | 3.91 | .47 | 79 | 32 | 2 |
| FLN | -0.393 | .87 | .75 | -20.45 | .66 | 55 | 17 | 3 |
| FRJ | .467 | -0.90 | -0.27 | 12.93 | .76 | 120 | 35 | 3 |
| FSJ | -0.330 | -8.35 | -3.06 | 58.67 | .71 | 51 | 17 | 2 |
| FUR | .115 | -2.78 | -2.49 | -9.81 | .50 | 95 | 23 | 2 |
| GAR | -0.715 | -3.10 | 4.12 | -17.85 | .85 | 115 | 34 | 3 |
| GBA | -0.471 | 2.42 | -1.06 | 18.65 | .78 | 63 | 13 | 3 |
| GDH | -0.572 | -4.77 | 1.61 | -8.81 | .67 | 43 | 14 | 3 |
| GIL | -0.896 | -5.09 | -0.68 | 16.88 | .33 | 107 | 29 | 3 |

TABLE 2 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 2

REF LAT = 35.00 N REF LONG = 102.00 E X AZI = 0 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| GRF | .198 | -5.10 | -1.39 | 15.00 | .35 | 85 | 24 | 2 |
| GRR | -0.599 | -3.05 | .08 | 25.54 | .31 | 57 | 13 | 2 |
| GRS | .038 | -2.05 | 1.25 | 8.53 | .80 | 83 | 29 | 3 |
| HFS | -0.644 | -3.35 | -4.47 | -18.93 | .83 | 87 | 20 | 2 |
| HHM | -0.810 | 5.38 | 4.22 | 10.31 | 1.10 | 45 | 32 | 2 |
| HKC | -0.370 | -13.69 | -4.49 | 26.89 | 1.12 | 81 | 21 | 2 |
| HYB | -0.060 | -1.56 | 2.24 | -17.14 | .79 | 80 | 13 | 2 |
| IFR | -0.294 | -1.33 | 1.73 | -11.08 | .62 | 115 | 27 | 3 |
| ILT | -1.132 | -6.47 | -3.21 | -1.01 | .28 | 81 | 18 | 2 |
| INK | -1.095 | -4.65 | -1.50 | 10.50 | .38 | 83 | 22 | 2 |
| ISK | -0.208 | .07 | 1.53 | -31.47 | .69 | 41 | 9 | 2 |
| ISO | -0.323 | -5.74 | -1.13 | 2.73 | 1.27 | 34 | 9 | 3 |
| IST | .171 | -2.27 | -1.45 | -7.39 | .71 | 49 | 14 | 3 |
| JER | .493 | -3.87 | -1.11 | -2.22 | .52 | 83 | 24 | 3 |
| KAS | -0.164 | -2.83 | .11 | 13.83 | .75 | 73 | 20 | 3 |
| KAT | 1.664 | -6.93 | .97 | -16.76 | 1.06 | 73 | 21 | 3 |
| KBL | .029 | -3.11 | 4.19 | -22.11 | .45 | 95 | 25 | 3 |
| KDC | -1.396 | -3.09 | -0.29 | 14.33 | .29 | 49 | 17 | 3 |
| KEV | -0.225 | -6.59 | -1.79 | 25.24 | .65 | 118 | 28 | 2 |
| KHC | .081 | -6.18 | -2.03 | -5.81 | .37 | 152 | 37 | 3 |
| KHE | .290 | -4.57 | -2.42 | -9.56 | .61 | 94 | 25 | 2 |
| KHO | .092 | -2.95 | 1.95 | 6.64 | .96 | 117 | 32 | 3 |
| KTR | -0.555 | -9.47 | -1.57 | 32.55 | .59 | 147 | 37 | 2 |
| KIS | -0.146 | -0.81 | 9.40 | -13.47 | .67 | 46 | 12 | 3 |
| KJN | -0.989 | -1.54 | -1.39 | 22.70 | .50 | 143 | 37 | 3 |
| KLG | -1.446 | -3.15 | -0.46 | 36.73 | .48 | 60 | 20 | 2 |
| KOD | -0.067 | .05 | -1.89 | 33.54 | .53 | 69 | 17 | 3 |
| KON | -0.026 | -8.04 | -1.05 | 11.35 | .97 | 75 | 17 | 3 |
| KRA | -0.036 | -4.19 | -0.43 | -8.04 | .76 | 86 | 27 | 3 |
| KRK | .053 | -1.93 | -0.49 | 20.37 | .55 | 32 | 9 | 3 |
| KRR | -1.716 | -9.13 | -3.15 | 25.03 | .35 | 82 | 15 | 2 |
| KRV | -0.365 | -4.11 | -0.59 | 5.00 | .70 | 101 | 25 | 3 |
| KSA | .648 | -7.17 | -8.50 | -23.41 | 1.50 | 37 | 11 | 3 |
| KTG | -0.213 | -7.09 | -6.14 | 37.75 | .64 | 42 | 11 | 3 |
| KUL | .211 | -4.58 | 2.88 | -7.78 | .26 | 27 | 6 | 3 |
| LAH | -1.358 | -4.79 | 12.08 | 57.02 | .95 | 49 | 11 | 2 |
| LHN | -0.439 | -1.78 | -0.52 | -14.54 | .59 | 42 | 15 | 2 |
| LUJ | -0.436 | -0.24 | -0.35 | -7.24 | .66 | 66 | 16 | 3 |
| LNS | -0.781 | -5.24 | -0.10 | 18.89 | .55 | 82 | 21 | 2 |
| LOR | -0.935 | -2.27 | -2.30 | 6.95 | .53 | 90 | 21 | 3 |
| LWI | -0.954 | -1.53 | -2.01 | 21.54 | .34 | 61 | 10 | 3 |
| MAG | .199 | 4.37 | -1.90 | -64.89 | .96 | 47 | 19 | 2 |
| MAT | -0.632 | -10.89 | 7.18 | 17.82 | .83 | 103 | 29 | 3 |
| MBC | -0.884 | -3.01 | -1.29 | -10.49 | .53 | 161 | 47 | 3 |
| MDR | 3.035 | -16.81 | 2.12 | -57.24 | 2.33 | 35 | 9 | 3 |
| MNY | -0.945 | -0.52 | .67 | 29.42 | .66 | 41 | 15 | 3 |
| MOS | .075 | 3.95 | .05 | -68.35 | .73 | 118 | 35 | 2 |
| MOX | -0.255 | -6.04 | -1.98 | 10.71 | .61 | 154 | 38 | 2 |
| MOY | 1.192 | -16.70 | -3.77 | 34.57 | .63 | 69 | 19 | 2 |
| MSH | 1.166 | -4.36 | -2.16 | 26.89 | 1.51 | 49 | 15 | 3 |

