

overcast during the evening, suddenly cleared up towards 11 P.M., but was again completely covered at 11.15. The barometer was heaving during the night, but no special disturbance is registered on the photographic curve; the corrected reading at 11 P.M. was 29.887, and 29.885 at 11<sup>h</sup> 11<sup>m</sup>.

The rise of temperature was rather sudden just before the passage of the earth-wave, attaining its maximum, 43.4° at 11<sup>h</sup> 11<sup>m</sup>, the wet bulb being then 42.4°.

For most of the afternoon the wind was W.S.W., and was changing from W.N.W. to S.W. between 11 P.M. and midnight; at the time of the shock it was due W. It was blowing gently at the average rate of some thirteen miles an hour from the previous midday, and at scarcely four per hour after midnight. At 10 P.M. its velocity was nine miles an hour.

The trace on the magnetic declination curve shows that the magnet was moving rather rapidly from W. to N. when the shock occurred, and a slight irregular movement at 11<sup>h</sup> 1<sup>m</sup> may be due to the earthquake. The magnets were very quiet before 10 P.M., and disturbed from 10 until morning.

The shock was felt very generally throughout the neighbouring villages.

The sound is generally described as that of a strong gust of wind, followed by a noise resembling the passage of an express train over a wooden bridge. This was followed by a very distinct rocking of the furniture, beds, and walls; the whole of the houses seemed to shake violently, and the floors to rise; the rooms swayed backwards and forwards several times. The motion was violent enough to awaken persons from their first sleep. Many thought that part of the building had fallen in, or that something heavy had tumbled down in a room over-head. The rushing sound and crash were followed by a rumbling noise. The motion appeared to begin suddenly, to grow stronger for a time, and then to die away. It was more regular and powerful than the shaking from a heavy waggon in the houses of an old street.

The time the whole disturbances lasted is generally estimated at about half a minute; but this, I should be inclined to think, is excessive.

The direction of the motion is supposed by most to have been from E. to W.

S. J. PERRY

Stonyhurst College Observatory, March 20

ALL who are acquainted with the North of England are aware that the districts comprising the counties of Northumberland, Durham, and Yorkshire, are physically divided from that occupied by those of Cumberland, Westmoreland, and Lancashire by a ridge or watershed, formed by the Pennine chain, which is a range of hills averaging 1,700 feet in height, composed of Lower Carboniferous strata, through the centre of which runs the Pennine or "Anticlinal Fault," which has the effect of throwing the strata in a downwards direction to the east and to the west, like the slopes of the ridge of a roof of a house.

To the west of this ridge, in Lancashire, are low undulating plains of Coal measures, and Triassic rocks, much faulted and covered with glacial drift, and in Cumberland and Westmoreland the high mountains and deep valleys of the Lake District intervene between it and the sea. These mountains, composed of Silurian rocks, existed as such, long before the anticlinal fault heaved the Pennine chain into existence, and long before the Oolite strata, forming the high Yorkshire Wolds on the eastern side of the watershed were deposited at the bottom of the sea. In the West Riding the moors have been cut, by the long-continued action of running water, into the deep ravines, or vales, which form so characteristic a feature of that district. It is an interesting question to observe how far this general arrangement of country, and the strata of which it is composed, and the dislocations which the latter has suffered, appear to affect the direction, localities visited, and the distribution of the lines of greatest intensity, of the earth-wave which visited the northern counties on the night of the 17th inst. The tract over which it was felt, as far as at present known, would be comprised within a circle, with a centre about ten miles due east of Sedburgh, the diameter of which would be a line drawn from Dumfries to Doncaster, the farthest limits to the north-west and to the south-east, respectively, to which the earth-wave extended. The greatest effects appear to have been experienced in a belt, about thirty miles broad, running inside this circle, the inner margin running along the towns of Scarborough, New Malton, York, Leeds, and Bradford, Preston, Longridge, Kendal, Penrith, Carlisle, Newcastle, and Sunderland, and thence probably passing out to sea

