

EARTHQUAKE OF 12TH JUNE.

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(With plates XVI and XVII.)

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On the afternoon of the 12th June, at five o'clock in the afternoon, Calcutta was startled by a shock of earthquake such as it had never felt before; many houses were more or less injured, the steeples of two churches broken off, and hundreds of people rendered homeless. Soon, however, it became evident that other places had suffered far more severely than Calcutta. Railway and telegraphic communication was cut off and it was only as the days wore on and news tardily arrived from the north and from the east that we found ourselves faced with a cataclysm which rivaled the classic earthquake of Lisbon in violence and extent.

No sooner were we aware of the scale of the event we had to deal with than preparations were made for its thorough investigation. The immediate succession of the rainy season on the earthquake rendered it imperative that observation of its effects should be made with all possible promptitude, and every officer of the Geological Survey then in Calcutta was despatched to observe and investigate. At the same time orders had been issued by Government to the local authorities to report fully on the effects of the earthquake. All the telegraph offices throughout India were instructed to report the time at which it was felt, and similar information was called for from all the station masters on the lines of Railway within the area likely to be affected. Circulars have also been widely distributed and communicated to the press, which has readily assisted in the endeavour to collect information.

The replies to these circulars and the reports called for from Government officials are now pouring in at a rate which defies satisfactory analysis, but some of the main facts about the earthquake, which have been already established, may be noticed here.

The area over which the earthquake was felt is enormous. On the east it has been reported as felt from the furthest extreme of Assam, at Mogok, Magwe, and Akyab in Burma; on the south, at Masulipatam in Madras, and Ellichpur in Berar; from Surat, Ahmedabad, Mount Abu, Ajmere, Panipat and Simla on the west. On the north it was felt at Katmandu; at Gnatong, on the frontier of Sikkim and Thibet, it was severe enough to overthrow some of the barrack chimneys, and it is reported to have been felt at Lhassa. Besides these observations which are free from doubt, the shock appears to have been just perceptible to a few people, particularly sensitive or specially favourably situated in Dharmasala, Madras and Pegu. Omitting these last, there remains the fact that the range of the shock was over 24 degrees of longitude and 16 degrees of latitude or an area of over 1,500 miles in length and 1,000 in width, or, say, 1,275,000 square miles in all.

The area over which the shock was destructive is also great; from Darjiling, Monghyr and Calcutta on the west, to Jorhat on the east, damage and occasional destruction was caused to buildings, but this destructive force reached its maximum in Shillong, Cherrapunji and Tura. In Shillong, it may be said almost without exaggeration, that not one stone has been left standing on another. All

masonry buildings have been levelled to the ground, and this, not by overthrow, but by a shattering of the walls into fragments, on the top of which the roof subsided. The nature of the destruction will be best understood by a reference to Plate XVI, which gives a view of Government house after the earthquake, drawn from a photograph taken by Mr. F. H. Smith, of the Geological Survey. The other drawing on the same plate shows the influence of construction; the central portion of the hotel was built of stone and has been shaken to the ground. The two ends, however, which were additions to the original building and built of a wooden framework filled with reeds plastered with mud, have stood though severely shaken.

At Shillong it is possible to form some idea of the violence of the shock. In 1882 a seismometer composed of a series of cylinders of various diameters was set up. The largest of these is 12" by 9" diameter, and the whole series was overthrown to the north-eastwards. According to Omori's formula a cylinder of these dimensions would be overthrown in a direction away from the origin of the shock, as these were, by a velocity of wave particle of 2 feet per second and if we take the period of vibration as 1 second which is about that of the more severe shocks in Japan, this would imply a range of motion of 74 inches. In other words, the violence of the shock at Shillong, while it lasted, was at least equal to a backward and forward shake of 7 inches repeated 60 times a minute. If the range of movement was less, the rate of shaking must have been greater; if the movement was slower, the range of motion must have been greater in the same proportion.

That few structures, except those most strongly braced together or possessed of a very great flexibility, could stand this is not difficult to understand, and the violence of the to and fro movement will perhaps be best appreciated from the fact that the very boundary pillars have been shaken to pieces and heaps of broken road metal by the roadside were scattered out in layers of a few inches deep.

