

P wave travel times from Nevada nuclear explosions and station corrections

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ABSTRACT. One hundred forty-nine Nevada explosions have been studied. These explosions had more than ten thousands observations. Travel times of *P*-waves have been obtained. These times are more than J. B. *P*-times for $6^\circ \leq \Delta \leq 17^\circ$. For all other distances they are less than J. B. *P*-times. The maximum difference is -2.70 second at 33° epicentral distance. Station corrections for most of the observing stations have also been calculated. These station corrections have been compared with the work of the other authors. The calculated station corrections are in good agreement with the ones obtained by other people for most of the stations. There are significant difference at some stations.

It has now become apparent that J-B *P*-wave travel times are generally two to four seconds late for both oceanic and continental regions. A good set of travel times is necessary to study the structure of the earth. Inaccuracies in the travel times may be separated into (1) source bias, (2) station bias, (3) path bias, *i.e.*, regional bias (originating along the path through the deep mantle). Source bias is particularly large when travel times are calculated from earthquakes, as their parameters are not known exactly. Significant regional variations in the upper mantle make it impractical to estimate the world average travel time curve and it is, therefore, necessary to estimate regional travel time curves. We have studied 149 Nevada explosions whose parameters are exactly known and their latitudes and longitudes lie in the intervals $(36.72, 37.44)^\circ\text{N}$ and $(115.90, 116.98)^\circ\text{W}$ respectively. More than 10000 observations distributed in nearly all azimuths were available. Our study is based strictly on statistical techniques and does not depend on subjective judgements. Jeffreys' method of uniform reduction is used to deal with the large residuals and no residual is rejected. The residuals are given proper weights. Frequency distributions at 1° intervals were obtained. It was evident from these values that mode of the distributions were not necessarily at zero of the ranges. The distributions were combined together after shifting the modes to the zero of the ranges. The mode of the combined distributions was approximately at zero. The value of the precision constant h is obtained to be 0.57 which gives $\sigma=1.2405$, where $\sigma^2=1/2h^2$.

The value of the Jeffreys' parameter $\mu(x_r)$ is $\mu(x_r)=0.02144+0.00008 x_r$, where x_r denote residuals.

Weights are calculated from:

$$W_r = [1 + \mu(x_r) e^{h^2 x_r^2}]^{-1}$$

Calculated weights are given below:

Residuals*	Weights	Residuals*	Weights
-5.0	0.01	1.0	0.98
-4.0	0.19	2.0	0.95
-3.0	0.71	3.0	0.81
-2.0	0.93	4.0	0.32
-1.0	0.98	5.0	0.03
0.0	0.98		

*These are deviations of residuals from mode of the range

2. It is clear from the above table that all residuals of magnitude greater than 5.0 seconds get zero weight. Weighted mean residuals, standard errors, total weights, and unsmoothed times at $1^\circ \Delta$ intervals were calculated. A cubic $T=a+b\Delta+c\Delta^3$ to the observations for the range $0^\circ \leq \Delta \leq 17^\circ$ gives a solution:

$$a = 5.3856 \pm 0.7141$$

$$b = 14.6060 \pm 0.1298$$

$$c = -0.0026 \pm 0.0004$$

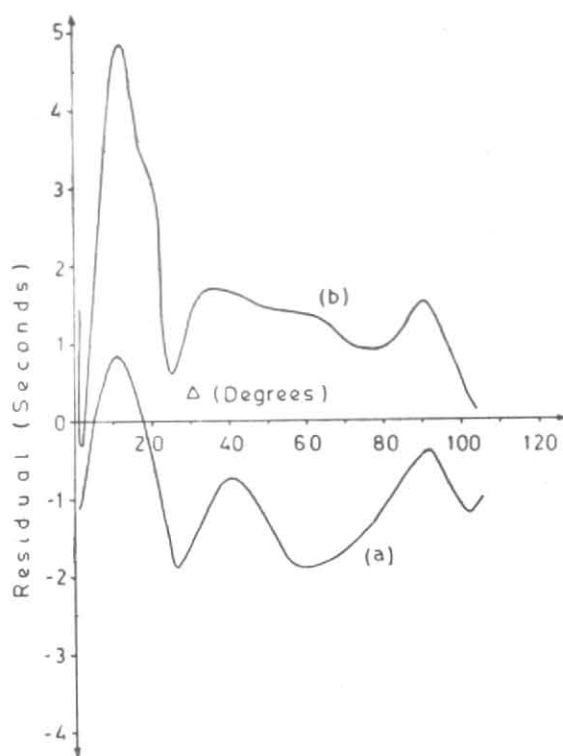


Fig. 1. Differences from J-B and Herrin Tables.

This curve gave a satisfactory value of χ^2 and was accepted for calculation of travel times for $0^\circ \leq \Delta \leq 17^\circ$. Data in the range $21^\circ \leq \Delta \leq 105^\circ$ was smoothed to reduce random errors. The method of summary values was used. Data was divided into nine ranges depending upon the number of observations. Two summary points for each range were calculated. A quadratic $T = a + b\Delta + c\Delta^2$ fit to the summary points gave the solution:

$$a = 68.1878 \pm 1.9183$$

$$b = 11.1593 \pm 0.0577$$

$$c = -0.0359 \pm 0.0004$$

with satisfactory value of χ^2 . Differences between the observed and the calculated values were large for $\Delta > 94^\circ$. This may be due to the fact that there are not many observations in this range. Therefore, the times for $\Delta > 94^\circ$ were calculated by extrapolation, keeping the value of $dT/d\Delta$ same as that at 93° . Similarly to avoid discontinuity around 20° , times for $18^\circ \leq \Delta \leq 20^\circ$ were calculated by interpolation. Differences from J-B P -times and Herrin (1968) P -times are shown in (a) and (b) respectively of Fig. 1. Herrin times are earlier than our times nearly at all distances while J-B times are later at all distances ex-

cept between $6^\circ \leq \Delta \leq 17^\circ$. Station corrections for 308 stations observing Nevada explosions were calculated and were compared with the works of the other authors. The calculated station corrections were found to be in good agreement with the ones obtained by other seismologists. Since the explosions are taken from one site, *i.e.*, Nevada test site, observations are therefore azimuthally dependent and any station residual will contain station bias and path bias. Thus when these station corrections are applied to the calculated times, at a particular station, the result will be the true arrival at that station. Source bias is already absent as the study is based on explosions whose parameters are exactly known. Thus the travel times calculated here may be assumed sufficiently correct.

References

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