and curving round to Scarborough. The outer margin, or circle before mentioned, runs by the Humber, Doncaster, Manchester, Salford, Roby, Huyton, Seaforth, Southport, and probably for some distance out to sea, Blackpool, west of Ulverstone and Coniston Lake, Dumfries, by the north of Tyneside, to the sea. If this belt be drawn on a map, it will be seen that that segment of the circle which occurs from Sunderland to Scarborough, falls entirely out to sea, and up to the present time the earthquake is not known to have been felt on that coast between these points. It would therefore appear probable that this earth-wave traversed the country in a circular belt, the entire north-eastern segment and the outer margin of the Lancashire portion being beneath the sea; that the area of greatest intensity was near the inner margin, but especially at Preston, Lancaster, Ulverstone, and Blaydon, near Newcastle; that the area in Yorkshire, within this belt, was not entirely free from the shock, as it was slightly felt in Wensleydale and Swaledale, on the eastern slopes of the Pennine chain.

At Preston, where the earthquake occurred at 11.4 P.M. Greenwich time, the motion I observed to be from south-east to north-west; the oscillation was considerable, and the hollow noise, which commenced and ceased with the vibration, resembled express trains running in underground tunnels. The air was close and oppressive, the wind S.W., the night starless and hazy, and the sky from the N.W. to the N.E. covered by a peculiar glare, resembling an incipient aurora, which lasted until 1.30 A.M.

In several places more than one shock is reported to have occurred: thus at Singleton Brook, Manchester, the first shock occurred at 10.56; the second, lasting two seconds, at 11.5; and the third, lasting four seconds, half a second after. Two shocks near together were also felt at Leeds, the second being the sharpest, which was felt at Armley, Headingley, Woodhouse, New Leeds, Chapeltown, and West Bar. Two shocks also occurred at Kendal, the first at 6.20 P.M.; the second, which was the most severe, at 11.15, lasting twelve seconds, that experienced by myself at Preston lasting about seventeen. From Grasmere also three shocks are reported, the first being at 6.40, and the second and worst at 11 P.M. At Ambleside, the first shock was also felt at 6.30, the true time probably of the two noted above, the second being at 11.3 P.M. At Coniston, a slight shock was felt at 7.0 P.M. on the 17th, and another at 6.3 A.M. on the 18th.

At Hexham, the chief shock is recorded as taking place at 11.15; Ambleside, 11.3; Ulverston, 11.5; Preston (by myself), 11.5; Bowdon, Manchester, 11.4; Singleton Brook, Manchester, 11.4; Newcastle, 11.30; Leeds, 11.15; Penrith, 11.4; Liverpool, 11.15; Kendal, 11.15; from which it will be seen that localities, comparatively near together, often differ more as to the time of occurrence than some of those far apart, and thus there is, therefore, strong reason to believe that these various observations (from 10.30 P.M. to 11.30 P.M.) represent one shock, occurring practically at the same moment over the whole area about 11.5 P.M.

In the year 1786, on August 11, an earthquake which extended over nearly a similar area to the present, like it, slightly displaced the waters of Windermere and the Lake District was felt; and the same district was also visited by an earthquake on Feb. 22, 1867, which was particularly felt on the north shores of Morecambe Bay. It is curious to observe that the northern margin of the area of the earthquake, which was felt over the greater part of central and southern England, in 1863, exactly coincides with the southern margin of the present, and that the latter, in its course to the north-west, directly crossed the Pennine chain in two places.

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C. E. de RANCE

ON Friday night last, March 17, at 11 P.M., we had a slight shock of an earthquake. I was reading, when suddenly I imagined I heard a carriage and pair drive rapidly up to the house, then rapidly drive on, there being a pause of half a second at least between the two rumbling sounds. After the second sound had continued a second, the house began to shake to such a degree that I rushed out of doors. The only damage done was that all the ceilings on the ground floor show cracks in the plaster. No doubt you will hear more of this from other correspondents.

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