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Direction of approach of Short Period Microseisms at Shillong

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ABSTRACT. Short period microseisms recorded by three matched component short period Benioff Seismographs at Shillong were analysed according to the amplitude method. The direction of approach thus determined supports the earlier findings of Saha (1962) that these short period microseisms are due to western disturbances moving from west to east.

1. Introduction

The short period microseisms recorded at Shillong by the short period vertical Benioff seismometers were reported by Saha (1962). From observed microseisms and the synoptic situations, he has concluded that the short period microseisms were recorded at Shillong when a cold front or upper air discontinuity associated with a western disturbance was over or near the station. He, however, could not come to any conclusion about the direction of approach of these short period microseisms because observations were available only from a single vertical component Benioff seismometer.

Recently the United States Coast and Geodetic Survey has installed a world wide network of standard seismographs at Shillong in April 1963. The network consists of matched units of long and short period systems. In the present investigation we are interested in the records of the short period system. It consists of three matched components of short period Benioff seismometers. With calibration coils and other adjustments it is possible to operate these instruments with identical magnifications so that the recorded amplitudes could be used for computation with great degree of reliability. Since the installation it has not been possible to record many observations on short period microseisms. But on two occasions when the components were in perfect order, the data were analysed and the results of the analysis are presented in the present communication.

2. Method

Recently Bath (1962) has discussed three methods for determination of direction of approach of microseisms of the usual storm type and he concluded that Jensen's method, amplitude method and Teisseyre-Siemek's method can all be applied to standard seismograph records in three matched components and do not require any elaborate technique for the evaluation. According to him Jensen's method and the amplitude method are superior to the last method, *i.e.*, Teisseyre-Siemek's method. We propose to use only the amplitude method. The working theory of the method is given below:

The microseisms are assumed to consist of Rayleigh and Love waves. The x and y components of R and Q are given by

$$\left.\begin{aligned} R_x &= R_H \sin\alpha; \quad Q_x = Q\cos\alpha \\ R_y &= R_H \cos\alpha; \quad Q_y = Q\sin\alpha \end{aligned}\right\} \qquad (1)$$

$x,\ y,\ z$ = rectangular co-ordinate directed eastwards, northwards and upwards respectively with station as the origin, the suffix H implies to the horizontal component and α to the direction of approach of microseisms, counted from north over east. R, Q=Rayleigh and Love wave amplitudes respectively.

The components of the displacement, U, at time t along the co-ordinate axes are

$$\left.\begin{aligned} U_x &= R_x \sin\omega t + Q_x \sin(\omega t+\gamma) \\ U_y &= R_y \sin\omega t + Q_y \sin(\omega t+\gamma) \\ U_z &= R_z \sin(\omega t-\pi/2) \end{aligned}\right\} \qquad (2)$$

Where ω=angular frequency (assumed to be

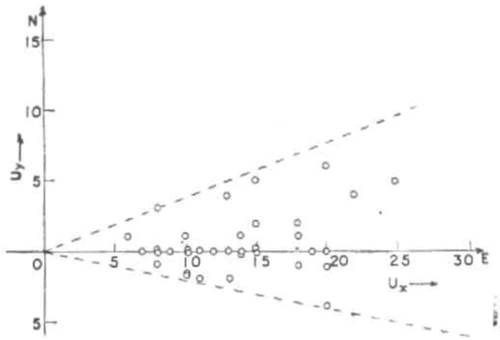

Fig. 1(a). Direction determination for 10 July 1963, 1610 to 1620 GMT at Shillong

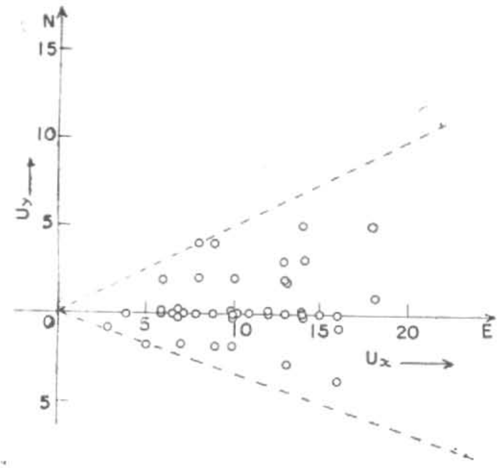

Fig. 1(b). Direction determination for 6 September 1963, 0051 to 0106 GMT at Shillong

(OE and dashed lines indicating mean and extreme directions)

same for R and Q)

γ=phase displacement between R and Q waves.

