Station magnitude corrections for Shillong, Poona and New Delhi

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ABSTRACT. Station magnitude corrections for WWSSN stations in India have been evaluated and their variations discussed. The probable causes of station corrections were suggested. A preliminary examination of azimuthal distribution of station corrections indicated their variation in different directions.

1. Of the many quantitative parameters of an earthquake the determination of magnitude which is of special interest is still in debate. Attempts have been made by numerous workers to express the magnitude in terms of relative energy ratings of seismic events. Richter (1935) defined the local magnitude, M_L, from the recorded trace amplitude of the Wood-Anderson instrument of stated physical constants. Subsequent studies concentrated in expressing the magnitude of teleseisms of shallow origin from the surface waves of 20-sec period. Later, Gutenberg and Richter (1956) used P, PP, S, and SS phases with appropriate factors to account for the depth-distance function to arrive at M_b (Body wave magnitudes). Of late the efforts have been to average out the various magnitude values to arrive at a unified magnitude (m).

Gutenberg and Richter expressed M_b as

$$M_b = Q + q + s \qquad (1)$$

where Q is the depth-distance factor which was extended from 5° to 2° assuming the amplitude is inversely proportional to the cube of the distance in this range,

$$q = \text{Log}_{10} A/T$$

where A is trough to peak amplitude reduced to ground motion in microns, T is wave period in seconds, and s is station correction factor. It is seen that all the parameters can be evaluated to determine the magnitude except the station correction factor which is the correction to be applied to the magnitude values obtained by the station to evolve the USCGS magnitude which is considered as a standard in the present study, The purpose of the present paper is, therefore, a preliminary attempt to find out the station correction factors for all WWSSN (World Wide Standard Seismograph Network) stations in India as the knowledge of station corrections enables one to arrive at the standard (USCGS) magnitude.

2. The data necessary for the present study has been culled out from the PDE (Preliminary Determination of Epicentres) cards regularly published from U.S. Department of Commerce, Coast and Geodetic Survey, Washington Science Center since 1964. Since no magnitude values for Kodaikanal were available in the PDR cards the present study is thus confined to the rest of WWSSN India stations only, *viz.*, Shillong, New Delhi and Poona. All the shocks recorded by any station are classified according to depth into shallow, intermediate and deep foci. Further, the difference between station values and USCGS were obtained and these differences were grouped together with reference to the distance from the recording station in steps of 10°. The grouped values were then averaged for each station separately for each depth.

3. Distances in degrees are indicated along abscissa and corrections on the ordinate. The circles represent the average of the number of observation (given in brackets) falling in the group. Fig. 1 shows the plots of station correction of Shillong with respect of distance for shallow, intermediate and deep foci shocks. Smooth curves were drawn to fit the points with proper weightage to the population of data. For shallow shocks it is seen that the station correction is positive only for shocks arriving from 20–50° distance. For shocks of other ranges the correction is negative. The correction curve more or less follows suit in the case of intermediate focus with a slight increase in the positive correction range with consequent decrease in the other. Interestingly enough in the case of deep focus correction remains positive from 20°—100°. The correction curve appears to have peak value at about 50°. A simultaneous study of the three curves reveals that with increase of depth the negative corrections are reduced and positive corrections are increased. Also the distance covered by the positive correction increases with the depth with consequent decrease in the negative side.

4. Fig. 2 represents the station correction nomograms for New Delhi. It is evident that the shape of curves for shallow and intermediate foci is sinusoidal. For shallow, between 20° and 40° and beyond 80° the correction came out to be positive but for intermediate focus the former range is unaltered while the later starts from 90° only. Also the positive and negative corrections in shallow focus earthquakes vary widely than that of intermediate focus. In contrast to Shillong the positive correction in case of deep focus shocks of New Delhi begins from 50° only with negative values down below. The other feature brought about in Fig. 1, *viz.*, the variation of the range of positive correction with increase of depth can also be seen here.

5. Poona station correction diagrams are shown in Fig. 3 and the similarity in case of shallow and intermediate foci with New Delhi is interesting. The range between the positive correction and negative is larger in the case of shallow focus than that of intermediate. Also the postive range lies between 20° and 50° and beyond 90° in the case of shallow focus, while for the intermediate there is a bodily shift in the curve and the distance coverage of positive as well as negative corrections have widened. The station correction diagram, in case of deep focus, resembles that of Shillong but with a higher correction from 20° to 110°.

6. A collective study of the nomograms of the three stations suggests that there is a regular variation from shallow to deep focus. These variations are not similar at all stations as the stations corrections depend primarily upon—

(1) the focal mechanism of the earthquake which is recorded by the station and its position with reference to the earthquake;

(2) the physical properties of the medium transmitting the energy of earthquake; and

(3) the azimuthal variation in the geology of the station.