TABLE 2  SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 2

REF LAT = 35.00 N  REF LONG = 102.00 E  X AZI = 0 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| MUN | -0.780 | -2.31 | 1.34 | -9.23 | .39 | 77 | 18 | 3 |
| NAI | -0.017 | -14.94 | -0.81 | 97.20 | .82 | 64 | 28 | 2 |
| NDI | -1.804 | 2.68 | 8.33 | -42.02 | .88 | 153 | 42 | 2 |
| NEW | -0.103 | 3.00 | -1.43 | -34.92 | .33 | 50 | 31 | 2 |
| NIE | -0.022 | -1.47 | -1.58 | -6.94 | .65 | 88 | 25 | 3 |
| NIL | -0.301 | -1.99 | 12.73 | -19.67 | .81 | 41 | 9 | 3 |
| NP- | -0.802 | -2.47 | -2.36 | -5.97 | .19 | 39 | 11 | 2 |
| NOR | -0.956 | -6.11 | .05 | 10.97 | .47 | 77 | 16 | 2 |
| NUR | -0.757 | -1.48 | -2.04 | 16.67 | .47 | 171 | 49 | 3 |
| OBN | -0.933 | -1.16 | -1.64 | 8.30 | .36 | 74 | 15 | 3 |
| OUL | -1.122 | -2.62 | -2.10 | 25.18 | .52 | 91 | 22 | 3 |
| PLV | 5.424 | -42.71 | -10.93 | -66.43 | 1.75 | 34 | 9 | 3 |
| PMG | -0.048 | -0.46 | -0.59 | -18.57 | .73 | 84 | 20 | 2 |
| PMR | -1.497 | -5.48 | -0.83 | 14.87 | .40 | 113 | 32 | 3 |
| PNT | -0.393 | .91 | .48 | -24.82 | .79 | 61 | 29 | 2 |
| POO | -0.936 | -2.24 | -3.59 | 29.09 | .54 | 102 | 22 | 3 |
| PRA | .970 | -3.57 | .55 | -28.10 | .59 | 51 | 11 | 2 |
| PRE | -1.018 | -4.32 | -2.85 | 8.37 | .57 | 57 | 9 | 3 |
| PRJ | .124 | -5.15 | -1.22 | -6.85 | .45 | 155 | 38 | 3 |
| PRZ | .259 | 5.86 | 2.96 | 3.09 | .58 | 68 | 16 | 2 |
| PUL | -0.104 | -5.89 | -1.21 | 26.05 | .59 | 69 | 15 | 2 |
| QUE | -0.428 | -4.27 | -1.96 | 3.94 | .68 | 154 | 38 | 3 |
| RAB | .905 | -7.03 | 1.29 | 20.71 | .48 | 54 | 18 | 3 |
| RES | -0.799 | -4.14 | -3.07 | 4.55 | .59 | 100 | 31 | 2 |
| RSL | -0.422 | -6.87 | -3.65 | 12.63 | .74 | 60 | 17 | 3 |
| SAM | -0.528 | .58 | -2.96 | 38.23 | .65 | 67 | 13 | 3 |
| SEM | -1.471 | 4.08 | 5.27 | 30.62 | .64 | 93 | 22 | 3 |
| SHI | -0.939 | -8.74 | .45 | 29.97 | .51 | 117 | 26 | 2 |
| SHK | -0.132 | -6.84 | 8.14 | .71 | .81 | 47 | 18 | 2 |
| SHL | -2.079 | 3.34 | -0.47 | 55.64 | .70 | 144 | 39 | 3 |
| SIM | .305 | -3.40 | 2.76 | -28.15 | 1.28 | 49 | 16 | 3 |
| SKA | -0.914 | -12.59 | -5.50 | 63.20 | .61 | 39 | 7 | 2 |
| SOD | -0.714 | -3.89 | -1.63 | 16.69 | .52 | 182 | 48 | 3 |
| SSC | -0.660 | -5.94 | .01 | 42.14 | .55 | 58 | 14 | 2 |
| SSF | -0.619 | -2.40 | -1.15 | -7.01 | .36 | 94 | 22 | 3 |
| STR | .732 | -11.26 | -0.49 | 65.14 | 1.03 | 45 | 10 | 2 |
| STJ | -0.024 | -6.13 | -1.00 | -17.59 | .43 | 53 | 7 | 3 |
| SVE | -0.056 | -2.14 | .49 | -2.06 | .61 | 121 | 29 | 2 |
| TAB | 1.011 | -4.32 | -0.94 | -5.11 | .33 | 58 | 13 | 3 |
| TAM | -0.750 | -1.45 | 3.61 | 11.75 | .46 | 45 | 15 | 3 |
| TAS | .220 | 2.58 | 3.41 | -35.13 | .87 | 115 | 34 | 2 |
| TIF | .331 | -1.87 | 5.07 | 19.63 | 1.60 | 36 | 13 | 3 |
| TIK | -1.840 | -1.32 | .24 | -14.71 | .57 | 135 | 38 | 2 |
| TOL | .253 | -4.04 | 1.78 | 2.20 | .46 | 49 | 14 | 3 |
| TOO | -0.197 | -6.28 | -1.95 | 7.19 | .53 | 83 | 22 | 3 |
| TRI | -1.580 | -4.56 | -2.77 | 19.72 | .42 | 47 | 12 | 2 |
| TRO | -0.430 | -5.46 | -2.61 | 18.21 | .75 | 112 | 23 | 3 |
| UBO | .151 | 3.11 | -4.06 | 13.46 | 1.47 | 71 | 24 | 3 |
| UME | -0.942 | -4.10 | -2.84 | 15.54 | .55 | 144 | 37 | 3 |
| UPP | -1.011 | -3.16 | -2.19 | 13.53 | .44 | 176 | 43 | 3 |

TABLE 2 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 2

REF LAT = 35.00 N REF LONG = 102.00 E X AZI = 0 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| UZH | .078 | -3.91 | -1.69 | -32.27 | .83 | 121 | 27 | 3 |
| VAN | .793 | -10.18 | -2.39 | 9.63 | .66 | 95 | 25 | 3 |
| VLA | .828 | -6.92 | 6.01 | -59.56 | 1.10 | 93 | 23 | 2 |
| VRI | -0.301 | .70 | 3.03 | 5.82 | .65 | 31 | 8 | 3 |
| WAB | .999 | -8.03 | 4.59 | 61.74 | .25 | 31 | 4 | 2 |
| WIT | .797 | -2.83 | -9.11 | 17.19 | .73 | 38 | 11 | 3 |
| WLS | -0.530 | -4.76 | .40 | 11.99 | .46 | 53 | 10 | 2 |
| WRA | -1.244 | -5.00 | -3.90 | 15.57 | .51 | 105 | 26 | 3 |
| WRS | -0.491 | -4.56 | 6.44 | -10.77 | .86 | 93 | 23 | 3 |
| YAK | -0.856 | -7.57 | -0.67 | -10.50 | 1.11 | 104 | 27 | 3 |
| YKC | -1.408 | -1.63 | -0.87 | -3.81 | .59 | 104 | 41 | 3 |
| YSS | -0.408 | -3.74 | .03 | 35.83 | .93 | 82 | 22 | 3 |
| ZAK | .540 | -13.51 | -3.30 | 43.28 | .69 | 86 | 18 | 2 |

