Mausam, (1988), 39, 2, 227-230

Letters to the Editor

553.344.094

TEMPORAL VARIATION IN V_p/V_s IN A SELECTED AREA IN NORTHEAST INDIA

Northeast India is probably passing through the preparation stage of a large earthquake. Most of the earthquakes in this region are caused by thrust faulting. Nur *et al.* (1973) have shown that thrust faults are capable of large dilatancy. Anomalous decrease and recoveries of the ratio V_p/V_s are known to occur prior to some earthquakes (Aggarwal *et al.* 1973, 1975). Probably, dilatancy in the rocks of the focal zone is the cause of such anomalies. It is surmised that those anomalous variations in V_p/V_s ratio are caused mostly by lowering of *P*-wave velocities before earthquakes. In some cases the *S*-waves velocity also decreases to such an extent as to mask the effect. Srivastava and Chaudhury (1979) and Singh and Gupta (1979) have found *P*-wave velocities decrease in northeastern region preceding earthquakes.

Micro-earthquake observations in the northeast India by Geological Survey of India (G.S.I.) and University of Roorkee provided an opportunity to study V_p/V_s ratio as a precursor to impending earthquakes. In this paper an attempt has been made to present the results of these observations.

2. G.S.I. set up a number of temporary seismic stations, locations of which are given below to monitor micro-earthquakes in the northeast India :

Byrnihat (26°03.56′ N, 91°53.32′ E),
Borjuri (26°23.85′ N, 92°56.31′ E),
Umrangshu (25°31.45′ N, 92°43.68′ E),
Umso (25°11.06′ N, 92°22.08′ E),
Bellofonte (25°35.31′ N, 91°54.63′ E) and
Raliang (25° 5′ N, 92°4′ E)

The periods of observations were from 20 June to 17 August 1979, 1 June to 26 June 1981, 6 July to 26 July 1981, 1 August to 29 August 1981 and 1 April to 10 May 1982.

The stations were placed on Granite-Gneissic Complex and operated in a vertical mode with portable short period seismometer (teledyne, geotech model S-13) working on 1 Hz natural frequency and teledyne geotech portacorder model RV-320.

P and *S* arrivals times of micro-earthquakes during the period of observations, mentioned above, were used to compute V_p/V_s.

3. Wadati diagrams were drawn on the basis of 3 to 4 stations data (Fig. 1). Denoting the arrival times of *P* and *S* waves, reckoned from the origin time by t_p and t_s respectively and assuming the propagation path for both the waves as identical, we get :

$$V_p\, t_p = V_s\, t_s \tag{1}$$

$$\text{or} \quad \frac{V_p}{V_s} = \frac{t_s}{t_p} \text{ or } \frac{V_p}{V_s} - 1 = \frac{t_s - t_p}{t_p} \tag{2}$$

(*S-P*) time for each shock is plotted as a function of *P* arrival times as illustrated in Fig. 1 for 4 earthquakes. The slope of this curve is the ratio of traveltimes of *S*-waves to that of *P*-waves *minus* one. For a homogeneous medium the slope is (V_p/V_s)—1.

4. *P* and *S* arrival times for the earthquakes are plotted against (*S-P*) interval to compute V_p/V_s and origin time of each earthquake. V_p/V_s against time have been presented in Figs. 2-4. In the same figures all felt earthquakes presented in Table 2 are shown as arrows to see the relationship of V_p/V_s with respect to the occurrence of these earthquakes.

It is seen from Figs. 2-4 that lowering and subsequent recovery of V_p/V_s preceding earthquakes of magnitude 2 to 4 is generally discernible.

The average value of V_p/V_s during the period of observations has been computed as 1.78. It is also observed that the origin time calculated from Wadati diagrams are found to be in good agreement to those calculated on the basis of Jeffreys-Bullen traveltime table. Hence, origin time calculated from Wadati diagrams have been used.

Although the V_p/V_s ratio appears to hold some promise to predict earthquakes of magnitudes 2 to 4, but the observations are not adequate to derive any empirical relationship between magnitude and time of occurrence of impending earthquake. More data is required for the purpose.

