Appendix A.

Reports of officers of the Geological Survey of India despatched to investigate the effects of the earthquake.

This appendix contains, with unimportant omissions, all those parts of the reports, referred to on p. 2, which have not been incorporated in the body of the text. They were drawn up under specific instructions to report only the facts observed, and to refrain from any expression of opinion as to the conclusions to be drawn, as this could only be profitably done after a review of the whole of the facts, of which only part could become known to each individually.

---

1. Report by Mr. T. D. LaTouche, *Superintendent, Geological Survey of India.*

Calcutta, Assam, Sylhet.

Calcutta.—The monument consists of a massive oblong pedestal built of brick, measuring 16 feet 2 inches from east to west, and 13 feet from north to south, 10 feet 3 inches in height, surmounted by a tapering obelisk, also of brick, the original height of which from the ground was 50 feet. The upper 6 feet or so of this has been broken off, and the fragments, including a conical stone cap which formed the summit of the obelisk, are now lying at the foot of the pedestal on its south-west side. The longer sides of the monument run E 20° S and W 20° N.

Monument to Sir William Jones, Old Cemetery, Park Street, south side.

The brickwork in falling from the top has struck and broken off the edge of the cornice running round the top of the pedestal over the south-west side, rather to the west of the centre, the mean direction of the break, measured from the centre of the obelisk, being S 20° W. The stone cap struck the cornice still further to the west, and made a separate fracture, the direction of this from the centre being S 53° W. As the stone cap was, however, fixed to the monument by an iron pin, it is likely that the latter, striking against the sides of the monument, caused the cap to be deflected in its descent, and the fracture caused by the brickwork probably represents more nearly the actual direction of the shock.

This monument consists of a square brick pedestal about six feet in height, with an ornamental cornice and frieze running round the top, which is conical. This was surmounted by a brick and plaster urn, fixed to the pedestal by an iron pin. The urn has been shattered into fragments and fell to the south-west, striking the cornices in three places in a direct line, the direction

Monument to Mrs. Mary Ann Wiltshire, Old Cemetery, Park Street, north side.

of which is S 27° W from the iron pin, which still remains fixed in the top of the pedestal.

St. Paul's Cathedral, Calcutta.

The iron framework forming the top of the spire was thrown off, and a number of bricks were dislodged from the portion of the spire immediately beneath it. Some of these fell to the north side of the tower, crashing through the corrugated iron roof, but the larger portion fell to the southern side, and, penetrating the roof, struck the tiled ceiling of the Church and dislodged some plaster from the inside. A large number of bricks also fell down the sides of the spire on all sides and lodged on the gallery running round the base of it. The iron framework was projected in a direction S 31½° W from the centre of the tower, to a mean distance, horizontally, of about 40 feet, and struck the corrugated iron roof, but only partially broke through it. The top is described by eye-witnesses as having oscillated for some time, a rain of bricks falling at the same time from the base of it, and then pitched over, coming down head foremost. The iron stays fixing it to the brickwork of the spire have been broken through.

Cracks have appeared at each of the angles where the body of the Church joins the tower, but the crowns of the arches supporting the tower are intact.

Town Hall, Calcutta.

At the south-east corner a large portion of the cornice, which projected four feet from the top of the wall, has fallen, as well as the heavy balustrade above it at the edge of the roof. The corner pillar of the balustrade, a large mass of brick masonry, has fallen almost intact, and is now lying 21 feet from the base of the building, in a direct line with the eastern wall. The height from the ground to the centre of the pillar, as it stood originally, was approximately 54 feet. In falling it is possible that the pillar struck the cornice and was thus projected further from the building than would otherwise have been the case, but it is quite likely that the cornice fell as soon as the balustrade, and did not affect the fall of the latter. The direction of projection is S 20° W. A large portion of the balustrade adjoining this pillar on the southern side of the roof was thrown down with it, and is lying at the same distance from, and parallel to, the foot of the wall.

1. **Brahmaputra above Goalundo.** Proceeding up the river from Goalundo, I first noticed fissuring of the banks about Sirajganj, the first place the steamer stopped at. From about this point the banks are fissured on either side to a greater or less distance from the edge of the bank, usually about 20 or 30 yards, to the neighbourhood of Mangaldai in Assam, a distance of some 260 miles, and fissures extend of course along the banks of all the minor branches of the river and its tributaries within this area. As a rule, the fissures run parallel to the bank of the river, and where this is not the case, some peculiarity in the contour of the ground, a drop for instance from a higher to a lower level, can usually be found to account for the change in direction.

Fissuring of river banks.

2. At Rowmari, for instance, besides the fissures parallel to the bank of the river, which here runs nearly north-east and south-west, a large fissure runs to the south-east at right angles to the river bank for a distance of at least 500 yards, when it becomes lost in a jheel. (It is

Rowmari.

said to run to a distance of nine miles from the river, and very likely extends much further than I traced it.) This fissure runs along the edge of a tract of ground, on which the village stands, rather higher than the level of the river bank, probably marking the line of an old river channel. Sand and mud have been ejected from the fissure to a depth of at least four feet. Other fissures branch off from this through the higher ground to the north, one of them passing beneath the huts of the villages. Subsequent to the ejection of the sand, the surface sank down to a depth proportional to the amount of material ejected, and several crater-like hollows were formed as the water drained back into the fissure (Plates X and XI). Where the principal fissure crosses those parallel to the river bank, the surface of the ground is broken up into a number of square blocks.

Jatrapur.

3. At Jatrapur the narrow gauge railway from Kaunia to Dhubri joins the river. The railway bund[1] is much fissured, the fissures running parallel to the bank of a jheel along which the railway is carried. In places the bund has subsided vertically by settlement and spreading out on either side of the earth composing it, and the rails are bent and twisted.

Time of shock.

4. Dhubri. No accurate record of the time was taken at the Telegraph Office, as the pendulum of the clock was broken by the shock. It is estimated to have occurred at about 5-20 P.M. local time, which is 39 minutes in advance of Madras time.[2]

Gate pillar at Telegraph Office.

5. The gateway faces south-east. The pillars are of square section 1 foot 8 inches square by 4 feet 10 inches high, built of brick. That on the north-east side has fallen towards N 40° E and struck the bank alongside the gateway, rolling off into the ditch. The capping has turned round in its fall and is lying with its point facing the pillar. The other post is standing, but cracked through at the base.

Treasury.

6. This is a strongly brick-built structure, measuring outside 80 feet by 41 feet 4 inches, standing nearly cardinal, the longer side facing N 5° E. It is divided in the centre of its length by a passage eight feet wide, on either side of which are two large rooms.[3] The flat roof is supported as usual by strong beams, on which small battens are laid, which in turn support the tiles of the ceiling. In the passage way the beams run east and west, the battens north and south, while in the rooms the position of the beams and battens is the reverse of this. In the passage way the battens have been dislodged some of them having fallen out and all having moved more or less out of their places. In the side rooms, on the contrary, the battens have not moved at all, but the beams can be seen to have moved backwards and forwards on the walls. The upper part of each corner of the building has fallen, in the most symmetrical manner, for about eight or ten feet from the roof.

Observatory.

7. This is a hexagonal brick structure, two storied, measuring 9 feet 6 inches on each side (outside measurement). The door faces S 15° E. From the top of the door-way, 7 feet 6 inches

[1] Embankment.

[2] The Cutcherry and Treasury clocks both stopped at 5½ minutes past 5 P.M.

[3] *i.e.*, four rooms in all.

above the plinth, a crack runs diagonally up to the roof on the east side, passing through the small hexagonal window on that side. A portion of the cornice has fallen from the east-south-east and north-east sides.

Thermometer shed.

7(*a*). The thermometer shed is in front of the observatory building. A plan of this is given in fig. 24. It consists of a thatched roof up ported by eight brick pillars, each of which is cracked through near the base and twisted in the direction of the hands of a watch from 5 to 12 degrees.

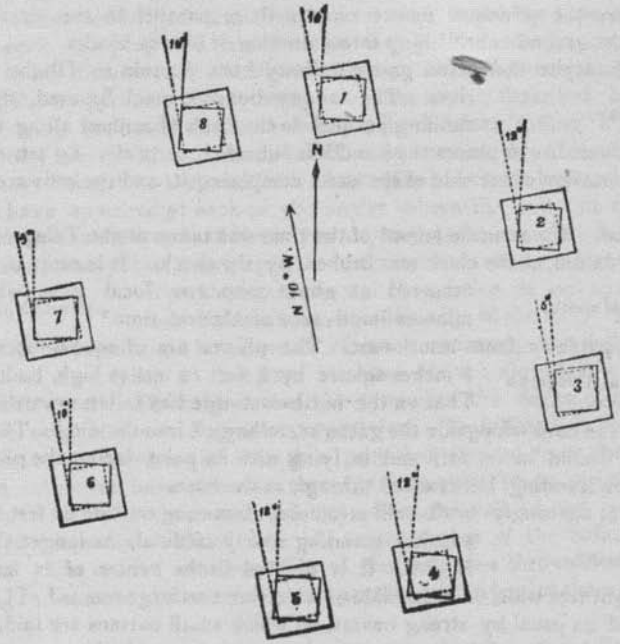


Fig. 24. Plan of pillars of thermometer shed at Dhubri.

The anemometer, which was fixed to the top of a wooden structure 14 feet high, was thrown down, but had been removed at the time of my visit.

Gate pillars at Zamindar's house.

8. Of these two gate pillars one has fallen due north, having broken off at 20 inches from ground level. The other pillar has not fallen, but is leaning over at an angle of 5° from the perpendicular towards S 15° E.

Jubilee well.

9. This was an octagonal structure, well built of brick masonry, with alternate walls about 14 feet high supporting an ornamental roof. Between these on three sides were low walls supporting an iron tank above the well, the fourth side on the west being left open to allow access to the well. Of the four walls supporting the roof three, *viz.*, those on the south-west, north-west and north-east sides, have each fallen flat

on the ground away from the well, while the fourth on the south-east side is still partly standing, but cracked through. The well was originally about 30 feet deep and held about 20 feet of water. It is now filled up with sand to nearly one foot below the surface of the water.

Fissures along river bank, etc.

10. The greater part of the station of Dhubri is built on a low eminence of gneiss, bounded on the north, east and south by the river, and to the west by alluvium, on which the bazar is built. This portion of the station has suffered severely from fissuring, especially near the banks of the river. Several high bunds which run due north from the bazar to the road connecting Dhubri with Kuch Bihar have been fissured transversely at intervals of a few feet, and settled down considerably.