TABLE 3 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 3

REF LAT = 25.00 N REF LONG = 95.00 E X AZI = 103 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| AAB | 1.239 | -0.0028 | -3.74 | -17.58 | .65 | 163 | 66 | 4 |
| AAE | 3.582 | -0.0544 | 11.17 | 5.65 | 2.15 | 45 | 11 | 4 |
| ADE | -1.058 | 3.31 | -1.40 | 15.52 | .44 | 71 | 39 | 2 |
| ALE | -1.507 | -1.98 | -4.42 | -12.28 | .42 | 113 | 41 | 2 |
| ANP | .397 | .0088 | -7.72 | 81.69 | 1.89 | 37 | 13 | 4 |
| ANR | .227 | -3.23 | -1.30 | -25.96 | .50 | 37 | 9 | 2 |
| APA | -1.038 | 1.92 | -5.51 | -29.24 | .48 | 80 | 32 | 2 |
| ASH | .882 | -1.89 | 3.47 | 31.62 | .74 | 49 | 12 | 3 |
| ASP | -1.112 | 3.65 | -0.89 | .0045 | .31 | 63 | 12 | 1 |
| AVE | -0.571 | -0.0097 | 6.07 | 78.06 | .87 | 51 | 19 | 4 |
| BHA | -1.789 | 4.88 | .0151 | -0.0001 | .80 | 103 | 46 | 6 |
| BKR | .536 | 4.75 | -3.86 | .0039 | .54 | 134 | 52 | 1 |
| BLC | -2.263 | .64 | -1.51 | 20.70 | .53 | 53 | 17 | 2 |
| BMO | .708 | 3.70 | 9.25 | 12.20 | 2.72 | 93 | 24 | 3 |
| BNG | -2.752 | 3.18 | .0117 | -0.0001 | .83 | 117 | 40 | 6 |
| BNS | 1.478 | -0.0664 | 4.09 | .0003 | 1.00 | 42 | 4 | 5 |
| BOD | -1.240 | 2.15 | -3.56 | -11.50 | .74 | 116 | 37 | 3 |
| BOM | -0.311 | 3.12 | -4.91 | 49.98 | 1.44 | 39 | 24 | 2 |
| BRA | 1.187 | -0.0743 | 6.31 | .0003 | 1.58 | 47 | 8 | 5 |
| BRS | -0.802 | -0.0056 | 1.90 | 20.17 | .84 | 85 | 41 | 4 |
| BRW | -0.997 | 5.54 | -10.58 | .0071 | .70 | 40 | 16 | 1 |
| BUL | -1.838 | 3.68 | .0129 | -0.0001 | .69 | 159 | 59 | 6 |
| CAL | 3.841 | -0.0779 | 10.99 | .0002 | 2.43 | 36 | 22 | 5 |
| CAN | -0.758 | 2.18 | -0.0071 | 19.92 | .79 | 90 | 38 | 7 |
| CHG | -0.955 | -5.16 | -18.64 | -0.0072 | 1.92 | 76 | 39 | 1 |
| CHT | .922 | -10.02 | -0.0362 | 99.27 | 1.66 | 48 | 22 | 7 |
| CIR | -1.595 | 2.92 | -0.0029 | 30.78 | .95 | 66 | 30 | 7 |
| CLK | -1.323 | 6.50 | -0.45 | -11.68 | .79 | 102 | 47 | 2 |
| CLL | -1.105 | 3.25 | -4.86 | 5.21 | .46 | 150 | 47 | 2 |
| CMC | -1.772 | 5.90 | -5.66 | -0.0029 | .56 | 36 | 18 | 1 |
| CMP | 1.257 | -9.17 | -0.0484 | .0003 | 1.85 | 43 | 16 | 6 |
| COL | -1.293 | 3.14 | -4.93 | -17.25 | .42 | 183 | 70 | 3 |
| COP | .999 | -3.78 | -0.0031 | -28.71 | 1.47 | 43 | 13 | 7 |
| CTA | -1.223 | 2.16 | -0.59 | 8.95 | .39 | 123 | 49 | 3 |
| DAR | -0.210 | 9.00 | -0.0445 | .0003 | 1.25 | 52 | 20 | 6 |
| DAV | .669 | .0030 | 3.49 | 76.19 | .95 | 47 | 17 | 4 |
| DOJ | 1.147 | -0.0625 | .14 | .0005 | 2.25 | 52 | 18 | 5 |
| DSH | -0.550 | -0.21 | -0.0040 | -1.81 | .96 | 115 | 48 | 7 |
| EDM | -1.338 | -1.19 | -10.14 | -23.60 | .53 | 88 | 19 | 3 |
| EIL | -1.243 | 4.58 | -0.0060 | 21.61 | .87 | 49 | 16 | 7 |
| EKA | -0.285 | -0.30 | -0.0055 | -22.14 | .72 | 75 | 32 | 7 |
| ELT | -0.897 | 5.43 | -5.23 | -23.60 | .68 | 108 | 34 | 2 |
| ESK | -1.057 | .0017 | -1.99 | 19.33 | .50 | 52 | 21 | 4 |
| EUR | 1.527 | -0.0071 | -8.64 | -61.40 | 1.03 | 32 | 18 | 4 |
| FBC | -1.822 | 5.36 | -0.0047 | .0001 | .58 | 64 | 38 | 6 |
| FFC | -2.678 | 3.93 | -7.39 | .0036 | .82 | 73 | 16 | 1 |
| FLN | -1.056 | .0199 | -1.28 | -0.0001 | 1.04 | 59 | 23 | 5 |
| FRJ | .852 | 3.58 | .42 | -0.0043 | .76 | 122 | 43 | 1 |
| FSJ | -0.278 | .98 | -0.0054 | .0000 | .63 | 42 | 17 | 6 |
| FUR | -0.450 | -0.31 | .50 | 45.91 | .92 | 96 | 30 | 3 |

