Direction of faulting in the Great Assam Earthquake of 15 August 1950

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ABSTRACT. Using Byerly's method as modified by Hodgson and Milne, the direction of faulting in the case of the Great Assam Earthquake of August 1950 has been calculated. The results show that the displacement took place in a normal fault striking East, West and dipping to the North at an angle of 75°, the hanging wall side moving down and slightly West with respect to the footwall side.

1. Introduction

Byerly in a series of papers (Byerly 1926, 1934, 1938) had evolved a method by which the direction of first motion of P recorded at near and distant seismological observatories could be used to determine the direction of faulting in earthquakes. The method has with some improvements and modification been used in recent years by Hodgson and his co-workers for a number of earthquakes. A detailed description of the method was given by Hodgson and Milne (1951) in their paper on Direction of Faulting in Certain Earthquakes of the North Pacific. The same method has been used in the present paper to determine the strike and dip of the fault in the case of the Great Assam Earthquake of 15 August 1950. Epicentre and origin time of the shock was determined by the author (Tandon 1954) and the same has been used in the present paper. Distances of the observatories and their bearings with respect to the epicentre were also given in the above paper.

2. Materials used

In connection with the detailed study of this earthquake a large number of seismograms were collected from observatories in the world, and from these the direction of first motion (compression or dilatation) was determined in those cases where the onset was very clear. This was supplemented by data collected from individual station—Bulletins. Unfortunately there were no observatories functioning near the epicentre and consequently the direction of first motion at places near the epicentre had to be inferred from reports of observers who had felt the shock strongly and had given the direction of arrival of the first impulse in unambiguous terms. For example, Kingdon Ward (1951) who was stationed at Rima about 30 miles east of the epicentre at the time of the earthquake has described that the first impulse came from west, thus showing that the first arrival at Rima was a compression. Reports from a large number of voluntary observers from places located within Isoseismal VIII to X of the Rossi Forel Scale were also available and they point out generally that at these distances the first impulse came from the direction of the epicentre, *i.e.*, a compression. The azimuths of these places are, however, confined between SE to W with respect to the epicentre. Three observers' reports were available from Tezpore situated due SW of the epicentre at a distance of approximately $\Delta = 3°{\cdot}50$. Out of these, one reported that the first wave came from west, the second reported that it seemed to have come from a SW direction while the third reported that it appeared to have come from a NE direction. The first two were from experienced observers of the India Meteorological Department and seem to be more reliable. If these are taken to be correct the first impulse at Tezpore was a rarefaction. Several observers from Digboi, an oil town in Assam, reported that the first motion came from NE, that is a compression.

Table 1 gives the direction of first motion, recorded at different places, which have been used in the present investigation. The places which have been marked with an asterisk

TABLE 1

S. No.	Station	Distance from epicentre in degrees	Extended distance	Azimuth with respect to the epicentre in degrees from North	Compression or dilatation
1	Rima*	0·4	0·04	92	C
2	Digboi*	1·4	0·055	214	C
3	Myitkyina*	3·3	0·119	164	C
4	Tezpore*	3·8	0·130	242	D
5	Chatra	8·7	0·265	262	D
6	Calcutta	9·6	0·297	234	D
7	Delhi	17·2	0·558	275	D
8	Hyderabad	20·0	0·840	241	D
9	Poona	23·1	1·073	250	D
10	Colombo	26·7	1·182	220	D
11	Djakarta	35·8	1·365	162	D
12	Tokyo	37·0	1·382	68	C
13	Sendai	37·9	1·395	63	C
14	Sapporo	38·6	1·404	55	C
15	Fukuoka	29·5	1·250	72	D
16	Helwyn	56·4	1·704	289	D
17	Athens	60·3	1·845	300	C
18	Upsala	60·4	1·850	325	C
19	Kiruna	63·1	1·925	312	C
20	Copenhagen	63·8	1·946	321	C
21	Praha	63·9	1·950	315	C
22	Zagreb	64·0	1·950	310	C
23	Trieste	65·5	1·995	310	C
24	Jena	65·5	1·990	318	C
25	Göttingen	66·3	2·015	317	C
26	Rome	67·5	2·054	307	C
27	Stuttgart	67·6	2·055	319	C
28	Chur	68·0	2·069	312	C
29	Zurich	68·4	2·080	313	C
30	de Bilt	68·9	2·098	319	C
31	Kew	72·4	2·201	319	C
32	College	74·5	2·278	24	C
33	Rathfarnham	74·9	2·285	323	C
34	Ebro	76·3	2·336	309	D
35	Brisbane	77·5	2·378	131	D
36	Cartuja	80·8	2·500	307	D
37	Riverview	80·6	2·497	137	D
38	Sitka	84·2	2·663	26	C
39	Ivigtut	86·2	2·741	344	C
40	Seattle	96·5	2·998	25	C
41	Hungry Horse	98·7	3·023	20	C
42	Ottawa	106·2	3·072	354	C
43	Pasadena	109·5	3·096	29	C
44	Palisades	110·3	3·097	352	C