Effects of earthquake in district.

11. From a letter written after the earthquake by the Deputy Commissioner, Mr. Hallifax, to the Commissioner, Assam Valley Districts, dated 24th June 1897, I obtained the following particulars:—

At Gauripur, 5½ miles to north of Dhubri, pucca buildings and bridges were all destroyed and low-lying places filled with sand. The time is given as 4-30 P.M.

At Sukhchar, a khal, 300 × 78 × 5 feet, was entirely filled with sand ejected from fissures, which is said to have spouted up to a height of 10 cubits.

At Mankachar (Lat. 25° 32', Long. 89° 55'), the thana is said to have sunk 4 cubits. The river, which was 30 feet deep before the earthquake, was choked with sand to within 8 feet from the surface, and heavy floods occurred in consequence.

At Bijni (Lat. 26° 30', Long. 90° 45'), sand and water were forced up to a height of 4 or 5 cubits. The time of shock is given as 4-55 P. M.

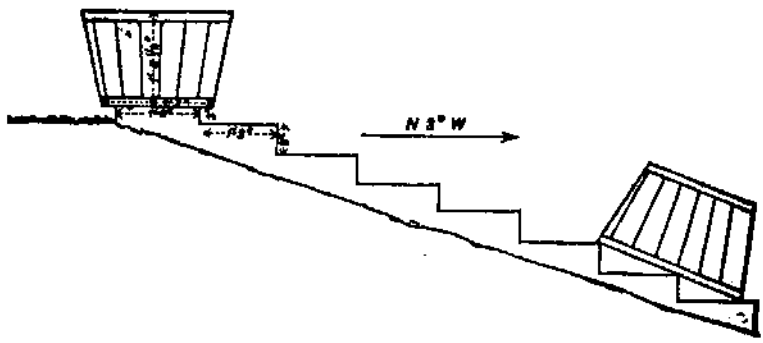


Fig. 25. Overthrow of plant-tubs at the Assistant Commissioner's bungalow, Goalpara.

12. Goalpara. The Assistant Commissioner's bungalow is situated on the crest of a ridge of gneiss overlooking the river, running from south-east to north-west.

Assistant Commissioner's bungalow.

The bungalow itself has entirely fallen, the general direction of fall being towards north. In front of it is a flight of steps eight in number (see fig. 25), on the topmost of which stood two tubs, one at each side, filled with earth. Both of these have toppled over and rolled down the steps, both falling in exactly the same direction, to N 3° W. They seem to have struck the third step from the top in falling and then turned completely over. It is possible that the tubs were jerked forward to the edge of the steps by the shock and then tilted over. If they were first tilted up, it would, I found by trial, require an angle of tilt of 35° to cause the tub to slip off the edge of the step.[1]

Cemetery. Tomb of Mrs. Ann Simons.

The cemetery is situated on the south-south-east slope of the ridge, the average angle of slope being 15°. The monuments are mostly of the oblong box form, common some 50 years ago, with their longer axes lying east to west, or transverse to the slope of the hill. Mrs. Simons' tomb has fallen over to S 5° E without breaking, and now stands at an angle of 24° from the vertical.

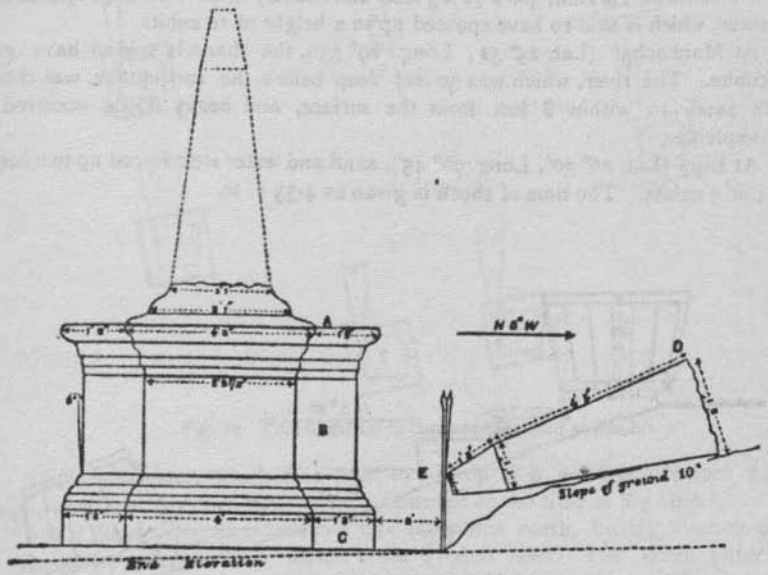


Fig. 26. Tomb of Ensign Law, Goalpara.

Tomb of Ensign Law.

Ensign Law's tomb is of the same shapegenerally, but was surmounted by an obelisk 5 feet 8 inches high, which broke off at its plane of junction with the top of the tomb and was thrown to N 5° W. As it fell, it must have

[1] It seems more probable to suppose that they were projected, like the tomb of Ensign Law.—R. D. O.

turned over, since the apex is now lying at the foot of the railings surrounding the tomb. It just touched the top of one of the spikes of the railings in falling and bent it slightly outwards.

A square column at the lower end of the Cemetery has fallen over to E 30° S. This measures 3 feet 5 inches high by 1 foot 10 inches square, with a conical cap 2 feet 4 inches square by 1 foot 6 inches high.

Two other tombs similar to that of Mrs. Simons have slipped off their foundations and heeled over to south without breaking.

All these tombs are built of brick masonry.

Treasury.

14. The Treasury was a massive brick building standing at the foot of the hill near the river bank, and facing N 17° E. A portion of the front of the building has fallen out, and the west end is also destroyed; the remainder is greatly cracked.

Bazars.

15. A large fissure opened beneath the houses along one side of the bazar, running roughly parallel to the river bank, in a westerly direction. From this a large quantity of sand was ejected, filling the interior of the houses up to the eaves. The surface of the ground then subsided, carrying the houses with it, so that the roofs are now resting on the sand (Plate XXII, fig. 1). A view of the fissure at the eastern end of the bazar is given in Plate XXII, fig. 2. A well, seen at the left hand side of the picture, was entirely filled with sand, which was ejected with such violence that the wooden cover of the well is said to have been hurled through the air to a distance of several yards.[1]

Time of shock.

16. The Telegraph Office was destroyed entirely at the beginning of the shock and the time was not noted.

Subsequent shocks.

17. At the time of my visit slight shocks of earthquake were very frequent. As a rule each shock was accompanied by a more or less distinct booming sound, apparently proceeding from the south-south-east, and generally heard slightly in advance of the shock. Frequently the sounds were heard without any shock following, and they then resembled very closely the well known "Barisal Guns," though they were not so sharp and well defined as I have heard them in the south-western portion of the Garo Hills.

Time of shock.

18. Gauhati. The clock at the Telegraph Office stopped at 5·15 P. M., local time, which is 46 minutes in advance of Madras time. The clock is said to have been correct within one or two minutes. The pendulum was broken by the shock.

Deputy Commissioner's bungalow.

19. At the head of the steps leading from the bungalow to the river bank, two low brick pillars, supporting a wooden railing, have fallen to S 30° E and S 40° E, respectively. These were 3 feet 6 inches high by 1 foot 7 inches by 1 foot 1 inch on sides, the longer sides facing south.

Commissioner's bungalow gate pillars.

20. At the entrance were two large gate pillars, on either side of the gateway facing west-south-west, 10 feet high and 2 feet 5 inches square. One of these has broken through at 2 feet

[1] See p. 104.

9 inches from the ground and twisted 6°, from N 24° W to N 30° W. The other pillar is broken through at the same level but is not twisted.

Old Dák bungalow gate pillars, Pl. XXI, fig. 2.

21. Of the four gate pillars at the two entrances to this bungalow,[1] three are broken off and twisted in the same direction as that mentioned above. The fourth pillar has fallen to S 20° W. These pillars are all built of brick masonry.

Civil Surgeon's bungalow gate pillar.

22. The coping of a small gate pillar in the compound wall of this bungalow was shot off and is now lying on the ground at a distance of 4 feet 4 inches from the centre of the pillar. The direction in which it was thrown was S 35° E.

Commissioner's and Deputy Commissioner's cutcherries.

23. Both the cutcherries were wrecked, but a great portion of the roof of each is standing, merely the walls having fallen. The Commissioner's cutcherry is shown in Plate XX, fig. 2. The roof of this was partly supported by strong wooden posts. The Deputy Commissioner's cutcherry (Plate XX, fig. 1) is in the form of a cross with equal arms facing the four points of the compass. The roof was partially supported by round brick pillars, which, though cracked through, have not fallen. The weathercock, seen in the photograph, was an effigy of a peacock and has tilted over to the north, so that its tail is hanging down beside the rod supporting the letter N.

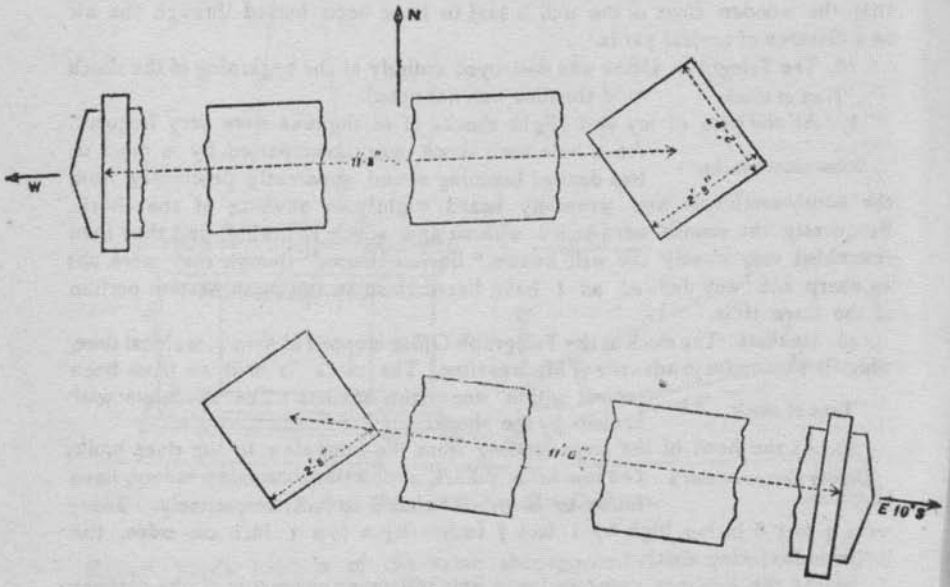


Fig. 27. Plan of overthrown gate pillars at Gauhati.