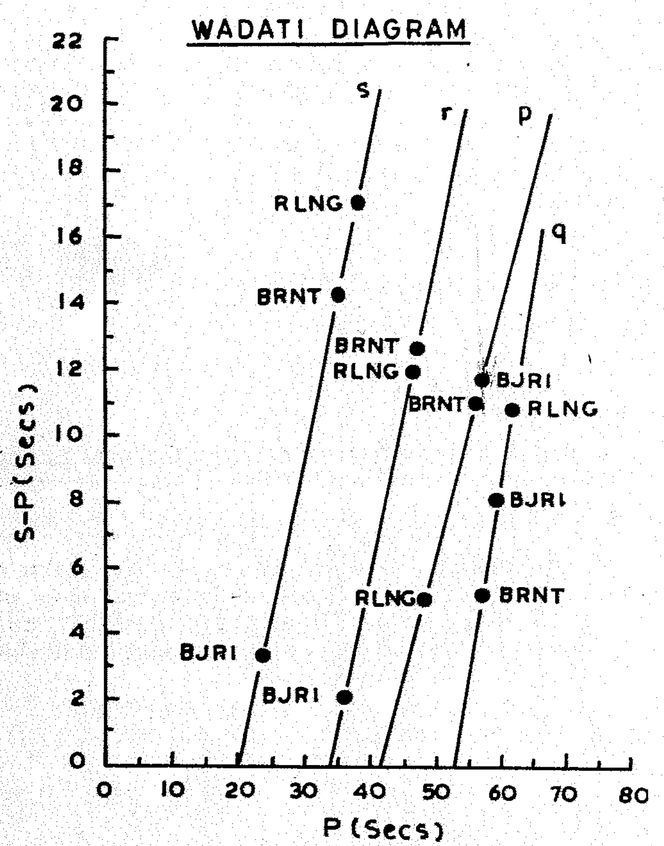

Fig. 1. *S-P* times as a function of *P* arrival times at station for four earthquakes

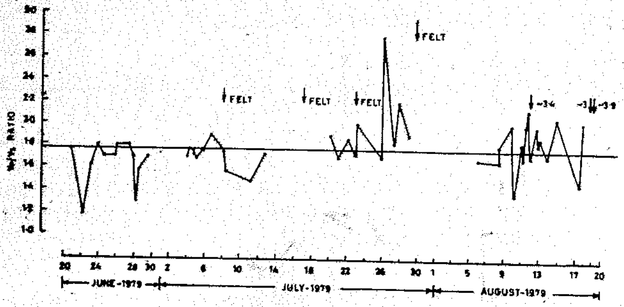

Fig. 2. Variation of V_P/V_S ratio with time during period 20 June to 20 August 1979

TABLE 1

Wadati diagrams

Curve	Date	Origin time (GMT) from J.& B. Table			Origin time (GMT) from Wadati diagrams		
		hr	min	sec	hr	min	sec
p	20 Jun '79	09	14	41	06	14	41
q	04 Jul '79	16	09	48.25	16	09	53
r	09 Aug '79	14	38	30.67	14	38	34
s	11 Aug '79	05	43	16.71	05	43	20

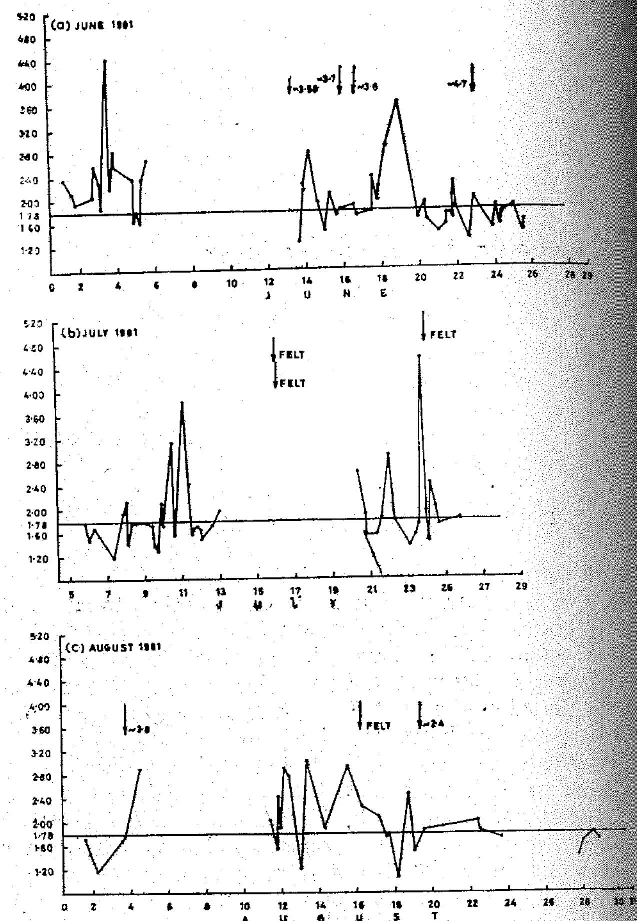

Fig. 3. Variation of V_P/V_S ratio with time during: (a) June, (b) July and (c) August 1981