are those from which the inference has been based only on observers' reports. In the case of Indian stations the only reading from a vertical seismograph was available from Poona. For others, conclusions were drawn from direction of motion as recorded by the horizontal components. Thus, for New Delhi, the direction of pendulum motion of the first impulse for the north and east components was north and west indicating that the first impulse was a motion towards the epicentre and hence a dilatation.

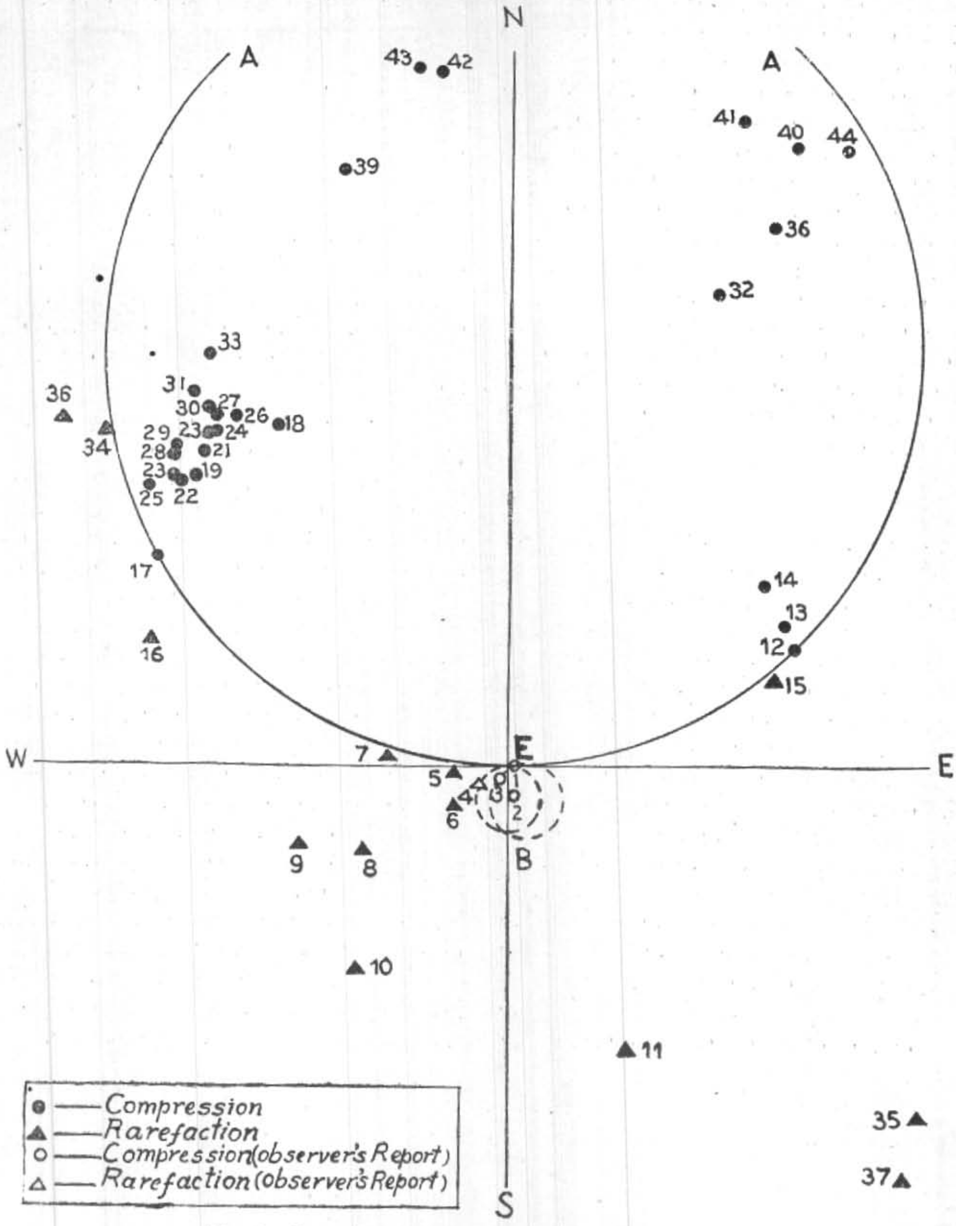

Fig. 1. Great Assam earthquake shock of 15 August 1950

(Epicentre : Lat. 28·46° N, Long. 98·66° E; origin time : $14^h\ 09^m\ 28{\cdot}5^s$ GMT ; depth : normal)

The data given in Table 1 have been plotted on a stereographic projection map (radius of the earth being taken as unity) with the anti-centre as the pole in Fig. 1. Extended distances used in plotting were taken from tables given by Hodgson and Storey (1953). Two circles marked A and B have been drawn on the map. These circles pass through the epicentre and separate the zones of compression and rarefaction. It will be seen that the circle A has been uniquely determined.

There was no direct instrumental evidence of the smaller circle B and its radius and centre had to be determined indirectly with the help of reports from observers and the Orthogonality Criteria of Hodgson (1951). It has been mentioned above that Tezpore recorded a dilatation while Digboi recorded a compression. This means that the smaller circle should pass between Digboi and Tezpore in addition to the epicentre. The dilatations recorded at Djakarta and Fukuoka also put limitations to the possible maximum radius of the circle B. Further limitations to the size of this circle are provided by the Orthogonality Criteria. Taking into consideration all the factors mentioned above the limits of the probable positions of the second circle B have been drawn in Fig. 1.

3. Results and discussion