TABLE 3 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 3

REF LAT = 25.00 N REF LONG = 95.00 E X AZI = 103 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| GAR | -1.416 | -7.40 | .0047 | -59.17 | .77 | 120 | 55 | 7 |
| GBA | .066 | -1.66 | .0104 | -0.0001 | .91 | 71 | 26 | 6 |
| GDH | -1.296 | 1.99 | -2.22 | 20.29 | .95 | 47 | 16 | 2 |
| GIL | -1.340 | 4.59 | -3.09 | -0.0017 | .34 | 111 | 42 | 1 |
| GRF | -0.303 | 2.89 | -2.79 | 16.10 | .65 | 39 | 23 | 2 |
| GRR | -0.983 | -3.81 | .0016 | 16.09 | .42 | 67 | 25 | 7 |
| GRS | -0.462 | -0.0033 | -5.17 | -13.50 | .78 | 80 | 28 | 4 |
| HFS | -1.040 | 4.20 | -4.02 | -10.06 | .76 | 94 | 24 | 2 |
| HHM | -0.956 | -2.34 | -13.96 | -88.40 | .82 | 32 | 7 | 3 |
| HKC | -0.936 | 7.03 | .0150 | -50.45 | 1.95 | 89 | 34 | 7 |
| HYB | -1.827 | -8.20 | -11.83 | -0.0014 | .84 | 92 | 35 | 1 |
| IFR | -0.729 | -0.49 | .73 | 29.17 | .41 | 124 | 46 | 2 |
| ILT | -1.812 | 5.39 | -5.12 | 2.55 | .51 | 88 | 27 | 2 |
| INK | -1.521 | 3.16 | -2.42 | 5.78 | .45 | 84 | 26 | 2 |
| IRK | .442 | .0015 | -4.96 | -47.74 | .78 | 100 | 22 | 4 |
| ISK | -0.407 | -0.0123 | 4.29 | 23.14 | 1.02 | 42 | 18 | 4 |
| ISO | -1.364 | -2.78 | -6.20 | 43.89 | .80 | 42 | 20 | 2 |
| JER | .004 | 3.71 | -1.51 | 24.29 | .43 | 90 | 37 | 2 |
| KAS | -0.974 | 2.84 | -5.61 | .0103 | .74 | 79 | 37 | 1 |
| KAT | .860 | -0.0242 | -5.18 | .0001 | 1.16 | 74 | 29 | 5 |
| KBL | -0.401 | -3.78 | .03 | -53.70 | .48 | 105 | 35 | 2 |
| KDC | -1.901 | 4.65 | -2.92 | 35.80 | .37 | 53 | 19 | 2 |
| KEV | -0.661 | 3.14 | -2.11 | .0026 | .62 | 132 | 43 | 1 |
| KHC | -0.884 | 2.05 | -6.29 | -7.58 | .49 | 161 | 60 | 2 |
| KHE | -0.361 | 6.99 | -5.18 | 10.33 | .61 | 101 | 45 | 2 |
| KHO | -0.234 | -7.75 | -3.44 | -92.91 | .90 | 129 | 46 | 2 |
| KIR | -1.240 | 3.16 | -3.42 | .0036 | .45 | 148 | 56 | 1 |
| KIS | -1.076 | -1.77 | -0.0042 | 85.16 | .78 | 48 | 19 | 7 |
| KJN | -0.952 | 3.50 | -4.68 | -32.20 | .47 | 138 | 59 | 3 |
| KLG | -1.144 | -0.0032 | .17 | -13.85 | .46 | 58 | 23 | 4 |
| KOD | .444 | 7.85 | -8.97 | -91.97 | .95 | 78 | 35 | 3 |
| KON | -0.764 | 4.62 | -7.92 | -49.74 | .86 | 89 | 32 | 2 |
| KRA | -1.061 | -0.61 | -4.85 | 21.89 | .51 | 89 | 25 | 2 |
| KRK | -0.120 | 2.26 | -3.48 | -21.80 | .47 | 35 | 15 | 2 |
| KRR | -2.293 | 4.63 | -1.40 | .0037 | .55 | 88 | 39 | 1 |
| KRV | -1.187 | 1.98 | -5.16 | .0053 | .71 | 106 | 36 | 1 |
| KTG | -0.107 | 5.52 | -0.0128 | .0001 | .68 | 51 | 17 | 6 |
| KUL | -1.553 | .0121 | -6.92 | -0.0001 | .90 | 28 | 7 | 5 |
| LAH | -1.592 | -3.52 | -0.0003 | 39.09 | 2.05 | 62 | 23 | 7 |
| LHN | -1.087 | 1.66 | -6.88 | -0.0023 | .56 | 39 | 19 | 1 |
| LUJ | -0.852 | -1.15 | .0171 | -0.0001 | .62 | 74 | 31 | 6 |
| LNS | -1.133 | -0.84 | -0.0006 | -0.0000 | .63 | 81 | 24 | 6 |
| LOR | -1.338 | -0.25 | -3.96 | -0.0021 | .63 | 101 | 44 | 1 |
| LWI | -0.885 | .0059 | .58 | -0.0000 | .71 | 74 | 26 | 5 |
| MAG | .602 | -1.09 | -0.0500 | .0002 | 1.90 | 46 | 8 | 6 |
| MAT | -1.178 | -0.0348 | 1.64 | .0001 | 1.30 | 112 | 31 | 5 |
| MBC | -1.412 | 1.49 | -3.03 | 6.62 | .46 | 162 | 64 | 2 |
| MDR | -0.354 | -0.0514 | -21.70 | .0003 | 1.85 | 41 | 18 | 5 |
| MNL | .114 | -8.80 | -0.0112 | -43.74 | 1.40 | 31 | 15 | 7 |
| MNY | .011 | -1.26 | -0.0552 | .0003 | 1.22 | 41 | 8 | 6 |

TABLE 3 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 3

REF LAT = 25.00 N REF LONG = 95.00 E X AZI = 103 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| MOS | -0.807 | 1.41 | -7.08 | 11.44 | .92 | 120 | 32 | 2 |
| MOX | -0.777 | 1.86 | -2.98 | -0.0025 | .53 | 163 | 59 | 1 |
| MOY | -0.060 | 4.27 | -5.41 | -16.42 | .74 | 73 | 18 | 2 |
| MSH | .680 | -0.0125 | -1.18 | 53.90 | 1.04 | 49 | 14 | 4 |
| MUN | -1.456 | -3.21 | -3.28 | -0.0019 | .42 | 82 | 48 | 1 |
| NAI | .336 | 4.07 | -5.27 | -82.09 | 1.02 | 56 | 18 | 3 |
| NEW | .631 | .16 | -0.0126 | -62.69 | 1.63 | 35 | 5 | 7 |
| NIE | -0.354 | .55 | -2.91 | 14.56 | .66 | 92 | 36 | 2 |
| NIL | -1.926 | -11.87 | .0124 | -0.0001 | .69 | 45 | 13 | 6 |
| NP- | -1.150 | 2.68 | -3.81 | -9.29 | .29 | 36 | 15 | 2 |
| NOR | -1.799 | 3.80 | -4.40 | 22.62 | .47 | 88 | 38 | 2 |
| NUR | -0.901 | 2.31 | -3.72 | -7.38 | .47 | 175 | 63 | 2 |
| OBN | -0.987 | 1.48 | -0.0056 | 11.78 | .65 | 83 | 22 | 7 |
| OUL | -1.283 | 5.40 | .0141 | -0.0001 | .71 | 88 | 38 | 6 |
| PBA | -4.009 | 12.32 | -33.65 | .0361 | 2.15 | 28 | 14 | 1 |
| PMG | -0.642 | 1.23 | -4.04 | -8.43 | .40 | 90 | 38 | 2 |
| PMR | -1.956 | 5.35 | -2.33 | 9.71 | .36 | 115 | 45 | 2 |
| PNT | -0.150 | 1.44 | 1.87 | -0.0073 | .94 | 53 | 10 | 1 |
| POO | -0.823 | .0067 | -1.80 | -0.0000 | 1.47 | 112 | 47 | 5 |
| PRA | .734 | -0.0353 | -1.49 | .0002 | 1.02 | 58 | 12 | 5 |
| PRE | -1.206 | 6.67 | -4.42 | -0.0009 | .61 | 67 | 28 | 1 |
| PRJ | -0.545 | 1.82 | -3.44 | -3.08 | .58 | 164 | 62 | 3 |
| PRZ | .953 | -4.67 | 3.60 | -0.0083 | .69 | 74 | 19 | 1 |
| PUL | -0.637 | -0.25 | -2.00 | 22.62 | .73 | 76 | 24 | 2 |
| QUE | -0.822 | 1.35 | -4.94 | -51.18 | .78 | 162 | 58 | 2 |
| RAB | .208 | -0.0072 | -2.07 | .0001 | .86 | 56 | 15 | 5 |
| RES | -1.254 | 2.64 | -6.55 | -31.48 | .54 | 104 | 39 | 3 |
| RSL | -1.109 | 4.44 | -6.91 | -0.0032 | 1.12 | 67 | 26 | 1 |
| SAM | .186 | 3.90 | -0.0036 | -0.0001 | 1.29 | 77 | 24 | 6 |
| SDB | .033 | 2.37 | -0.0073 | -19.09 | .65 | 44 | 16 | 7 |
| SEM | -1.144 | -1.52 | -0.0011 | .0000 | .63 | 101 | 42 | 6 |
| SHI | -1.866 | .0054 | -7.03 | -37.21 | .75 | 121 | 57 | 4 |
| SHK | -2.035 | -5.76 | -0.0006 | 62.86 | .84 | 38 | 7 | 7 |
| SHL | -0.384 | -0.0288 | -2.43 | -25.75 | 1.54 | 149 | 53 | 4 |
| SIM | -0.767 | 1.18 | -4.83 | 8.18 | 1.03 | 50 | 19 | 3 |
| SKA | -1.182 | 3.65 | -4.64 | -36.12 | .40 | 45 | 25 | 3 |
| SOD | -0.953 | 3.79 | -3.49 | -13.64 | .56 | 185 | 72 | 2 |
| SSC | -1.064 | -3.04 | -1.77 | 28.01 | .46 | 69 | 26 | 2 |
| SSF | -1.299 | .25 | -4.23 | 10.62 | .42 | 107 | 45 | 2 |
| STR | .748 | -0.0249 | -1.13 | .0001 | 1.32 | 50 | 14 | 5 |
| STJ | -1.018 | 2.30 | -2.94 | 39.48 | .41 | 58 | 25 | 3 |
| SVE | -0.080 | 3.21 | -0.0110 | .0001 | .81 | 130 | 53 | 6 |
| TAB | .110 | 2.69 | -5.84 | .0016 | .86 | 59 | 23 | 1 |
| TAM | -0.951 | -1.90 | -0.0029 | -16.87 | .55 | 49 | 20 | 7 |
| TAS | .221 | .16 | -0.0261 | .0002 | .92 | 121 | 43 | 6 |
| TEH | -0.507 | 4.70 | .49 | 95.56 | 1.84 | 58 | 23 | 3 |
| TFO | .559 | -3.82 | -0.0089 | 49.00 | 1.14 | 55 | 28 | 7 |
| TIF | .207 | 1.58 | 2.95 | 40.22 | .99 | 39 | 19 | 3 |
| TIK | -2.316 | 2.31 | -6.15 | -22.31 | .67 | 137 | 47 | 3 |
| TOL | -0.403 | -3.59 | 1.30 | 31.06 | .98 | 52 | 17 | 2 |