In the amplitude method the measuring moments correspond to $U_z = 0$ in well developed wave groups on the vertical component and the horizontal amplitudes are measured. If we put

$U_z = 0$ in equations (2) we find that

$$\left.\begin{aligned} U^x &= R_x + Q_x \cos \gamma \\ U_y &= R_y + Q_y \cos \gamma \end{aligned}\right\} \quad (3)$$

Again if γ is arbitrarily distributed, the mean ratio U_x / U_y for a sufficiently large number of observations will give the direction to the source.

In the amplitude method used here the time when the displacement of the vertical component is zero in a well developed wave group is noted down and the displacements of the north and east components corresponding to this time are as well noted. Next a graph is plotted between the two horizontal displacements corresponding to the same time. Joining the origin of co-ordinates with these points gives us the direction from which the disturbance is arriving.

3. Application to individual cases

(a) Short period microseisms recorded on 10 July 1963

Time interval measured in GMT	1610 to 1620
Number of observations	36
Wave period	~0·75 sec
Mean direction of approach	West
Disturbance from—	
N 75° W to N 85°W	16·3%
N 85° W to W 5° S	55·6%
W 5°S to W 15°S	16·3%
other directions	11·8%
Total range	32°

(b) Short period microseisms recorded on 6 September 1963

Time interval measured in GMT	0051 to 0106
Number of observations	42
Wave period	~0·75 sec
Mean direction of approach	West

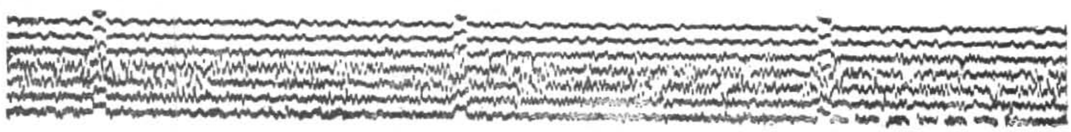

Fig. 2. Section of the Benioff Vertical Short Period (6 September 1963) record

Disturbance from —

N 75°W to N85°W	14·3%
N 85°W to W 5°S	57·1%
W 5°S to W 15°S	14·3%
other directions	14·3%
Total range	44°

The above results are graphically represented in Figs. 1(a) and 1(b). Fig. 2 represents a section of the record of the Benioff vertical short period ($To = 1^s.0$, $Tg = 0^s{\cdot}75$) of 6 September 1963.

4. Discussion and Conclusion

It is noticed that on occasions when these short period microseisms were recorded, there were no cyclonic storms or depressions in the Bay of Bengal. Neither there were cyclonic storms preceding these observations because some instances are available when short period microseisms were recorded by Benioff seismographs at Shillong when cyclonic storms of Bay of Bengal origin have crossed coast and moved towards Assam (Saha 1964). These microseisms are very similar to those which were reported by Saha (1962).

According to him, these microseisms are caused by the passage of secondary low pressure waves induced by extra-tropical depressions of the middle latitudes known as western disturbances in the Indian meteorological literature. The diffuse cold front present in these low pressure waves which move from west to east is accentuated by the incursion of moisture at lower levels from the Bay of Bengal across East Pakistan and induce these short period microseisms to be recorded by seismographs. The results of the present study clearly indicate that the direction of approach of these short period microseisms is from some westerly direction. The present study on the analysis of the microseisms observations clearly supports the conclusion that these microseisms are due to disturbances which move from west to east. The study on the direction of approach of storm microseisms recorded by the matched components of the long period Press-Ewing seismometer is proposed to be undertaken on a future occasion.

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