[1] This is the same building as the Telegraph signallers' quarters mentioned in Chapter XIV.

24. On the west side of the Deputy Commissioner's compound a low wall runs along the road, on which stood a balustrade of clay pilasters supported by pillars at intervals of about 11 feet. Nine of these have fallen, most of them to about S 20° E, one to N 70° W and another to N 35° W. The wall runs E 32° N, W 32° S. One of the pillars has broken off at the top of the wall and twisted, without falling, 10°, from N 25° W to N 15° W.

Compound wall.

At the gateway at the east end of this wall both pillars have fallen, one due west, the other to E 10° S (see fig. 27). At the western gateway there were similar pillars which have broken off at the height of the top of the wall, three feet from the ground, and fallen, one due N, the other to N 20° W.

25. Most of the tombs here are of the common square or oblong box shape built of brick masonry and plastered. That of G. T. Bayfield, died September 1840, was surmounted by an obelisk, the greater portion of which has fallen to S 20° E. A similar obelisk close by (F. Gomes, died September 1848), has fallen to S 25° E. The monument shown in Plate XXI, fig. 1, is of precisely similar construction, but in this case the obelisk is broken across at about half of its height, and the upper part has twisted 48°, from N 18° W to N 30° E. Close to this are two tombs standing on a common plinth and precisely similar in all respects, but instead of conical obelisks they were surmounted by cylindrical brick pillars 1 foot 6 inches in diameter and about 4 feet high. Of these one has fallen to N 45° W while the other has gone exactly at right angles to this, *viz.*, to S 45° W. Both pillars have been entirely broken up by the fall, but in the first case the base of the pillar is lying at a greater distance from the base of the tomb than the rest of the pillar. The tomb measures 3 feet square by 4 feet 6 inches high, and the base of the pillar is lying at a distance of 12 feet from the corner of the tomb nearest to it. The top of another obelisk (Samuel Fleming, died May 1853) has fallen to N 45° W. The lower part of the tomb on which this stands is also cracked through, at a height 1 foot 7 inches from the plinth. This tomb measures 4 feet 9 inches high by 2 feet 9 inches square.

Old cemetery.

Only one of the more recent tombs has been affected by the shock (Miss Lamb, died April 1875). This is a small marble pedestal standing on a brick plinth and surmounted by a cylindrical marble pillar 3 feet 5 inches high by 11½ inches diameter. The pillar was thrown off to the south and fell, without striking the low railing surrounding the tomb, and is now lying pointing east and west at a distance of 8 feet 6 inches from the centre of the pedestal. It may have rolled somewhat after touching the ground.

This cemetery is situated on the alluvial ground to the south of the station.

26. The new cemetery is situated on the flanks of a low hill of gneiss to the east of the station, and has suffered little or no damage from the earthquake, except that the wall surrounding it has fallen at the north-west and north-east corners and near the south-west corners. A marble slab on the tomb of R. J. Eades, died 1884, is cracked across the middle, the crack running N 10° E.

New cemetery.

27. This is a perfectly new brick building, but is greatly damaged by the shock. It faces S 10° E. The centre gable has fallen out on both sides of the building to south and north respectively, the brickwork having broken up into large masses. The end walls east and west are cracked but standing, the cracks running diagonally in both directions, north and south, at an angle of about 45°, from the corners of the windows in centre of walls.

Railway station.

28. This Temple is an octagonal building with a domed roof, built of tiles, 9 inches × 7 inches × 1½ inches in size. The sides facing E 15° S and W 15° N have fallen outwards altogether, and those facing north and south are partly fallen.

Old temple near steamer ghat.

29. This is a brick structure with a flat roof supported by numerous arches with minarets at each corner and on either side of the large central arches. The larger side, towards the river, faces west. Only one of the minarets has fallen, that on the north side of the central arch towards the river. This has fallen due west. The two side arches at each side of the central arch, and those at each end of the building, are cracked at the crown.

Pucka ghat at the steamer landing.

30. At the western end of the Gauhati Bazar is a bridge of three girders carrying the Grand Trunk Road over a small stream, which here joins the Brahmaputra. The original length of the bridge, as measured along the hand rail, was 99 feet 4 inches, while the present length, between the same points is 97 feet 10 inches. The bridge has therefore been shortened 18 inches. This has been caused by fissuring of the banks on both sides of the stream, the abutments having been carried forward. One of the piers has been tilted over, probably by the thrust of the girder. There are no cracks in the abutments.

Bridge on Grand Trunk Road west of Gauhati.

31. On the north bank of the Brahmaputra, opposite Gauhati, are some old temples standing on a rocky promontory immediately over the river. These were built of tiles similar to those in the temple above mentioned. All except one, which is at the base of the promontory close to the water, have fallen, the tiles having slid off each other in all directions. The dome of the one which is standing is split through the middle, the crack running N 15° E and vertical.

Temples at Gauhati north.

A small structure consisting of a corrugated iron roof supported by four low brick pillars, erected over a lingam near the temples, has fallen over bodily towards E 10° S.

32. The accounts of the earthquake received from the surrounding country all speak of fissures opening along the banks of rivers and consequent subsidence of the surface, also of quantities of sand being ejected, filling up the beds of rivers and jheels and causing floods. The Sub-Deputy Collector of the Borpeta Circle says that, while he was proceeding by boat down the Singur river towards Borpeta, which lies to the west-north-west of Gauhati, he heard, when near Kahi Kuchi, a low rumbling noise occasionally, apparently coming from the direction of the

Effect of earthquake in districts.

Garo Hills, to the south-west. The shock was immediately preceded by a noise of the same kind. The river became filled with sand, and the water flowed over the surrounding country. At Borpeta the water continued rising till the 19th June and the station was flooded.

At Patti Darrang, 10 miles to the north of Gauhati, an old stone bridge, said to have been built by the Mohamedans, has fallen.

At Hazu, 16 miles west-south-west from Gauhati, the Mahdub or Madhava temple,[1] said to have been the oldest in Assam, has also been destroyed.

33. **Tezpur.** The time at which the shock occurred was not observed in the Telegraph Office here.

Church.

34. The east wall of the Church has fallen outwards. The north and south walls are considerably cracked. The cracks run vertically upward from the crowns of the arches over the windows. At the western end of the Church is a small belfry supported by tall wooden posts let into a brick-and-cement plinth, raised 2 feet 9 inches above the ground. The posts have rocked from east to west, forcing out the bricks and cement at the edge of the plinth opposite to each post.

Cemetery.

35. In the Cemetery very little damage has been done and no good measurements could be obtained. An inverted *ghurra* on the top of a square pillar 8 feet high, has fallen over to south, and an obelisk on another tomb has been cracked through at about one-third of its height from the top, the plane of the crack dipping slightly to south-west.

A large pillar on one side of the gateway, measuring four feet square, has fallen to pieces, the greater portion having gone to the west. The corresponding pillar is badly cracked but standing. These were built of very loose masonry.

General remarks.

36. Beyond the cases above mentioned I could find no overthrown gate pillars or anything of the kind which would enable one to determine the direction of the shock at Tezpur. The banks of the river here were not fissured, and I did not notice any fissures to the east of Mangaldai. Numerous large fissures are, however, said to have occurred at Nowgong.

37. **Assam-Bengal Railway.** I went out along this line as far as the bridge over the Kopili river, about 41 miles from Gauhati. The rock cuttings, in gneiss, have not been affected in the slightest degree by the shock, but where the line passes over alluvium, the embankment has settled down carrying the rails with it. Many of the culverts are badly cracked, apparently from the same cause as has affected the bridge mentioned above at Gauhati, *viz*, the fissuring of the banks of the streams and the consequent sliding forward of the abutments and wing walls. The piers of the large bridge over the Kopili are cracked through horizontally at about 2 feet above the ground level, and the girders have shifted lengthways on top of the piers. This bridge runs east to west.

Telegraph Office.

38. **Shillong.** The time of the shock on the 12th June was not observed accurately, but it is said to have occurred at 5·15 P.M., local-time. Since the first shocks occurred the signallers have amused themselves by telegraphing a certain signal to Gauhati or Sylhet, whenever

[1] This temple was built in 1672 Saka, under orders of the King Pramatta Singha.

they happened to be at the instrument and felt a shock, at the same time receiving a signal from either of those places, if the shock was felt there. The Telegraph Master assures me that in all cases the shocks are felt absolutely simultaneously at these places. I asked him to note the exact second at which a shock was felt in Shillong, and to ask the signallers at Gauhati and Sylhet to do the same, but he assured me afterwards that no difference could be detected.

He also informed me that an Assistant was sent down to Nongpoh, on the Gauhati road, as soon as possible after the shock of the 12th June, to restore communication with Gauhati. On attempting to signal through a single wire, with return circuit through the ground, it was found that as each earthquake shock occurred the current was interrupted, or even reversed. What is called a "closed circuit" was being used, that is, the current was kept continuously flowing through the wire, and interrupted by the key only at the moment of sending a signal. Apparently the earthquake shocks set up currents in the earth, for, when a second wire was used instead of the earth as a return circuit, no effect of the kind was observed.

39. A large number of the monuments in the cemetery were affected by the shock. The cemetery lies on a spur at the west end of the station, the ground sloping at an average angle of about 7° to south and south-west. The greater number of the monuments, of which plans are given, lie close together on the more level ground on the crest of the spur.

Cemetery.

Major Willans, d. July 1886.

This is a marble slab, 4½ inches thick, resting on a plinth of quartzite.[1] The slab has been jerked towards E and at the west end, slightly to S.

G. R. Nicholls, d. May 1889.

A marble slab, carved into a cross, resting on a quartzite plinth. The movement of this has been towards S-E.

Mrs. Maxwell, d. February 1889.

This is a granite cross standing on a base of the same rock forming three steps, the lowest of which is tilted to E at an angle of 2° 50″, while the upper two have fallen over with the cross and are still attached to it.

Mrs. Spring, d. December 1885.

This is a similar cross but built of marble. The lowest step has tilted over at an angle of 8° 30″, the next has slid off and is resting against it, while the cross with the topmost step attached has fallen to E.

Mrs. Rossenrode, d. July 1885.
Pl. XXXVIII, fig. 2.

This is a small marble pedestal, resting on a plinth of quartzite slabs covering the grave, and supporting a small marble cross. The pedestal has twisted round 26°, the eastern side now facing E 26° S. The cross has fallen and is lying in the position shown at the foot of the pedestal.