7. Since the determination of either focal mechanism or physical properties of the transmitting medial is not easy, preliminary attempts have been made to study the azimuthal variation of station corrections in respect of Shillong which has sufficient data. As in the case of station corrections, the data was first categorized into shallow, intermediate and deep foci. Further the whole azimuth is arbitrarily sub-divided into sectors of 40° and the mean corrections found out. Fig. 4 represent the cases of shallow, intermediate and deep foci wherein hatched portion represent negative corrections. From the three diagrams it can safely be concluded that there are azimuthal variation of station corrections though not of the same sign and magnitude in all cases. The study could not be extended to other stations because of paucity of data and the results of the same will be reported when more data get accummulated.

REFERENCES

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Richter, C. F.	1935	*Bull. seismol. Soc. Amer.*, **25**, pp. 1-32.

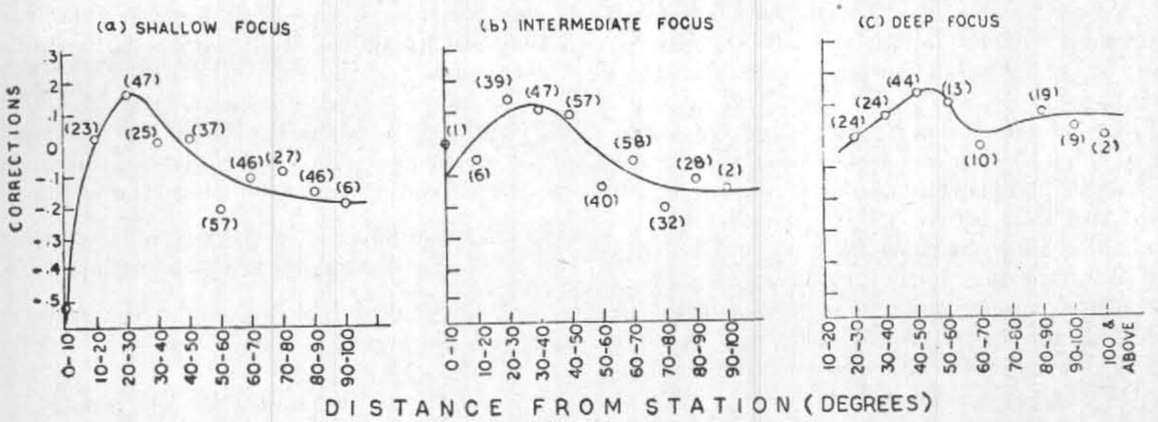

Fig. 1. Station corrections for shillong

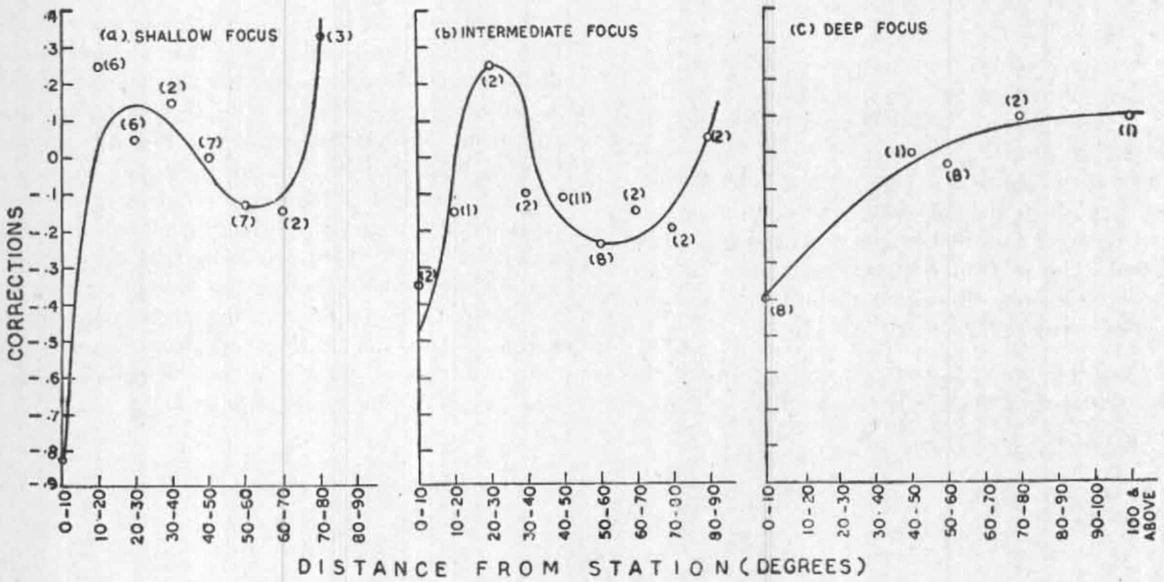

Fig. 2. Station corrections for New Delhi

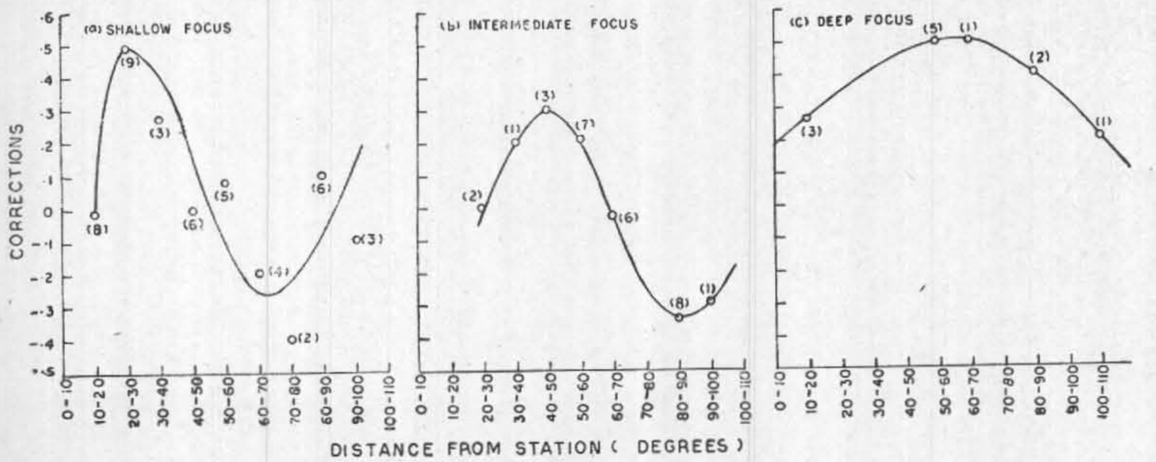

Fig. 3. Station correction for Poona

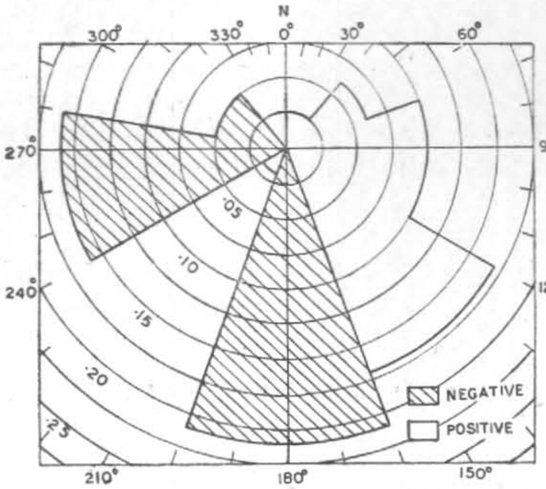

Fig. 4(a). Shallow focus

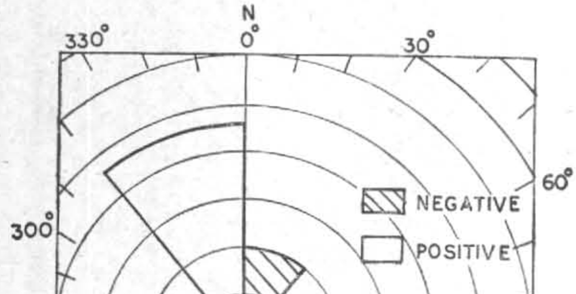

Fig. 4(b). Intermediate focus

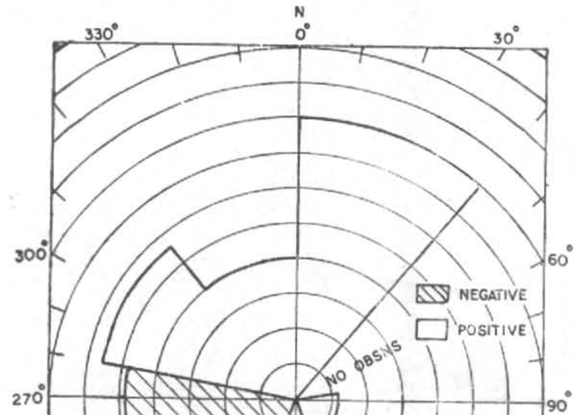

Fig. 4(c). Deep focus

Fig. 4. Azimuth variation of station corrections