Either of the circles drawn in Fig. 1 can represent the fault plane. If the larger circle A represents the fault plane the smaller circle B will represent the auxiliary plane or vice versa. Knowing the radius r of the fault plane circle, the dip δ of the fault is given by $r = \frac{1}{2} \tan \delta$. The strike of the fault is given by the direction of the tangent to the circle at the epicentre. In the same way the dip δ' of the auxiliary circle can be calculated from its radius r'. The motion direction lies in the fault plane and the auxiliary circle is perpendicular to it (by definition). If ϕ represents the angle between the strike of the fault plane and the strike of the plunge plane then the plunge of motion direction β is given by $\tan \beta = \tan \delta \times \sin \phi$. The plunge of motion direction is also equal to $(90—\delta')$.

If the larger circle is taken to be the fault plane circle it will represent a normal fault striking east west and dipping towards north at an angle of 75°. The motion took place in this plane along a line striking N to NW, the hanging wall side moving downwards and a little westwards relative to the footwall side.

If the smaller circle is the fault plane it would also represent a normal fault, the strike of which is limited between the sector E-W to NE-SW and dipping to S to SE at an angle of 15° to 20°. The motion took place in this plane in a N-S direction, the footwall side moving up.

It is not possible to choose between the two possibilities mentioned above from purely instrumental evidence. The general geological features of the epicentral region and the other effects caused by the earthquake can be helpful. Several isoseismal maps of this earthquake have been published (Tandon 1950, Poddar 1950 and Roy 1953). These maps which are in all cases incomplete and differ in some details, however, have two common features, one the elongation of the isoseismals in a general east west direction and second a tendency for the isoseismals to come closer together to the south of the epicentral tract in comparison to the north. From these observations, Roy (1953) concluded that the displacement took place along a fault striking NE to SW and heading towards NW. These observations and the fact that the major faults in the Eastern Himalayas generally head towards north make it more probable that the larger circle A represents the fault plane.

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