Mrs. Walker, d. July 1885.

This consists of two marble slabs, the upper one carved into a cross. The lower slab has tilted over to S, at an angle of 10°, and the upper one slid off in the same direction.

[1] The quartzite, of which all the plinths and some of the tombs are built, is quarried from the quartzites of the Shillong series in the neighbourhood.

Mrs. Sherriff, d. August 1881. Pl. XXXVIII, fig. 3. This is a similar tomb to the last, but in this case both slabs have been jerked to the north-east. The upper one then slid off and is lying beside the lower.

Captain Maitland, d. April 1873. This is a marble cross standing on a marble pedestal, supported by four narrow strips of marble. One of these strips on the southern side has been jerked to S-W and the pedestal has slid off to S. The cross then fell over to S 15° W, the top of it catching on the railings of the adjoining tomb.

Douglas Gray, d. June 1879. This is a small dome-shaped marble slab supported on a quartzite plinth. The slab has been jerked to S E.

Captain Cookesley, d. April 1872. This is a freestone slab carved into a cross, resting on a thinner slab of similar material, the whole supported on plinth of quartzite blocks. The lower slab has moved two inches to E, while the upper has moved three inches further in the same direction, and has been jerked off to S, the edge of it resting on edge of the plinth.

Mrs. McCulloch. Pl. XXXVIII, fig. 4. A marble slab with cross carved upon it, resting on a quartzite plinth. The western end of the stone has been jerked round to S, while the eastern end has hardly moved.

C. A. Eglinton, d. June 1892. This is also a marble slab, similar to the last but supported on four oblong strips of marble. The slab has been jerked to N E, while the strips at the W and S sides of the grave have gone in the opposite direction.

Small tomb without date. A small marble cross three inches thick lying on a quartzite plinth. The cross has been jerked its own width due S.

Alfred Goldney, d. July 1881. This is a small freestone slab carved into a cross resting on a quartzite plinth. The slab has been jerked towards S E.

R. D. Frazer, d. June 1884. Pl. XXXVIII, fig. 1. In this case the marble slab carries a small marble cross, supported on three steps near the west end. The cross has not fallen, but the west end of the slab supporting it has been jerked to the south, being twisted through an angle of 15°.

Miss F. Fitzpatrick, d. October 1888. This is a large marble slab resting on a quartzite plinth. It has been jerked about two inches to E, and the eastern end has moved slightly to south. This tomb lies on the slope of the spur near the south-east corner of the cemetery.

Rose Skene. This is a small tomb consisting of two oblong blocks of quartzite with a small marble cross let into the centre of the top. The blocks have been jerked towards S rather more at the western end than at the other.

Cecil Skene. This is a similiar tomb to the last, but in this case there are four blocks of quartzite covering the slab sup-

porting the cross. The whole have been jerked in the same direction as the other, but the block on the south has separated from the others and fallen over the edge of the plinth.

At the top of the cemetery near the north-east corner three crosses have fallen due W and broken up. The headstone of another grave near these has broken off a few inches above the ground and fallen to E.

40. The pillars on either side of the gateway are built of cubical blocks of stone with a heavy stone coping, facing the four cardinal points very nearly. That on the south side of the gateway has fallen due N. The other is standing, but has twisted about 5°, from N8° E to N3° E. The cubes have each an iron pin let into the centre, which fits into a hole in the cube above.

Fenton's Hotel gate pillars. Pl. XXXIV.

41. These pillars are similar to the last, but the blocks measure 16″ × 16″ × 10″ and the coping 21″ × 21″ × 3″. One of them has fallen to N10°E. The other has not fallen in any particular direction, but the stones are lying scattered round the base. These pillars were not able, however, to fall freely, as the wire fencing surrounding the compound was attached to them.

Inglisby gate pillars.

Two pillars on the opposite side of the road from this house, built of oblong blocks of stone, have both fallen due S.

42. These were two pillars built of rubble stone masonry, the longer sides of each facing north and south. Both have fallen, the one due N and the other due S.

Ashley Hall gate pillars.

43. These are two strongly built pillars of cut stone, neither of which has fallen. They are both a good deal shattered near the base, and the one on the western side of the gateway has shifted bodily above the second course from the base to the north-west, twisting slightly, from N15°E to N18°E, at the same time. The other pillar has also twisted, the greatest amount of twist having taken place between the 4th and 5th courses from the base, from N15°E to N19°E. The lower seven courses of this pillar are more or less shattered. Each pillar supports a heavy iron gate, which was standing open at the time of the shock.

Beauchamp Lodge gate pillars. Pl. XXXIV.

44. One of the pillars of the gateway of this house, built of squared stone blocks, has fallen to N 10° W, the pillar faced N 40° W, and was 5 ft. 2 in. high by 2 ft. square. The corresponding pillar to which the gate is attached is much shaken but has not fallen.

Col. Macgregor's house gate pillar.

45. Of other pillars of which I was not able to get the dimensions, as they have broken up entirely, the directions of fall were—

Other gate pillars.

(1) S 5° E.
(2) S 25° W ? stones probably moved since fall.
(3) S.

46. The Willans memorial stood in the club grounds, and consisted of a square pedestal supported on two steps, and surmounted by an obelisk. The whole was built of blocks of Shillong quartzite. The apex of the obelisk, which was a square

Willans memorial. Pl. XXXIII.

pyramidal stone measuring about 1 foot on sides, had been carried from the position in which it fell before I saw it, but I was able to identify four of the blocks immediately beneath this, and the positions in which they fell are shown in the plan. The three blocks seen in the sketch on the top of the portion of the pedestal still standing are twisted slightly towards the east.

Bridges on Gauhati Road.

47. The large bridge on the Gauhati Road about 1½ miles from Shillong, over the Umkra river, has suffered severely. The abutment on the south-east side fell entirely, carrying the girders with it. The two piers and the abutment on the north-west side, which are of more recent construction, remained standing, though somewhat cracked. It appears that the piers were recently widened and that the vertical cracks near the lower sides of them occurred at the junction of the newer and older masonry.

Landslips, Pl. III.

48. Numerous landslips have occurred along the steep hill sides between Shillong and the crossing of the Umiam river, 8 miles from the station. At the Bishop's Fall, about 2 miles from Shillong, the precipitous cliff on the right of the fall, down which the path was carried, slipped down entirely into the basin at the foot of the fall. The crest of the fall was not affected, as it is formed by a strong dyke of diorite. The nearly vertical quartzites have been shaken away from this dyke. Some fine slips are seen on the hillside facing the fall. A view of these is given in Pl. III.

Khasia monoliths.

49. At the Khasia Bazar at Maokhar, just outside Shillong on the Gauhati road, was a collection of the large monoliths of quartzite set up in former times by the Khasias as ancestral memorials. Several of these have fallen, the majority between W and S W, but one or two have fallen due N. Some of them are broken through at ground level or a foot or so above it.

Khasia monoliths.

50. **Maophlang.** At the Dâk bungalow at Maophlang, 14 miles to the south-west of Shillong, there were four large monoliths in a line running W. 30° S to E 30° N. Two of these have fallen, both to S 30° W. One of these was 20 feet high by 4 feet 3 inches broad and 9 inches thick at the base, slightly tapering towards the top. This has broken off at 2 feet from the ground. The other was 14 feet high and has broken off at ground level.

Reported change of level in hills.

51. Mr. Evans, the Missionary at Maophlang, informed me that soon after the earthquake his attention was called by one of his converts, a Khasia, to the aspect of the hill immediately to the west of the village. These hills are separated from that on which Maophlang stands by a deep valley, through which one of the tributaries of the Bogapani runs. It appeared to them that beyond the hill on the west side of this valley they could see more of the distant hills than before, and they came to the conclusion that the intermediate range of hills had subsided. The furthest peaks they can see from Maophlang are some four or five miles distant. Of course an elevation of the more distant hills or of that on which they were standing, would produce the same apparent effect as a subsidence of the intermediate hills

and if any change of level has taken place, I should think it more likely that it would be elevation than subsidence. The hills to the west of Maophlang, judging from the number of landslips visible, have evidently been very severely shaken.

Road to Cherrapunji.

52. The Khasia path from Maophlang to Cherrapunji, which is part of the old main road across the hills from Tharia Ghat to Gauhati, has not suffered much, as it usually avoids the side slopes of the hills. The cart road, however, from Shillong to Cherra has entirely disappeared in places, wherever it was carried along the edge of the scarps above the stream, which runs in a deep gorge to the east of Cherra, and is everywhere badly fissured.

David Scott's monument.

53. **Cherapunji.** The monument erected by the Supreme Government to the memory of David Scott is a very massive structure, built of large squared blocks of sandstone bound to each other with iron clamps. The upper portion of the obelisk has fallen, mainly towards the S W, but some portion has also fallen towards N N E. One of the loosened stones is still lying on the top, overhanging the southern side by about ⅓ of its length. The whole monument above the two steps at the base has moved bodily towards S W. The stones of the lowest course of the pedestal have been shaken apart from each other, the one on the west side having been jerked out to the edge of the step below.

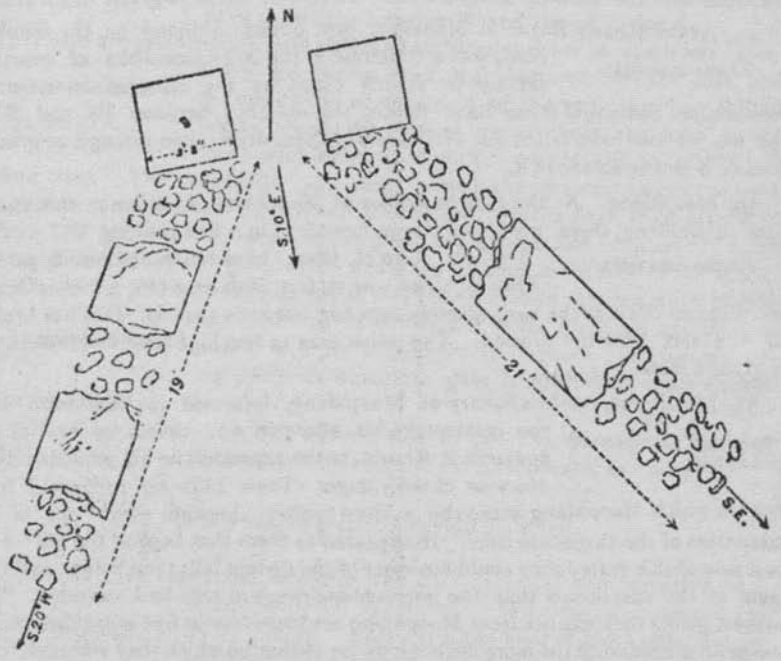


Fig. 28. Plan of overturned gate pillars at entrance to Inglis' house, Cherrapunji.