TABLE 2

Moderate to large local earthquakes felt at C.S.O., Shillong (25°31′ N, 91°53′ E)

Date	Arrival time (GMT)			Magni-tude	Distance* (km)
	h	m	s		
12 Jun '79	00	06	39	Felt	100
07 Jul '79	18	16	32	Felt	100
16 Jul '79	18	41	58	Felt	11
22 Jul '79	18	22	26	Felt	171
29 Jul '79	14	16	21	Felt	148
11 Aug '79	15	03	10	3.4	55
18 Aug '79	09	09	22	3.0	17
18 Aug '79	18	13	50	3.9	125
13 Jun '81	06	19	28	3.58	94
15 Jun '81	22	57	09	3.7	77
16 Jun '81	15	05	19	3.6	62
23 Jun '81	00	36	56	4.7	214
04 Jul '81	05	39	13	Felt	8
15 Jul '81	23	21	06	Felt	111
16 Jul '81	00	07	06	Felt	121
24 Jul '81	00	10	16	Felt	16.5
03 Aug '81	18	40	12	3.8	73
16 Aug '81	06	29	04	Felt	139.7
19 Aug '81	09	23	41	2.4	16.6
06 Apr '82	06	01	17	3.9	113
16 Apr '82	15	53	02	4.0	33
23 Apr '82	22	55	02	4.0	144
28 Apr '82	03	27	34	3.5	77
10 May '82	21	38	30	3.9	51
11 May '82	19	04	50	2.8	22
13 May '82	19	00	42	4.2	111

*Epicentral distance from C.S.O., Shillong

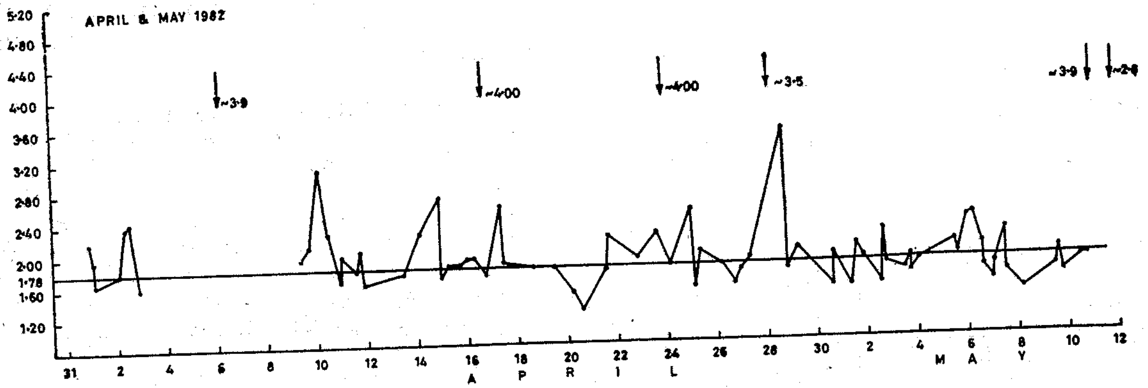

Fig. 4. Variation of V_P/V_S ratio with time during the period 1 April to 12 May 1982

5. The authors are grateful to Dr. D.K. Roy, Adviser (Minerals) N.E.C., Shillong for his kind help and advice. The authors also thank Dr. S.N. Saha, Director, Geophysics Division, G.S.I., Shillong for making use of the publication containing the basic data used in these studies. The authors also thank Dr. Amaresh Chakravarty, Geologist, G.S.I., who had collaborated at the initial stages of the present work and has helped us all along.

References

Aggarwal, Y.P., Sykes, L.R., Armbruster, J. and Sbar, M.L., 1973, *Nature*, **241**, 10, 1-104.

Aggarwal, Y.P., Sykes, L.R., Simpson, D.W. and Richards, P.G., 1975, *J. geophys. Res.*, **80**, 718-732.

Nur, A., Bell, M.L. and Talwani, P., 1973, Stanford Univ. Publ. *Geol. Sci.*, **13**, 391-404.

Srivastava, H.N. and Chaudhury, H.M., 1979, *Mausam*, **30**, pp. 289-296.

Singh, V.P. and Gupta, H.K., 1979, *Mausam*, **30**, pp. 297-300.

L. K. MALLICK

C. S. O., Shillong

UDAYAN GHOSH

Shillong College, Shillong

2 April 1985