Earth-fissures and sand-craters are reported throughout the alluvial plains from Purneah on the west, to Jorhat on the east. They are, as is well known, only superficial and secondary results of the earthquake wave, but afford, among other information, instances of the extraordinary manner in which observation may be influenced by imagination. Numerous accounts speak of a strong sulphurous smell of smoke issuing from the vents and of hot, even boiling hot, water being poured forth. More temperate accounts show that the sulphurous smell was that of decaying vegetable matter, that the smoke was dust, and that the heat of the water was no greater than was to be expected in the middle of June. Closely allied in origin to the sand vents was the filling up of all the drainage channels, tanks and wells over large areas. That this was not due merely to an outpouring of sand, but to an actual forcing up of the bottoms of the hollows is shown by the effect on bridges, whose piers have been forced bodily upwards, as is shown in Plate XVII, reproduced from one of the admirable series of photographs taken by Messrs. Kapp & Co. of Calcutta. The other figure on the same plate, reproduced from one of the same series of photographs, shows how the rails have been affected by the movement of the surface alluvium consequent on the shock.

The rate of transmission of the wave was very high, in fact it has been stated in newspapers, and frequently spoken of, as having been felt simultaneously throughout Northern and Eastern India. Such was not the case, however, though the time the wave took to travel from its origin to the furthest point at which it was sensible to unaided observation does not appear to have been more than 8 minutes. The

very large number of time observations, of every degree of accuracy, which have been communicated, have not yet been discussed, and no definite statement can be made, but a few selected at random as apparently good give an average rate of transmission of about 10,000 feet per second or 0 or 112 miles per minute. This result indicates the order of magnitude of the figures we have to deal with, though it cannot be accepted as final, or more than very approximate. The prevalent idea of the simultaneousness of the shock is disproved by a quaint report by the telegraph master of Chupra, who relates that he was working Durbhunga when there was suddenly a stoppage due to the earthquake at Durbhunga, and the signaller leaving the instrument there, and immediately afterwards the earthquake was felt by him. According to the daily papers a similar incident took place at Dhubri, which was at the time in communication with Goalpara.

Beyond the area over which the earthquake was felt its effects were traced instrumentally at Bombay, where the instruments in the magnetic observatory were affected by a disturbance commencing between four and five minutes past four, local time, or 16 h. 34 m. Madras time, that is, 6 minutes later than the shock was felt at Calcutta, and about 9 minutes after the probable time at which the shock started on its way from the place of origin, somewhere below the Garo or Khasia hills.

The effects of the shock are said to have been traced at Grenoble; and at Edinburgh a letter from Mr. Heath, Assistant Astronomer, to *Nature*, gives the time at which the tremors were first felt as June 11th, 23 h. 18 m. G. M. T.; they lasted about 10 minutes and then ceased, and violent oscillation again set in at 0 h. 32 m. G. M. T. of 13th June and continued up to 1 h. 12 m. They were equivalent to a tilting of the ground through 20 seconds of arc. Greenwich mean time June 11th, 23 h. 18 m. (astronomical) corresponds to Madras time 16 h. 39 m. of 12th June, (civil); 0 h. 32 m. G. M. T. of 13th June corresponds to Madras time 17 h. 53 m. of 12th June. If both these sets of tremors were due to the same earthquake the first must have travelled the distance from the origin to Edinburgh, starting at about 16 h. 25 m. Madras time, in 14 minutes, the other in 1 h. 28 m.

These few notes form no adequate account of the earthquake; this is in preparation, but the collection and discussion of the information will take some time. Meanwhile what has been written will serve to show the order of magnitude of the cataclysm of 12th June 1897, an earthquake unsurpassed by any since the great Lisbon earthquake of 1st November 1755, and rivalling this in magnitude of the area over which it was felt, surpassing it indeed if we exclude the doubtful records of the earlier shock.