54. At the entrance to the avenue leading to Mr. Inglis' house stood two lofty gate pillars, which formed a conspicuous object in the landscape. No gates were attached to them. They were built of rubble stone masonry. Both have fallen, but in different directions, as shown in the plan, fig. 28. The material of one lies scattered to a distance of 19 feet from the base of the pillar, and the other to 21 feet.

Mr. Inglis' house gate pillars.

Close to the gateway of the house a small stream crosses the road, over which, when the house was inhabited, a small aqueduct was carried on a series of brick pillars. One of these on the edge of the stream has fallen, and the corresponding one on the other side has cracked across at the base and twisted through 5° from N 25° E to N 30° E. The pillars are built of brick.

At the gateway leading into the compound of the house an ornamental pillar standing on the wall surrounding the compound has broken across at the top of the wall and twisted through 5° from N 54° E to N 58° E. The height of the fracture from the ground is 4 feet 6 inches. The two gate pillars have fallen in a heap in the gateway, that on the east side having fallen to south-west. These pillars are built of rubble stone masonry.[1]

55. On the road from Cherra to Maosmai, there are two gate pillars, one of which has fallen to N 50° E, while the other is not even cracked. These are cylindrical, 2 feet in diameter and 7 feet high, built of rubble stone masonry.

56. All the tombs are of the oblong form with sloping tops common 50 years ago, and are all built of rubble stone masonry. Very few are broken up, but nearly all have sunk down into the loose sand beneath them, and are leaning over at various angles to the north. The cemetery is situated on the top of one of the small knolls of sandstone which are scattered over the Cherra plateau. This sandstone originally rested upon the limestone of the plateau, which has been dissolved away from beneath it, and is accordingly much broken. The earthquake seems to have shaken the surface down into a perfect quicksand, into which the tombs sank.

Cemetery. Plate V.

57. **Maosmai.** At the village of Maosmai, on the edge of the cliffs about 3 miles south of Cherra, there are two well known groups of Khasia monoliths of unknown antiquity, from which the village takes its name (the stones of the oath of allegiance). In each group there are five stones ranging from about 12 to 18 or 20 feet high. They stand in a line facing due east on the edge of the stream running through the village. I found that one stone in each group had fallen, in each case due W.

Khasia monoliths.

In the larger group the fallen stone measures 14 ft. × 3 ft. × 1 ft. In the smaller 12 ft. × 3 ft. × 1 ft. They were let into the ground to between a foot and 18 inches.

58. I asked the missionaries both at Cherra and Maophlang, whether it was likely that, in case any of these monoliths, which are found all over the hills, had been overthrown by a former earthquake, the Khasias would have set them up again. They said that it might be done in the case of well known and venerated stones like those at Maosmai, but in ordinary cases, where they were put up by the members of a family in memory of an ancestor, no one after a generation or two

[1] For plans of these two pillars see plate XXXV.

would take any care of them. It seems then that as the erection of the monoliths must date back to a remote antiquity, and as the Khasias have for generations neglected the custom of putting them up, no shock at all comparable to that of the 12th June last can have visited the country for very many years.

59. Sylhet. The Telegraph Master can give no accurate information as to the time the shock occurred, but says that it was between 5-15 and 5-20 P.M., local time, which is 47 minutes in advance of Madras time.[1]

Time of shock.

60. All the public buildings in Sylhet suffered more or less, but many of them are still standing. Several are built on a narrow strip of land between the bank of the river and a large tank, the Nawab Talao, and it is likely that they were affected quite as much by settlement of the ground as by the shaking they received. Since the earthquake occurred many of the cracks in these buildings running parallel to the edge of the river or tank have opened out, more than at first, which fact certainly points to a gradual settlement of the soil.

Public buildings.

61. This pillar stood at the head of a flight of steps leading down to the water at the north-east corner of the Nawab Talao. The corresponding pillar at the other side of the steps has not fallen and is not even cracked. The fallen one broke off at ground level, and apparently fell in a northerly direction, but struck the wall on that side and rolled off to the west.

Pillar at side of Nawab Talao.

A gate pillar at the side of the road near the Government School fell towards N40°E and broke to pieces in the fall. Another near the Deputy Commissioner's bungalow fell due N.

62. The cemetery is situated on a low knoll near cantonments, and about 3 miles north of the river bank. Very few of the tombs have been damaged by the shock. They are nearly all fairly old and built of brick masonry.

Cemetery.

A tomb near the east wall, without any inscription. It was surmounted by a plaster urn fastened to the top of the tomb by an iron wire. The urn has fallen over to S 25° E and is now lying on top of the tomb.

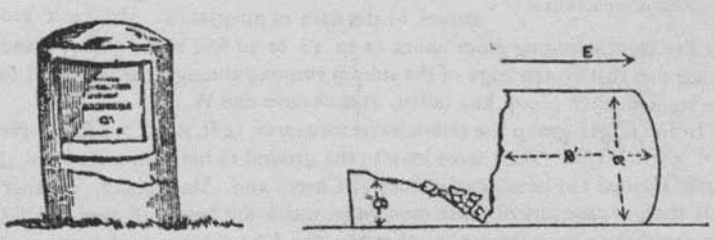


Fig. 29. Overturned tomb in Cemetery, Sylhet.

[1] A clock in a small tower near the river fell with the tower and stopped at 5-15 P.M.

A low brick pillar, fig. 29, built of bricks rather loosely put together. The pillar broke across at about 9 inches from the ground and fell due east.

A small brick pillar 2 feet 7 inches high by 1 foot 2 inches in diameter to the north of the last has fallen due south. The top has turned over in its fall and is lying 3 feet from the centre of the pillar. A portion of the side is lying further away in the same direction at a distance of 5 feet from the pillar.

A square column at the south side of the Cemetery has fallen due south-west and broken up almost entirely. The pillar was probably about 4 feet high and has broken off at 18 inches from the ground.

63. The cantonment was situated on some rising ground to the north-west of the Civil station and nearly a mile from the river bank.

Cantonment. Hindu temple.

A Hindu temple near the hospital, the four sides facing the cardinal points, has been cracked in a curious way as shown in fig. 30, the cracks running diagonally from corner to corner of the base. On the sides facing north and south a horizontal crack runs along at the top of the base beneath the dome. On the west side there is an arched door-

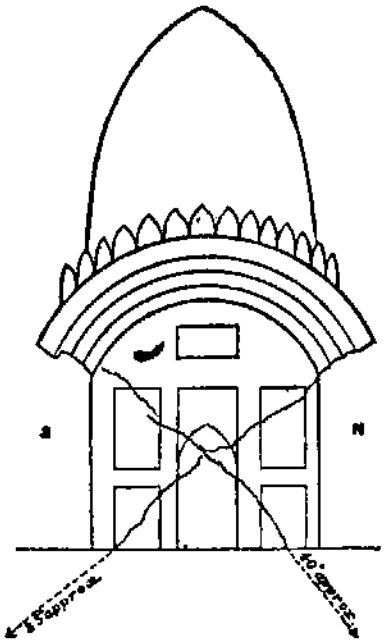


Fig. 30. Hindu Temple in cantonments, Sylhet.

way and two cracks run diagonally upwards from the crown of the arch to the base of the dome. The wall surrounding the temple has fallen in the north and south sides, in each case to south, but is standing on the east and west.

A gate pillar at the foot of the hill on which the hospital stands has broken off

at ground level and fallen to W 18° N. It stood at the end of a culvert, the wall of which may have interfered with its fall. The corresponding pillar on the other side of the culvert is not cracked. Both are built of brick masonry, 1 foot 10 inches square. The broken piece is 5 feet long.

Vertical boiler overturned.

64. At the entrance to the bungalow occupied by the Executive Engineer, on the main road leading north and about a mile from the station, was a well from which water was pumped by an engine with a vertical boiler. The boiler has fallen over to W 30° S. Its dimensions are, height 7 feet 9 inches, diameter 3 feet 6 inches; chimney of sheet iron, height 4 feet, diameter 10 inches.

Church gateway.

65. The Church has fallen entirely. At the gateway in the east wall were two large pillars of brick, both of which have partially fallen. The one on the north side of the gateway apparently fell due north, struck the churchyard wall and rolled off to east. The other fell towards W 20° S.

The churchyard was surrounded by a low wall on which stood a balustrade of clay pilasters, supported by brick pillars at intervals. On the walls facing north and south these have nearly all fallen to the south, but on the east and west walls they are standing.

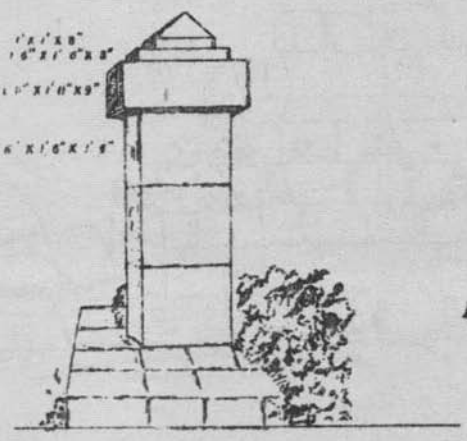
Fissures in banks of rivers and jheels.

66. Sonamganj. Everywhere in Sylhet, so far as I saw, the banks of the rivers are fissured for some distance from the edge, in the same way as those on the Brahmaputra. At Sonamganj, where the river runs nearly due west, I noticed a considerable difference in the way in which the shock had affected either bank of the river. On the north side a large slice, some 50 or 60 yards broad, had been detached and slipped forward and downward, the portion furthest from the river sinking more deeply than the edge of the bank, so that there is now over 30 feet of water over the inner edge of the slipped portion, while over the former edge of the bank the depth is only 8 or 10 feet. As the houses are built close to the edge of the bank, this being the only ground in the country that is above the usual flood level, they were carried down, and the inhabitants, to the number of about 40 were drowned. On the southern bank, however, there was no subsidence of this kind, but the ground was fissured to a distance of 30 or 40 yards from the edge of the bank by a number of cracks running parallel to each other and to the bank. It seems that on the north side the bank was not sufficiently supported by the water and so slid forward, but at the moment of the shock the water was violently driven over to the south side of the river and supported that bank.

