

THE GREAT JAPANESE EARTHQUAKE.

STR,—In answer to some enquiries concerning the effects of the great earthquake of 1891, Professor Kotô, of Tôkyô, has just favoured me with further interesting particulars that meet some of the points mooted by the Rev. E. Hill, in this Month's Number of the *MAGAZINE*, and adds something to the Professor's previous paper in the *Japanese Journal of Science*. In this letter he remarks: "As to the questions you put on my earthquake paper, I shall attempt to answer you in a few particulars, though I may not satisfy you, owing to my superficial geological knowledge. The uplift in vertical direction, at its maximum point, is from $5\frac{1}{2}$ to 6 metres. This is, however, an exceptional one, found in Modori, in the Neo Valley. This local uplift seems to me to have been caused by the pushing up of the crust between two fault-lines by lateral pressure of the neighbouring strata (see p. 340 of my paper). In all other cases the vertical displacement is insignificant; in plains it may only be seen by slight undulation of the ground. Along hill-sides it may be seen in small landslips covered by soil, and in this case the fault could not be distinguished from ordinary landslips accompanying severe shocks. A very characteristic feature of the fault in question is the horizontal displacement along the faulting plane, by which the boundaries of field becomes discontinuous. From this displacement I could measure the amount of shift of wing relative to the opposite wing. Along the junction the soil is much disturbed and raised from the surrounding field, appearing just like tracks of a mole. At the spur of the hills this could not be well seen, as the junction is covered by fallen talus. The displacement is, therefore, best studied in cultivated fields. I have traced the Neo fault for 112 km. by the marks left in the fields by slight elevations, and by displacement of field boundaries, and the regularity and constancy of these marks. Sometimes I have traced it in wooded hills where I often lost sight of the marks, but by the help of the compass I caught the track again beyond the hills on the other side. It was a very troublesome task to keep my route right in this way.

"You ask me whether the faulting plane is *vertical* or *oblique*? I am sorry I cannot tell you which it is. As may be understood from the foregoing statement the vertical displacement, as a general rule, amounts to very little. The best opportunity for study in this direction may be that of Midori (photograph, Pl. xxxiv.), but, unfortunately, the faulting took place in alluvial ground, consequently solid strata did not come into view at the surface. As the raised mound in the fields is very narrow and sharply marked, I surmise that the faulting plane is vertical, or nearly so; if, on the contrary, the faulting plane makes large angles, with normal upon the surface, the head of shifting plane should not be so clearly marked as in the Mino-Owari district, but the proximity of fault must be much disturbed, which is not the case with ours.

"Whether the hard rocks, as well as the drift-gravel and sand, are affected by the fault is the next question you put to me, which I answer in the affirmative. As the line of fault goes through field

and hills as well as mountains alike with great regularity and sharpness, I think I am justified in saying that the hard rocks are also affected by the fault. If diluvial and alluvial deposits were only affected by it, the line must be of only short distance, and may perhaps not be a straight line, but I found the line of fault crossed intervening hills and appeared again on the opposite side, keeping thereby the same direction on either side. The faulting in one case took place in a rocky crust, and must be deep-seated. Unfortunately the fault did not cross the hard, eroded valley bottom where the effect of *friction* by shifting might perhaps be observed.

“The next question is whether the shock was of sudden or prolonged nature. As there was no sign of change in topography before the last convulsion, the shock must be a sudden one, otherwise houses standing upon the fault-line must have inclined toward one or other side before the shocks, which was not the case, at any rate I have heard of no such signs when going through earthquake-districts when I had opportunity to converse with the unhappy people. I think the faulting, which produced the last catastrophe, was what the miners call *heave*, or *blatt* of German geologists, *i.e.* the fault crossing the strike of strata complex. If the solid large mass of crust had suddenly shifted, as I think was the case in the earthquake of Japan 1891, a great amount of friction must have occurred along the plane of fault, and thereby, mechanically, heat may have been developed which may have melted the rock or produced slicken-side on the cheeks of bounding rocks. I regret much that I made no observations in this direction. Till now I have not heard of any new appearances of hot springs in faulted district. In every textbook on geology it is stated during mountain-making process faults are produced by which rock-masses slide along the dislodged plane, thereby partially melting the neighbouring rocks by the development of mechanical heat by friction, and convert a rock into another form and producing regional metamorphism. In the last sudden faulting no such changes were observed by me. Such phenomena might occur in the deeper parts of the earth-crust, but near the earth-surface, so far as I know, nothing resembling such phenomena was observed or recorded by any person.”

Allow me to observe in reply to Mr. Hill's courteous letter that I do not take the great fault at all as a measure of the forces to be dealt with, but merely as an indication of their *nature*, and not as evidence of their *degree*, which can only be judged of by the results in each particular case of disturbance.

SHOREHAM, KENT.
10th March, 1894.

JOSEPH PRESTWICH.

WILLIAM PENGELLY, F.R.S., F.G.S.—With deep regret we record the death of this well-known geologist, who has done so much during the past forty years in the exploration of Brixham Cave, and Kent's Cavern, Torquay; in the establishment of the Devonshire Association for the Advancement of Science, and the Torquay Natural History Society. He died at Torquay on 17th March, in his 83rd year. We hope to give an Obituary Notice of Mr. Pengelly next month.