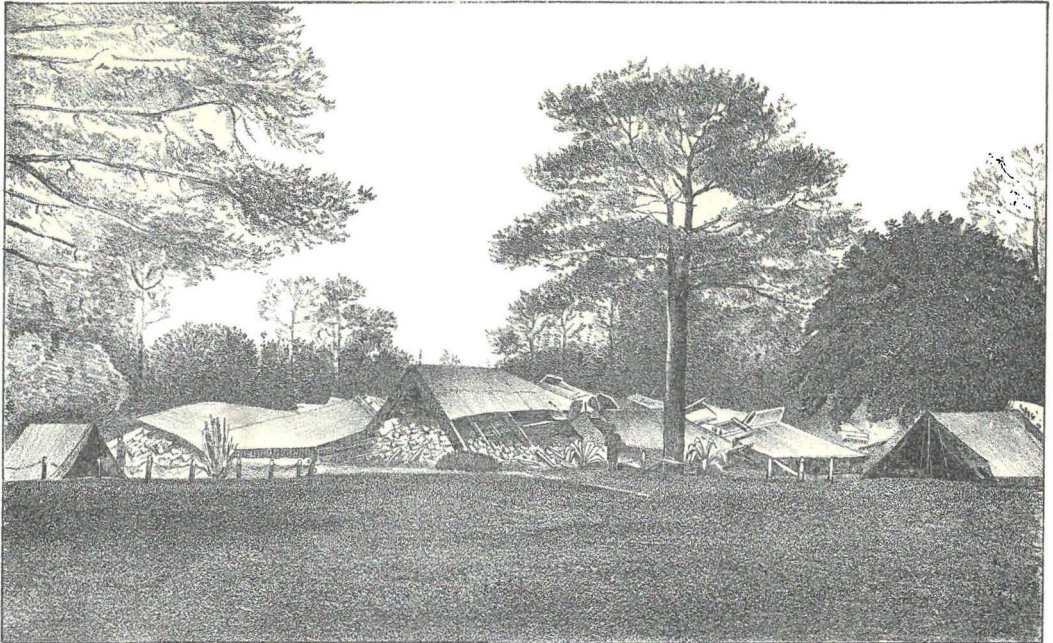
31st July 1897.