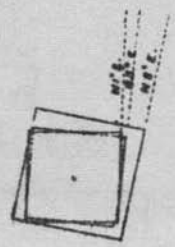
Probable results of the fissuring of the banks.

67. At the time of my visit to the country round Sylhet, the rivers were in high flood, the water over large areas overflowing the banks. So long as they remain full it is probable that the banks will not slip down, since they are supported by the water. But as the rivers fall it is almost certain that the fissured portions of the banks will slip down, at any rate until they attain their former slope. A large amount of silt will thus be thrown into the bed of the river, far more than the water, with its diminished velocity during the cold weather, and its very slight fall, will be

Fig. 1.

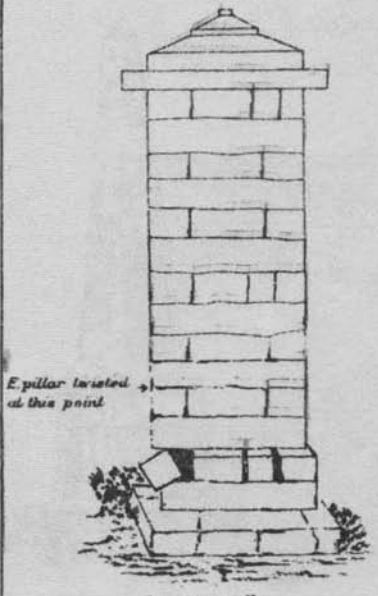


S. pillar fallen due N.

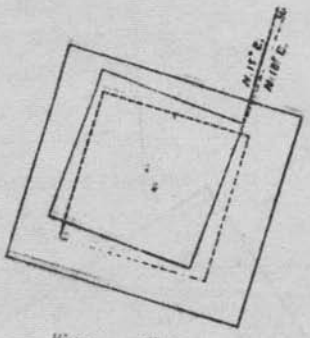


Plan of N. pillar

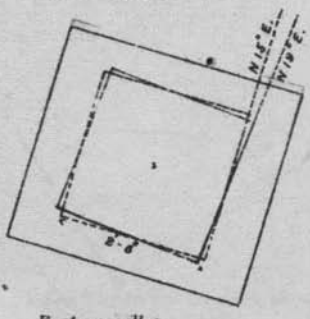
Fig. 2



Western pillar



Western pillar

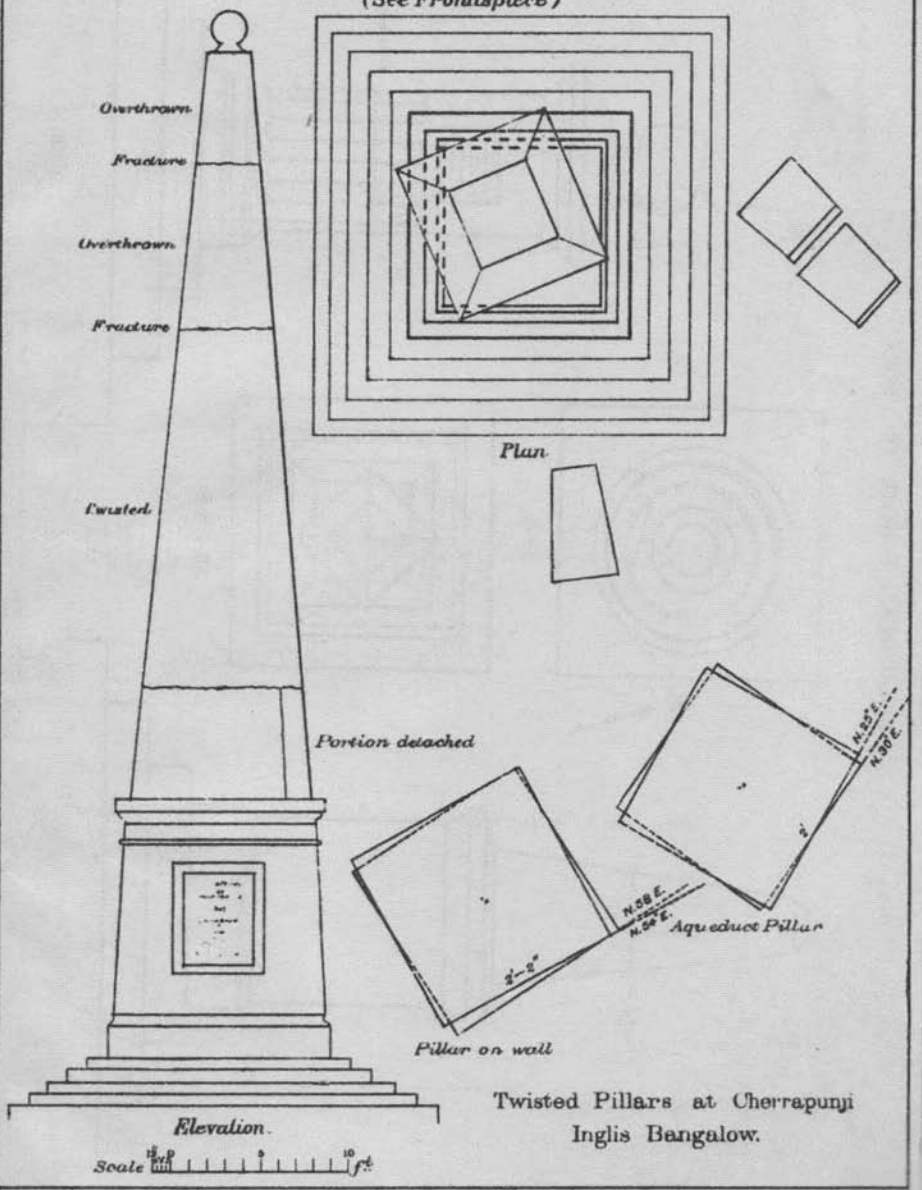


Eastern pillar

TWISTED GATE PILLARS, SHILLONG.

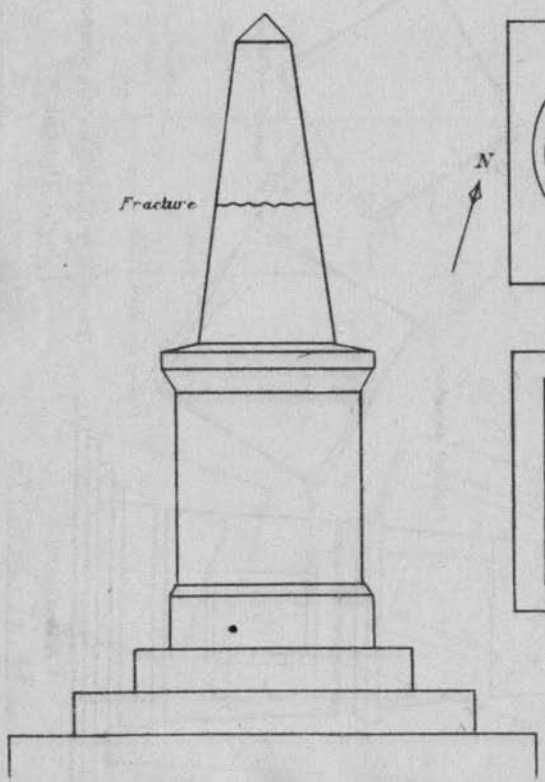
Monument to George Inglis at Chatak.

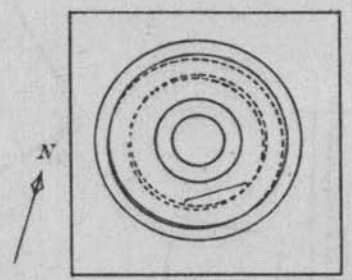
(See Frontispiece)



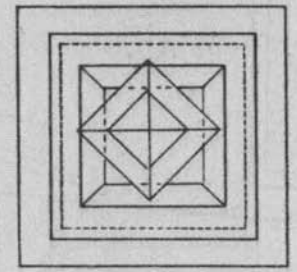
Twisted Pillars at Cherrapunji
Inglis Bangalow.

TWISTED PILLARS AT CHATAK AND CHERRAPUNJI.

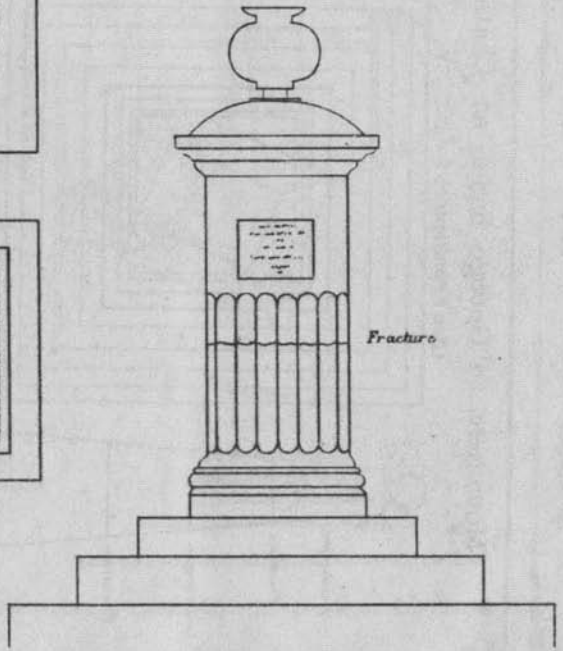


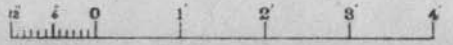


Nº 3.

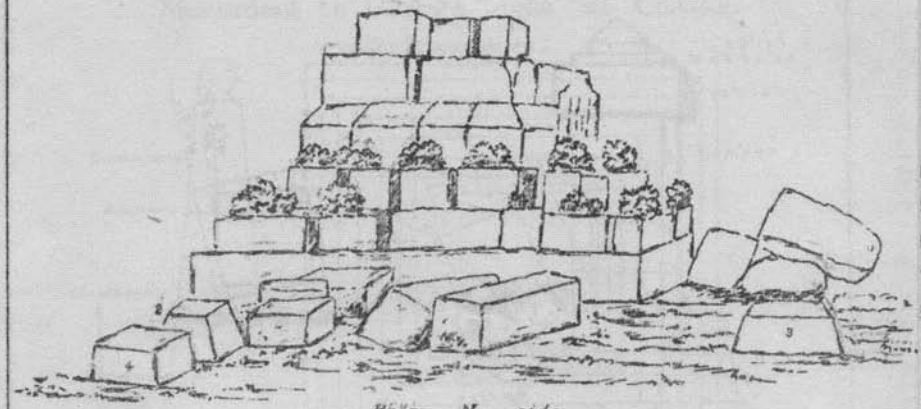


Nº 1. & 2.