TABLE 3 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 3

REF LAT = 25.00 N REF LONG = 95.00 E X AZI = 103 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| TOO | -1.044 | 3.66 | -4.64 | 13.90 | .54 | 87 | 38 | 2 |
| TRI | -1.798 | 5.38 | .0036 | 44.36 | .50 | 49 | 15 | 7 |
| TRO | -0.616 | 3.24 | -0.0107 | .0000 | .60 | 127 | 51 | 6 |
| URO | -0.205 | .0101 | -15.09 | -0.0001 | 1.64 | 68 | 35 | 5 |
| UME | -1.032 | 3.77 | -2.54 | -24.09 | .33 | 145 | 59 | 2 |
| UPP | -1.452 | 2.94 | -4.53 | .0015 | .41 | 188 | 71 | 1 |
| UZH | -0.596 | -0.0001 | -0.28 | 25.28 | .65 | 130 | 48 | 4 |
| VAN | -0.254 | 4.73 | 5.40 | 89.07 | 1.05 | 101 | 37 | 3 |
| VIS | .576 | -1.68 | -0.0567 | .0002 | 2.38 | 28 | 11 | 6 |
| VLA | -1.126 | 4.76 | -9.31 | -0.0093 | 1.30 | 93 | 33 | 1 |
| VRI | .068 | -0.0241 | 1.43 | .0002 | .91 | 31 | 13 | 5 |
| WAB | .950 | -1.01 | 4.57 | 24.76 | .35 | 31 | 9 | 2 |
| WIT | 1.372 | 2.29 | -0.0320 | .0002 | 1.15 | 40 | 10 | 6 |
| WLS | -1.314 | 1.22 | -2.71 | 28.68 | .38 | 59 | 17 | 2 |
| WRA | -1.237 | 5.77 | -2.46 | -31.29 | .49 | 112 | 39 | 2 |
| YAK | -1.007 | 5.01 | -0.0314 | .0002 | .90 | 107 | 37 | 6 |
| YKC | -1.275 | 1.25 | -0.0126 | .0001 | .77 | 105 | 30 | 6 |
| YSS | -0.485 | 4.59 | -3.88 | -0.0091 | .90 | 82 | 30 | 1 |
| ZAK | -0.283 | 2.96 | -5.21 | -15.32 | .53 | 92 | 25 | 3 |