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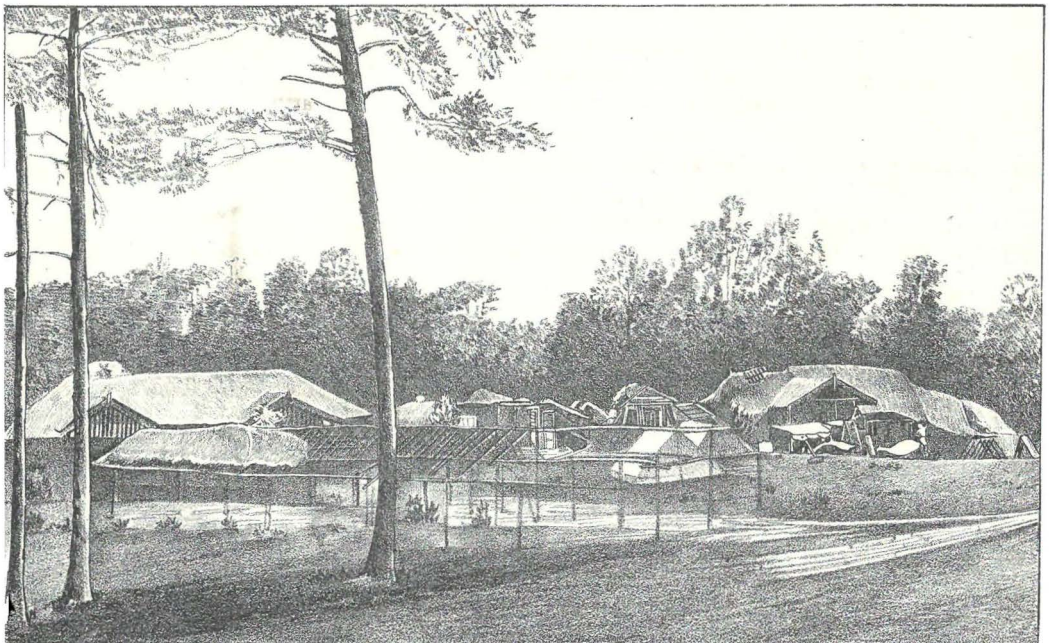
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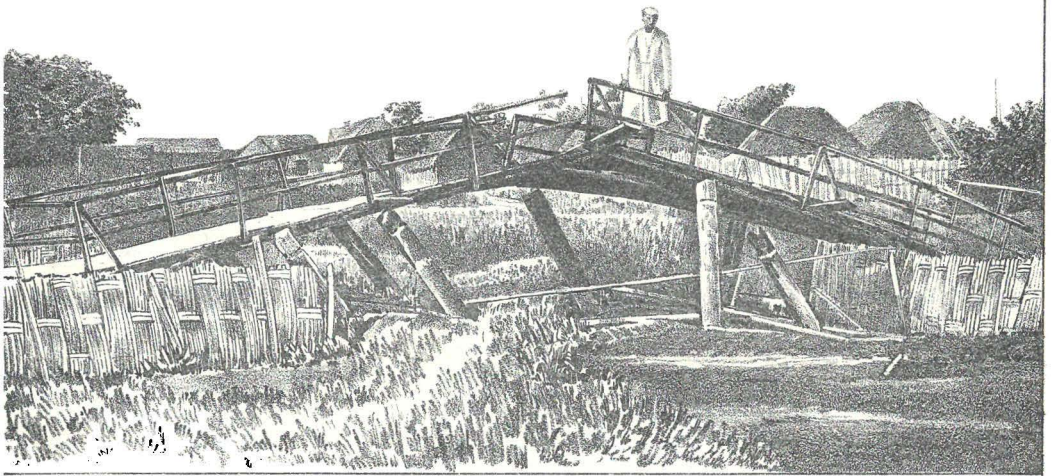
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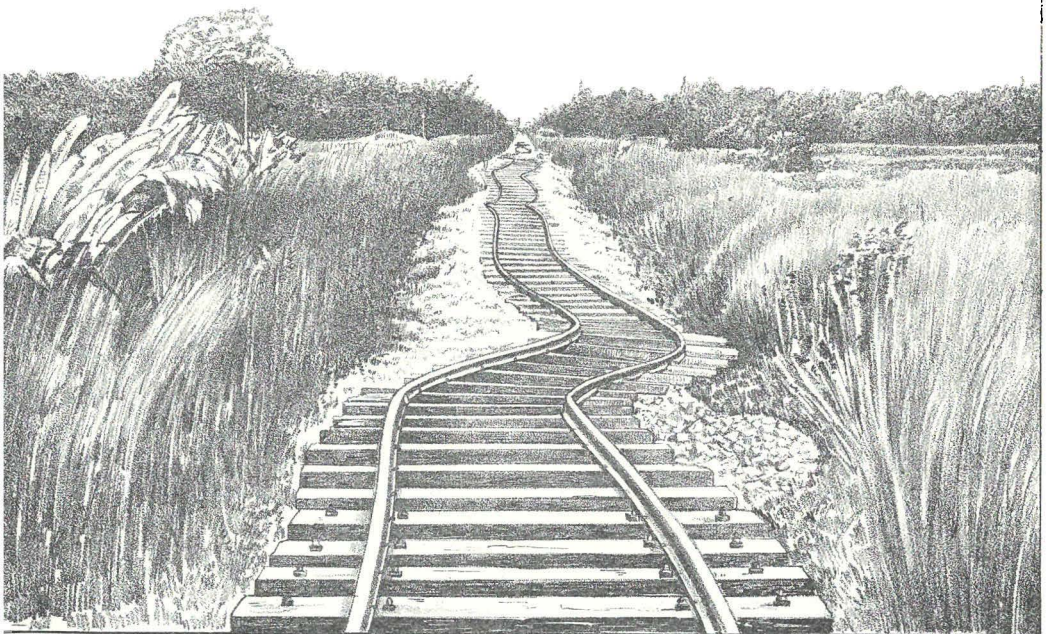
GOVERNMENT HOUSE SHILLONG.



FERNDALE HOTEL SHILLONG.



BRIDGE ACROSS NALLAH AT HALDIBARI.



From photos. by Messrs K. Kapp & Co.

LINE BETWEEN HALDIBARI AND MOGHAL HAT.