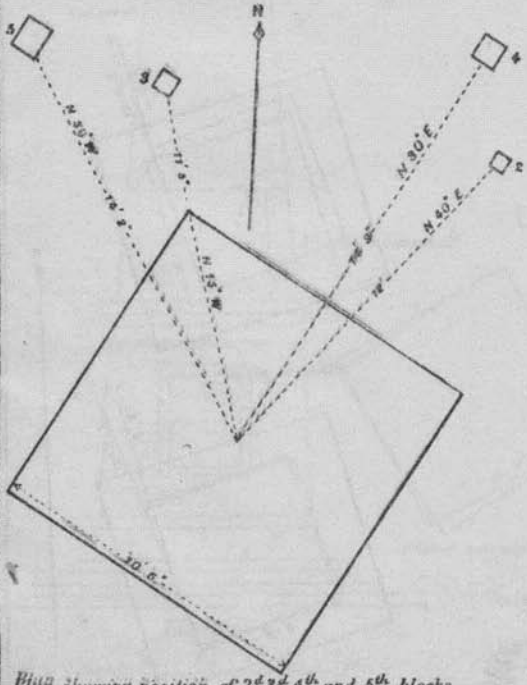




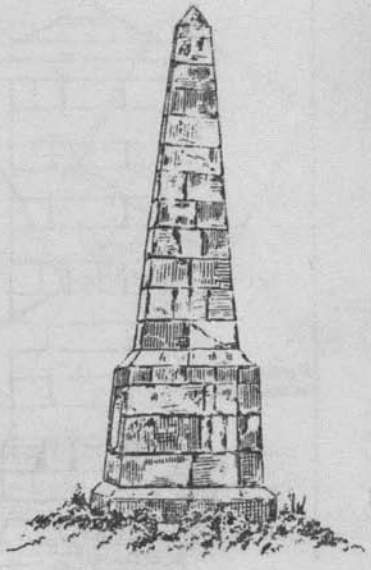
TOMBS IN OLD CEMETERY, GAUHATI.



From N side



Plan showing position of 2d 3d 4th and 5th blocks from top of obelisk



WILLANS MEMORIAL, SHILLONG.

R.D.Oldham.

Memoirs Vol. XXIX Pl. IV.

S.K.Chakravarti photo.

Photo-etching-Survey of India Offices, Calcutta, May 1898

THE CEMETERY - SHILLONG.

R. D. Oldham.

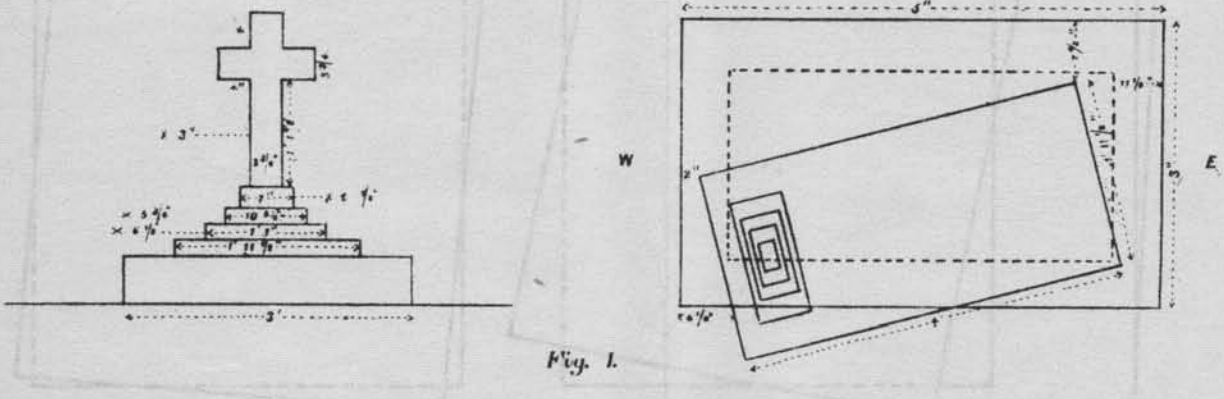
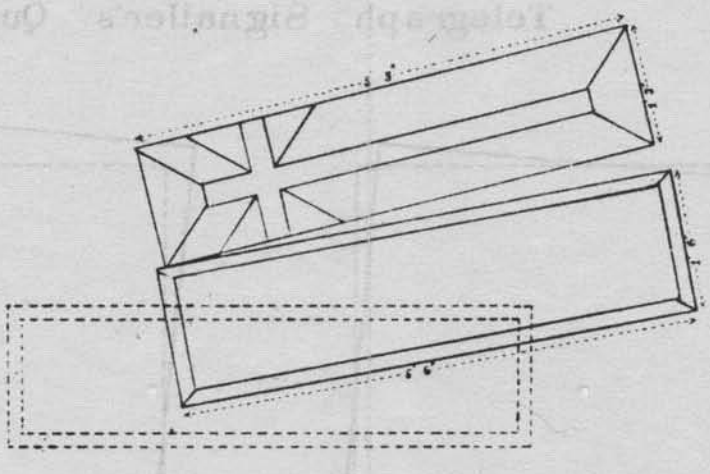


Fig. 1.



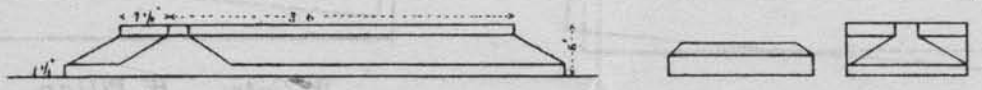
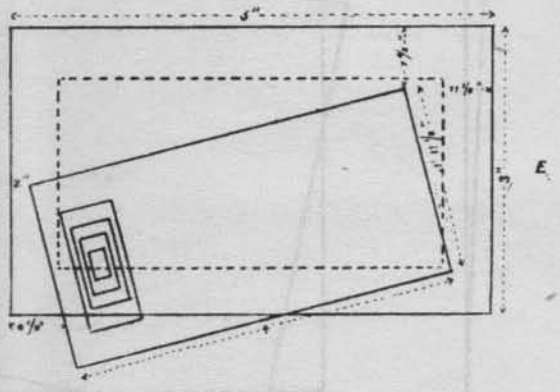
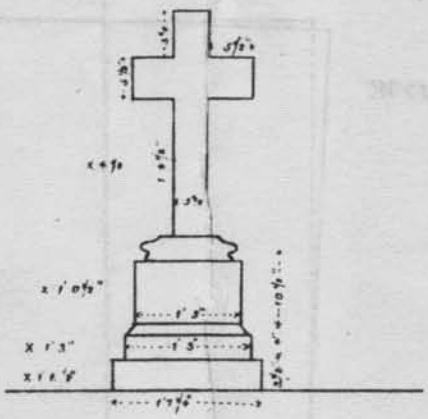


Fig. 3.

PLANS OF DISTURBED TOMBS IN THE SHILLONG CEMETER





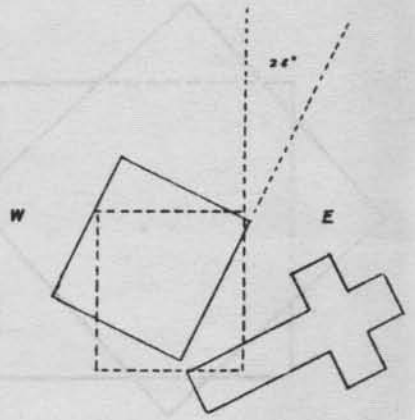
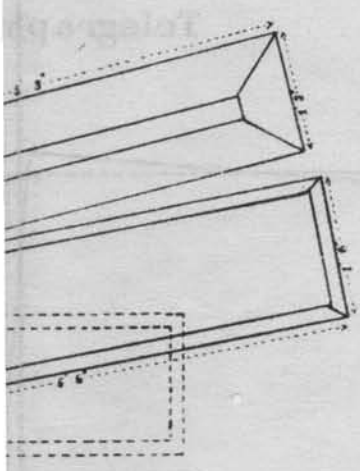
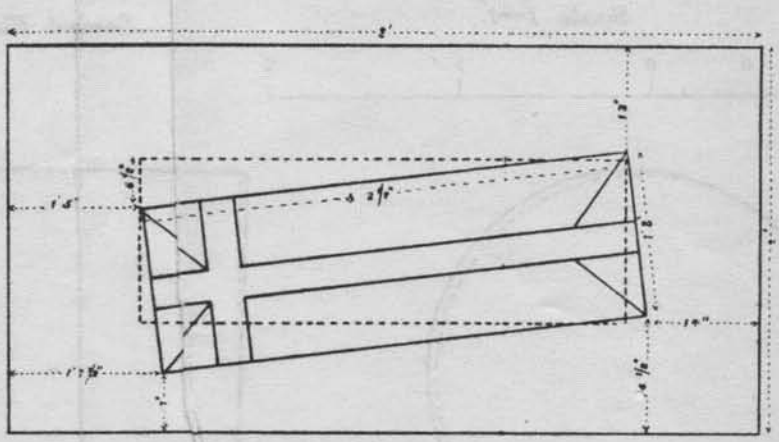
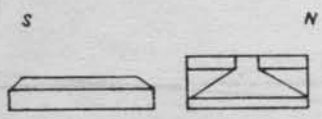


Fig. 2.