TABLE 4 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 4

REF LAT = 26.00 N REF LONG = 102.00 E X AZI = 80 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| AAB | .795 | 4.96 | -6.48 | -20.18 | .72 | 143 | 25 | 2 |
| AAE | 1.938 | -5.99 | 5.47 | 53.06 | 1.31 | 37 | 9 | 3 |
| ADE | -1.203 | 1.12 | -2.64 | 9.19 | .56 | 66 | 12 | 3 |
| ALE | -1.262 | -1.74 | -4.30 | -4.95 | .58 | 98 | 25 | 2 |
| ANR | .146 | 1.37 | 4.67 | 32.83 | .67 | 23 | 4 | 3 |
| APA | -1.293 | -2.10 | -7.98 | 29.60 | .70 | 69 | 15 | 2 |
| ASP | -1.294 | 4.75 | -1.82 | -14.61 | .57 | 48 | 15 | 2 |
| AVE | -0.456 | -5.02 | -0.92 | 5.31 | 1.20 | 43 | 7 | 2 |
| BAG | .940 | -11.61 | 14.29 | 88.00 | 1.60 | 84 | 30 | 3 |
| BHA | -2.056 | 2.46 | -3.10 | 22.08 | .81 | 100 | 22 | 2 |
| BKR | .373 | 2.56 | -4.85 | 2.20 | .55 | 117 | 25 | 3 |
| BLC | -2.126 | -3.39 | -0.99 | 21.84 | .59 | 47 | 13 | 2 |
| BMO | .565 | -1.41 | 9.76 | -15.84 | 2.32 | 76 | 18 | 2 |
| BNG | -2.944 | -0.45 | -2.79 | 27.37 | .81 | 102 | 22 | 2 |
| BNS | -0.036 | -3.52 | 1.32 | 36.59 | .95 | 35 | 8 | 3 |
| BOD | -1.333 | 1.35 | -9.02 | -59.28 | .66 | 98 | 24 | 3 |
| BOM | -1.014 | 6.29 | -4.62 | -4.53 | .44 | 35 | 3 | 2 |
| BRS | -1.366 | 1.94 | -1.80 | 23.82 | .53 | 75 | 11 | 3 |
| BRW | -0.906 | 3.45 | -10.37 | -4.47 | .64 | 36 | 12 | 2 |
| BUL | -2.128 | 2.87 | -2.59 | 14.41 | .59 | 139 | 34 | 3 |
| CAN | -1.340 | -2.05 | -7.04 | 23.15 | .81 | 94 | 12 | 2 |
| CIN | -1.050 | -8.68 | 4.03 | 74.95 | .97 | 30 | 7 | 3 |
| CLK | -2.381 | .36 | -6.04 | 56.36 | .84 | 95 | 21 | 2 |
| CLL | -1.172 | -2.60 | -4.76 | 25.03 | .60 | 129 | 29 | 2 |
| CMP | 1.362 | -2.79 | .67 | -60.93 | 1.61 | 38 | 8 | 2 |
| COL | -1.526 | -0.66 | -5.00 | 17.76 | .44 | 160 | 33 | 2 |
| COP | .748 | 2.73 | -9.46 | -83.45 | 1.44 | 35 | 9 | 3 |
| CTA | -1.381 | 1.43 | -2.73 | 2.89 | .38 | 111 | 26 | 3 |
| DAR | -2.017 | 15.89 | -10.49 | -85.55 | .68 | 51 | 15 | 2 |
| DAV | 1.110 | 2.88 | -2.69 | -37.92 | 1.15 | 42 | 11 | 2 |
| DOI | -1.527 | -6.55 | 4.14 | 65.17 | .47 | 31 | 3 | 3 |
| DOJ | .678 | -4.23 | -6.11 | -68.79 | 2.26 | 45 | 12 | 3 |
| DSH | -0.473 | -5.67 | -2.65 | 16.13 | .93 | 97 | 15 | 2 |
| EDM | -0.768 | -3.25 | -3.89 | -14.41 | .49 | 77 | 21 | 2 |
| EIL | -1.706 | 1.02 | -4.10 | -4.01 | .59 | 48 | 11 | 3 |
| EKA | -0.877 | .65 | -0.92 | 54.00 | .63 | 68 | 10 | 3 |
| ELT | -1.412 | 7.32 | -7.74 | -31.39 | .78 | 93 | 26 | 2 |
| ESK | -1.192 | 1.74 | -2.30 | 43.67 | .33 | 44 | 5 | 3 |
| EUR | 1.096 | 2.61 | -2.13 | -46.84 | 1.82 | 32 | 4 | 2 |
| FBC | -2.361 | -3.28 | -1.88 | 68.74 | .76 | 61 | 5 | 2 |
| FLN | -0.197 | -3.64 | 2.75 | 15.23 | .67 | 51 | 9 | 3 |
| FRJ | .137 | .29 | -3.73 | 30.09 | .59 | 102 | 18 | 2 |
| FSJ | -0.471 | 1.64 | -2.63 | -45.64 | .79 | 37 | 7 | 3 |
| FUR | -0.067 | .93 | -2.49 | -43.74 | .55 | 86 | 23 | 2 |
| GAR | -1.093 | -2.27 | 1.83 | 2.53 | .63 | 105 | 14 | 2 |
| GBA | -0.053 | 1.86 | .45 | -5.51 | 1.43 | 63 | 17 | 3 |
| GIL | -1.725 | 2.48 | -8.75 | -29.23 | .42 | 100 | 20 | 3 |
| GRF | -0.276 | -0.56 | .92 | 32.39 | .61 | 75 | 23 | 3 |
| GRR | -0.442 | -4.10 | 4.83 | 35.28 | .52 | 57 | 10 | 3 |
| GRS | -0.352 | -2.45 | -3.22 | -11.92 | .61 | 73 | 14 | 3 |

TABLE 4 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 4

REF LAT = 26.00 N REF LONG = 102.00 E X AZI = 80 DEG

| STA | A | B | C | D | SD | NU | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| HFS | -1.393 | 1.84 | -0.68 | 43.00 | .75 | 78 | 21 | 3 |
| HHM | -0.432 | -3.87 | -11.72 | -93.49 | .49 | 30 | 4 | 3 |
| HKC | -1.929 | 16.83 | -6.76 | 3.86 | 1.81 | 82 | 26 | 3 |
| HYB | -0.440 | -4.28 | -5.29 | -61.59 | .90 | 83 | 22 | 2 |
| IFR | -0.507 | -6.70 | .35 | 39.92 | .72 | 106 | 23 | 2 |
| ILT | -2.198 | .28 | -7.71 | 24.10 | .50 | 71 | 22 | 2 |
| INK | -1.685 | .38 | -2.88 | 9.75 | .47 | 74 | 22 | 2 |
| ISK | -1.267 | -8.31 | -2.45 | 57.89 | .98 | 42 | 9 | 2 |
| ISO | -0.819 | 6.21 | -2.63 | -86.30 | .36 | 37 | 3 | 2 |
| IST | -0.426 | -7.86 | -5.39 | 45.06 | .98 | 45 | 8 | 2 |
| JER | -0.196 | 1.81 | -3.98 | 2.71 | .45 | 79 | 14 | 3 |
| KAS | -0.825 | 7.65 | -3.03 | -42.17 | .82 | 72 | 8 | 2 |
| KAT | .592 | -0.37 | -5.54 | -31.00 | .91 | 59 | 11 | 2 |
| KBL | -0.625 | -0.91 | -2.66 | 10.44 | .64 | 95 | 23 | 2 |
| KDC | -1.852 | .15 | -4.14 | -9.27 | .56 | 45 | 10 | 3 |
| KEV | -0.849 | -0.82 | -3.23 | 32.91 | .75 | 120 | 28 | 2 |
| KHC | -0.929 | .08 | -7.49 | -1.90 | .52 | 143 | 26 | 3 |
| KHE | -0.793 | 4.48 | -7.00 | -3.96 | .82 | 88 | 14 | 2 |
| KHO | -0.046 | 6.54 | 1.36 | -74.97 | 1.03 | 105 | 22 | 2 |
| KIR | -1.265 | 3.15 | -3.04 | -9.52 | .43 | 134 | 30 | 2 |
| KIS | -0.205 | -7.99 | 3.65 | 27.49 | .89 | 43 | 8 | 3 |
| KJN | -1.254 | 2.73 | -5.05 | -19.82 | .56 | 134 | 28 | 3 |
| KLG | -1.064 | 4.90 | -0.33 | -57.72 | .73 | 53 | 11 | 2 |
| KOD | -0.543 | 1.56 | -5.88 | 36.49 | 1.10 | 72 | 14 | 2 |
| KON | -1.351 | -2.87 | -9.64 | 61.57 | .69 | 75 | 16 | 2 |
| KRA | -0.652 | -6.94 | -3.95 | 26.64 | .92 | 76 | 23 | 2 |
| KRK | -0.322 | 10.01 | -3.17 | -63.57 | .49 | 30 | 4 | 2 |
| KRR | -2.663 | 4.19 | -2.86 | 10.71 | .63 | 85 | 19 | 3 |
| KRV | -0.952 | 3.97 | -4.88 | -28.79 | .84 | 90 | 21 | 2 |
| KSA | -0.091 | .03 | 2.52 | 66.66 | 1.87 | 38 | 8 | 3 |
| KTG | -0.938 | 4.41 | 4.24 | 83.68 | .53 | 44 | 9 | 3 |
| LAH | -0.787 | -14.28 | 13.93 | 41.57 | 1.58 | 54 | 13 | 2 |
| LHN | -1.654 | 3.33 | -9.95 | 5.36 | .89 | 32 | 4 | 3 |
| LUJ | -0.484 | -1.04 | 1.31 | 17.45 | .48 | 70 | 11 | 3 |
| LNS | -1.170 | -4.57 | -2.20 | 18.84 | .55 | 70 | 19 | 2 |
| LOR | -1.186 | 2.97 | -3.53 | -41.07 | .48 | 92 | 15 | 2 |
| LWI | -1.131 | .27 | -3.88 | 42.46 | .85 | 62 | 12 | 2 |
| MAG | -0.751 | -5.82 | -10.45 | 33.47 | 1.41 | 37 | 7 | 2 |
| MAT | -2.037 | -3.88 | -2.36 | 36.30 | 1.29 | 97 | 19 | 3 |
| MBC | -1.366 | -0.28 | -3.57 | -3.84 | .55 | 141 | 25 | 3 |
| MDR | .299 | -17.01 | -23.81 | -64.91 | 1.83 | 36 | 4 | 3 |
| MNL | .135 | -7.83 | 3.81 | 33.27 | 1.62 | 27 | 6 | 3 |
| MNY | -1.372 | -6.29 | -6.37 | 47.28 | 1.16 | 37 | 6 | 2 |
| MOS | -0.733 | -0.81 | -6.47 | 6.32 | .96 | 98 | 21 | 3 |
| MOX | -0.891 | -0.45 | -2.27 | 21.56 | .66 | 143 | 31 | 3 |
| MOY | -0.549 | 2.75 | -6.78 | 22.32 | .68 | 64 | 17 | 3 |
| MSH | .250 | .53 | -12.66 | 27.55 | .90 | 38 | 7 | 3 |
| MUN | -0.967 | -4.84 | -1.06 | -5.75 | .55 | 74 | 8 | 2 |
| NAI | -0.539 | 8.28 | -0.70 | -4.08 | 1.37 | 48 | 6 | 2 |
| NDI | -2.317 | -10.79 | -3.13 | 8.26 | .99 | 141 | 33 | 2 |

TABLE 4 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 4

REF LAT = 26.00 N REF LONG = 102.00 E X AZI = 80 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| AAB | .795 | 4.96 | -6.48 | -20.18 | .72 | 143 | 25 | 2 |
| AAE | 1.938 | -5.99 | 5.47 | 53.06 | 1.31 | 37 | 9 | 3 |
| ADE | -1.203 | 1.12 | -2.44 | 9.19 | .56 | 66 | 12 | 3 |
| ALE | -1.262 | -1.74 | -4.30 | -4.95 | .58 | 98 | 25 | 2 |
| ANR | .146 | 1.37 | 4.67 | 32.83 | .67 | 23 | 4 | 3 |
| APA | -1.293 | -2.10 | -7.98 | 29.60 | .70 | 69 | 15 | 2 |
| ASP | -1.294 | 4.75 | -1.82 | -14.61 | .57 | 48 | 15 | 2 |
| AVE | -0.456 | -5.02 | -0.92 | 5.31 | 1.20 | 43 | 7 | 2 |
| BAG | .940 | -11.61 | 14.29 | 88.00 | 1.60 | 84 | 30 | 3 |
| BHA | -2.056 | 2.46 | -3.10 | 22.08 | .81 | 100 | 22 | 2 |
| BKR | .373 | 2.56 | -4.85 | 2.20 | .55 | 117 | 25 | 3 |
| BLC | -2.126 | -3.39 | -0.99 | 21.84 | .59 | 47 | 13 | 2 |
| BMO | .565 | -1.41 | 9.76 | -15.84 | 2.32 | 76 | 18 | 2 |
| BNG | -2.944 | -0.45 | -2.79 | 27.37 | .81 | 102 | 22 | 2 |
| BNS | -0.036 | -3.52 | 1.32 | 36.59 | .95 | 35 | 8 | 3 |
| BOD | -1.333 | 1.35 | -9.02 | -59.28 | .66 | 98 | 24 | 3 |
| BOM | -1.014 | 6.29 | -4.62 | -4.53 | .44 | 35 | 3 | 2 |
| BRS | -1.366 | 1.94 | -1.80 | 23.82 | .53 | 75 | 11 | 3 |
| BRW | -0.906 | 3.45 | -10.37 | -4.47 | .64 | 36 | 12 | 2 |
| BUL | -2.128 | 2.87 | -2.59 | 14.41 | .59 | 139 | 34 | 3 |
| CAN | -1.340 | -2.05 | -7.04 | 23.15 | .81 | 84 | 12 | 2 |
| CIN | -1.050 | -8.68 | 4.03 | 74.95 | .37 | 30 | 7 | 3 |
| CLK | -2.381 | .36 | -6.04 | 56.36 | .84 | 95 | 21 | 2 |
| CLL | -1.172 | -2.60 | -4.76 | 25.03 | .60 | 129 | 29 | 2 |
| CMP | 1.362 | -2.79 | .67 | -60.93 | 1.61 | 38 | 8 | 2 |
| COL | -1.526 | -0.66 | -5.00 | 17.76 | .44 | 160 | 33 | 2 |
| COP | .748 | 2.73 | -9.46 | -83.45 | 1.44 | 35 | 9 | 3 |
| CTA | -1.381 | 1.43 | -2.73 | 2.89 | .38 | 111 | 26 | 3 |
| DAR | -2.017 | 15.89 | -10.49 | -85.55 | .68 | 51 | 16 | 2 |
| DAV | 1.110 | 2.88 | -2.69 | -37.92 | 1.15 | 42 | 11 | 2 |
| DDI | -1.527 | -6.55 | 4.14 | 65.17 | .47 | 31 | 3 | 3 |
| DOJ | .678 | -4.23 | -6.11 | -68.79 | 2.26 | 45 | 12 | 3 |
| DSH | -0.473 | -5.67 | -2.65 | 16.13 | .93 | 97 | 16 | 2 |
| EDM | -0.768 | -3.25 | -3.89 | -14.41 | .49 | 77 | 21 | 2 |
| EIL | -1.706 | 1.02 | -4.10 | -4.01 | .59 | 48 | 11 | 3 |
| EKA | -0.877 | .65 | -0.92 | 54.00 | .63 | 68 | 10 | 3 |
| ELT | -1.412 | 7.32 | -7.74 | -31.39 | .78 | 93 | 26 | 2 |
| ESK | -1.192 | 1.74 | -2.30 | 43.67 | .33 | 44 | 5 | 3 |
| EUR | 1.096 | 2.61 | -2.13 | -46.84 | 1.82 | 32 | 4 | 2 |
| FBC | -2.361 | -3.28 | -1.88 | 68.74 | .76 | 61 | 5 | 2 |
| FLN | -0.197 | -3.64 | 2.75 | 15.23 | .67 | 51 | 9 | 3 |
| FRJ | .137 | .29 | -3.73 | 30.09 | .59 | 102 | 18 | 2 |
| FSJ | -0.471 | 1.64 | -2.63 | -45.64 | .79 | 37 | 7 | 3 |
| FUR | -0.067 | .93 | -2.49 | -43.74 | .65 | 86 | 23 | 2 |
| GAR | -1.093 | -2.27 | 1.83 | 2.53 | .63 | 105 | 14 | 2 |
| GBA | -0.053 | 1.86 | .45 | -6.51 | 1.43 | 63 | 17 | 3 |
| GIL | -1.725 | 2.48 | -8.75 | -29.23 | .42 | 100 | 20 | 3 |
| GRF | -0.276 | -0.56 | .92 | 32.39 | .61 | 76 | 23 | 3 |
| GRR | -0.442 | -4.10 | 4.83 | 35.28 | .52 | 57 | 10 | 3 |
| GRS | -0.352 | -2.45 | -3.22 | -11.92 | .61 | 73 | 14 | 3 |