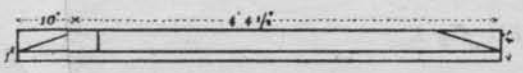
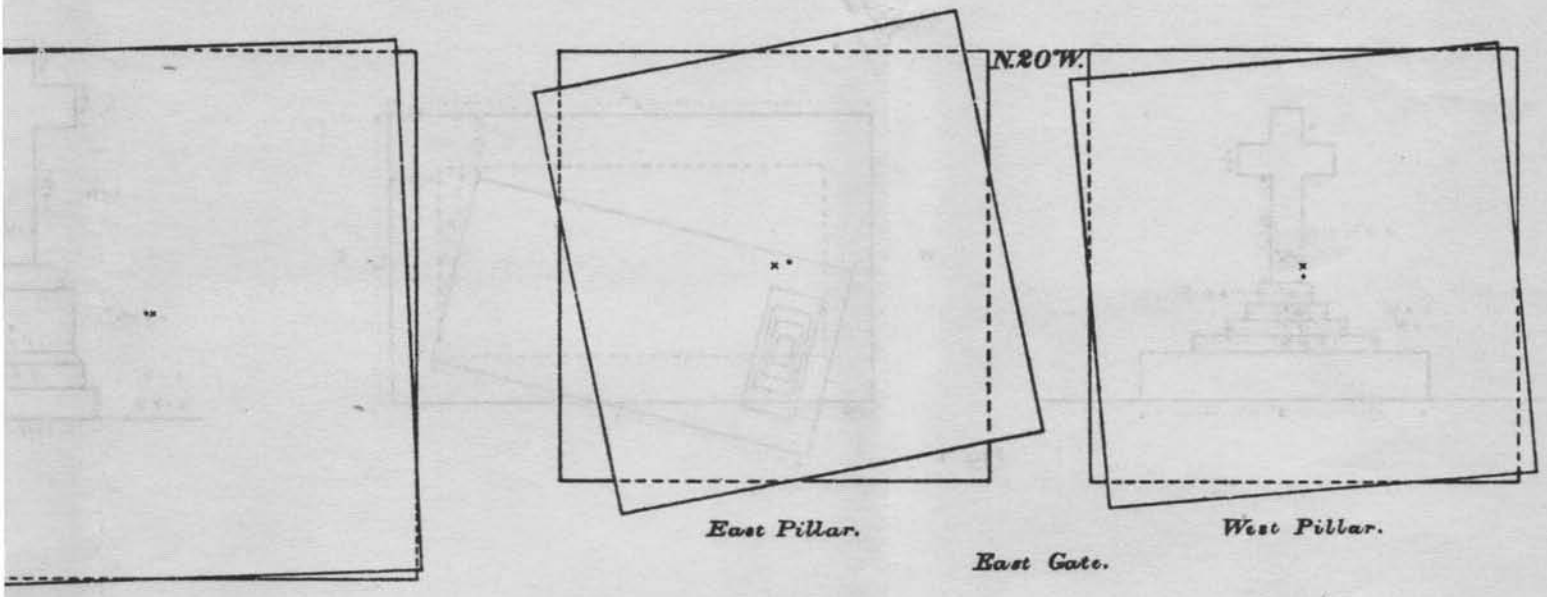


Fig. 4.

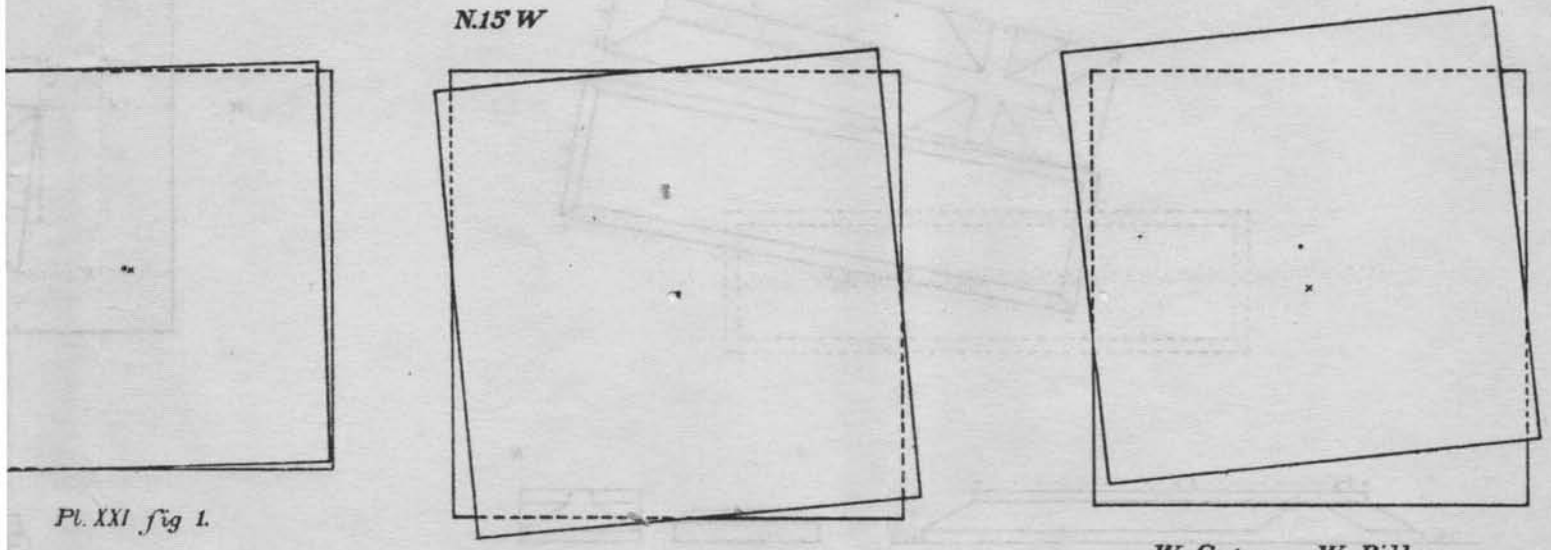
PLANS OF DISTURBED TOMBS IN THE SHILLONG CEMETERY

GEOLOGICAL SURVEY OF INDIA.

Memoirs Vol. XXIX, Pl. XXXVII.



Samuel Fleming.

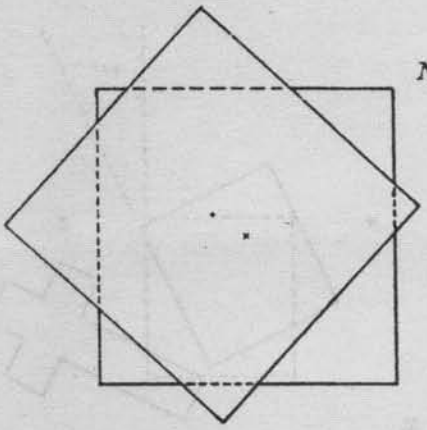


Pl. XXI fig 1.

OF TWISTED TOMBS AND PILLARS AT GAUHATI.

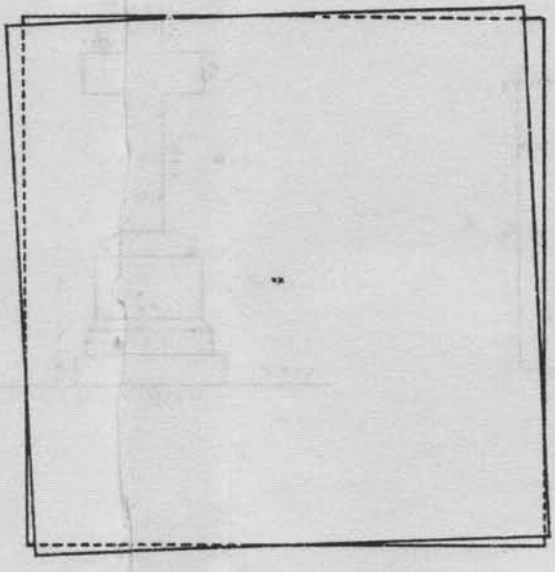
GEOLOGICAL SURVEY OF INDIA.

R. D. Oldham.

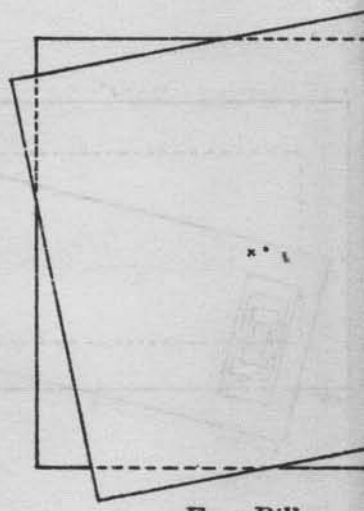


N.15°W.

Pl. XXI fig 1.



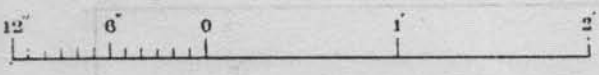
Samuel Fleming.

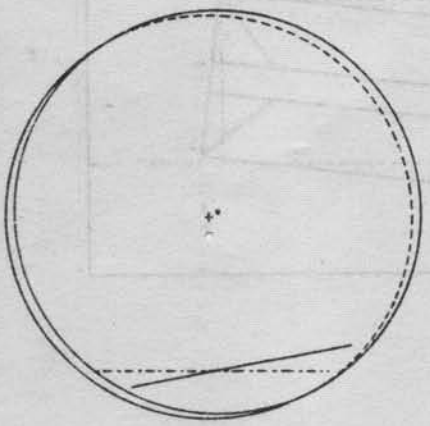


East Pillar.

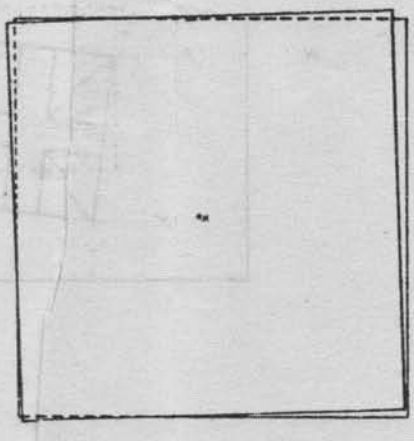
Telegrapl

Scale 1'—1".



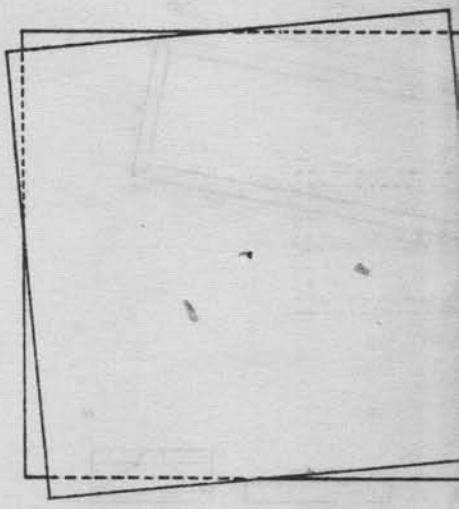


Pl. XXI fig 1.



Pl. XXI fig 1.

N.15°W



Judge's Compound.
N. Gate Pillar.

PLANS OF TWISTED TOMBS AND PILLARS AT G

Litho., S. I. O., Calcutta.

F THE EPICENTRAL TRACT OF THE GREAT EARTHQUAKE OF 12th JUNE 1897.

● Pools and Lakes, not due to faulting

○ Reported changes in aspect of Hills

Scale 1 Inch=16 Miles

10 20 30 40 50 Miles

ART OF ASSAM TO ILLUSTRATE THE EXAMINATION OF THE EPICENTRAL TRACT OF THE GR

llowed

nd Fractures