TABLE 4 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 4

REF LAT = 25.00 N REF LONG = 102.00 E X AZI = 80 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| NEW | -0.416 | 2.77 | -4.21 | 7.68 | .93 | 30 | 5 | 2 |
| NIE | -0.116 | -1.44 | -3.59 | -17.22 | .85 | 85 | 19 | 3 |
| NIL | -0.603 | -11.07 | -1.12 | -23.04 | .60 | 41 | 14 | 3 |
| NP- | -1.357 | 2.73 | -5.29 | -9.39 | .22 | 34 | 9 | 2 |
| NOR | -1.759 | -3.50 | -4.28 | 27.98 | .45 | 77 | 17 | 2 |
| NUR | -0.975 | 7.21 | -3.47 | -53.58 | .56 | 154 | 31 | 2 |
| OBN | -1.156 | -3.95 | -2.78 | 15.57 | .80 | 70 | 21 | 2 |
| OUL | -1.700 | 2.85 | -4.64 | 26.56 | .42 | 92 | 23 | 2 |
| PMG | -0.676 | 3.00 | -4.59 | -23.17 | .46 | 81 | 17 | 2 |
| PMR | -2.399 | -2.53 | -4.53 | 52.75 | .38 | 107 | 21 | 2 |
| PNT | -0.747 | -1.46 | -1.28 | 23.00 | .73 | 44 | 9 | 2 |
| POO | -1.051 | 6.71 | -1.16 | -8.21 | .98 | 93 | 14 | 3 |
| PRA | -0.043 | -4.05 | -1.49 | 54.25 | .79 | 53 | 13 | 3 |
| PRE | -1.640 | -2.85 | -7.72 | 48.44 | .37 | 62 | 16 | 2 |
| PRJ | -0.436 | -0.59 | -2.46 | -5.45 | .65 | 141 | 27 | 2 |
| PRZ | 1.073 | -2.55 | -0.97 | -67.39 | .62 | 58 | 16 | 3 |
| PUL | -0.191 | -2.33 | .85 | -10.09 | .35 | 57 | 11 | 2 |
| QUE | -1.101 | 2.16 | -9.29 | -36.11 | .68 | 141 | 28 | 3 |
| RAB | -0.089 | 5.92 | -5.14 | -17.40 | .50 | 51 | 14 | 2 |
| RES | -1.389 | 1.74 | -7.36 | -34.08 | .55 | 95 | 25 | 3 |
| RSL | -1.500 | .91 | -2.81 | 63.05 | .89 | 58 | 8 | 3 |
| SAM | -0.759 | 2.72 | -7.35 | 21.21 | 1.06 | 64 | 14 | 2 |
| SDB | -0.546 | .92 | -5.52 | 10.91 | .40 | 32 | 3 | 2 |
| SEM | -0.975 | -3.28 | 1.78 | 23.54 | .52 | 84 | 14 | 2 |
| SHI | -1.668 | .74 | -5.31 | -20.84 | .62 | 110 | 21 | 3 |
| SHL | -1.500 | -1.44 | -7.34 | -30.05 | 1.70 | 133 | 25 | 3 |
| SIM | -0.422 | -10.05 | -4.26 | 52.18 | .84 | 41 | 6 | 2 |
| SKA | -1.574 | 10.33 | -2.48 | -58.68 | .11 | 43 | 1 | 2 |
| SOD | -1.321 | 1.64 | -4.66 | 11.49 | .52 | 165 | 33 | 2 |
| SSC | -0.368 | -6.32 | 1.60 | 23.72 | .72 | 59 | 8 | 3 |
| SSF | -1.055 | -2.32 | -3.59 | 7.47 | .44 | 96 | 15 | 3 |
| STR | .313 | -5.19 | 2.49 | 46.05 | 1.14 | 42 | 10 | 3 |
| STJ | -0.896 | -2.03 | -1.14 | 61.20 | .34 | 51 | 13 | 3 |
| SVE | -0.496 | -0.26 | -2.53 | 7.23 | .77 | 110 | 23 | 2 |
| TAB | .209 | -1.98 | -7.03 | -10.39 | .58 | 55 | 13 | 3 |
| TAM | -1.039 | -1.81 | 1.00 | 25.40 | .52 | 42 | 5 | 3 |
| TAS | -0.544 | -4.06 | -5.66 | 32.00 | .57 | 99 | 16 | 2 |
| TEH | -0.415 | -8.93 | -5.92 | 87.70 | 1.71 | 50 | 9 | 2 |
| TFO | 1.357 | -17.74 | -3.11 | 56.96 | 1.47 | 50 | 9 | 2 |
| TIF | .169 | .04 | 2.58 | 57.94 | .66 | 33 | 3 | 3 |
| TIK | -2.378 | 4.15 | -5.72 | -35.97 | .62 | 116 | 26 | 2 |
| TOO | -1.196 | .50 | -3.42 | 41.15 | .41 | 76 | 14 | 3 |
| TRI | -1.778 | -3.54 | -0.24 | 47.56 | .29 | 42 | 6 | 2 |
| TRO | -1.301 | 3.13 | -5.55 | 10.07 | .67 | 113 | 21 | 3 |
| UBO | -0.078 | -1.26 | -6.36 | 13.03 | 2.53 | 64 | 8 | 3 |
| UME | -1.502 | 6.53 | -4.17 | -20.73 | .44 | 135 | 28 | 2 |
| UPP | -1.486 | 3.86 | -4.78 | -20.72 | .43 | 164 | 37 | 2 |
| UZH | -0.531 | -1.54 | -4.15 | -9.77 | .79 | 112 | 24 | 3 |
| VAN | -0.602 | 3.07 | -4.09 | 15.64 | 1.08 | 84 | 15 | 2 |
| VLA | -1.478 | -3.41 | -11.70 | 27.29 | 1.19 | 82 | 24 | 3 |

TABLE 4 SOURCE-REGION/STATION TIME CORRECTIONS FOR REGION 4

REF LAT = 25.00 N REF LONG = 102.00 E X AZI = 90 DEG

| STA | A | B | C | D | SD | NJ | NR | TYPE |
|---|---|---|---|---|---|---|---|---|
| VRI | -0.483 | 3.89 | -0.81 | -20.99 | .88 | 33 | 9 | 2 |
| WAB | 1.277 | 5.29 | 3.92 | -73.67 | .57 | 27 | 11 | 2 |
| WIT | .377 | .27 | 4.09 | 77.65 | 1.02 | 38 | 9 | 3 |
| WLS | -1.071 | -5.09 | -0.44 | 29.22 | .30 | 50 | 17 | 2 |
| WRA | -2.019 | 6.71 | -6.32 | -5.05 | .62 | 101 | 27 | 2 |
| WRS | -1.016 | -7.24 | 1.36 | 14.49 | .93 | 86 | 17 | 2 |
| YAK | -1.962 | -1.70 | -5.14 | 29.57 | .94 | 93 | 19 | 2 |
| YKC | -1.648 | -2.96 | -1.86 | 23.75 | .56 | 89 | 17 | 2 |
| YSS | -1.094 | .18 | -6.84 | 13.12 | .74 | 71 | 18 | 2 |
| ZAK | -0.388 | 5.97 | -4.53 | -41.29 | .57 | 76 | 25 | 2 |