AURORA AND MAGNETIC DISTURBANCES OF AUGUST 27, 1916.

WITH reference to the aurora reported by Mr. W. F. Denning at Bristol on August 27, between 2 and 4 a.m. G.M.T. (NATURE, August 31, p. 551), the Director of the Meteorological Office notes a report received from Mr. J. Ernest Grubb, observer at Seskin, near Carrick-on-Suir, Co. Waterford, Ireland, that aurora was visible there on the night of August 26 between 10.5 and 10.40 p.m. G.M.T. The greatest display noted by Mr. Grubb occurred about 10.25 p.m., when streamers from N.W. to N.N.E. stretched to within 20° or 30° of the zenith. The light was sufficiently brilliant to illuminate the interior of a room facing W.N.W.

At Eskdalemuir, Dumfriesshire, in spite of a cloudy sky, auroral glow in the N.W. was reported by the observer at 9 p.m. on August 26 and 1 a.m. on August 27. The magnets at Eskdalemuir and Richmond (Kew Observatory) were considerably disturbed, especially at the former station. The full amplitude of the disturbance there in the north and vertical components cannot be assigned, owing to the limit of registration being passed, but the range in each element considerably exceeded 400 γ ($1\gamma \equiv 1 \times 10^{-5}$ C.G.S.), and in the west component it was fully 300 γ. At Kew the ranges of the horizontal force and vertical force were approximately 250 γ and 200 γ respectively. Declination at Kew had a range of 27′, the most rapid movements occurring early on August 27; the extreme easterly position was reached at about 2.5 a.m., and the extreme westerly at about 2.35 a.m.

A notable feature, especially at Eskdalemuir, was the "sudden commencement," introducing the storm at about 7.45 p.m. on August 26. Its oscillatory character was particularly well shown in the north component, a very rapid fall of 11 γ preceding a rapid rise of 100 γ. After this commencement the horizontal component at Eskdalemuir and Richmond (Kew Observatory) remained above its normal value until about 10 p.m., when it fell below normal and remained so, while oscillating considerably, during the rest of the disturbance. The depression in the horizontal component at Kew Observatory at 6 a.m. on August 27, when the storm was nearly over, exceeded 100 γ. An interesting feature in the vertical force curves at Eskdalemuir towards the end of the storm after 6 a.m. on August 27 is a series of oscillations of short period, averaging about 4·6 minutes, which recall a similar phenomenon observed there in the storm of November 5-6, 1915.

THE display of Aurora Borealis on August 26–27 was observed by Dr. John Satterly in Canada. Writing from Jackson's Point, Lake Simcoe, Ontario, Dr. Satterly says that on August 26 the whole northern sky from horizon to zenith was illuminated for several hours. On the horizon there was a strong yellowish glow with streamers radiating upwards. Arcs of light encircled the zenith, and flickering bands and patches of colour were seen in middle altitudes. The smallest newspaper headlines could be read at 11 p.m. On August 28 the northern lights were feeble, but at 10.30 p.m. (Eastern time) an immense riband of light, practically a complete semicircle, spread across the sky. It extended from the east and rose a few degrees south of Jupiter, threaded Pegasus diagonally, cut Cygnus, passed through Lyra to the north of Vega, and dipped down through Hercules to the west. Stars in their apparent rotation passed across it, so that the band was fixed relatively to the earth. The arc intersected the Milky Way at about 60° or 70°, very nearly at the zenith; it was much brighter and narrower and more definite than the Milky Way. No portion of the arc appeared in the northern sky. At 11.15 p.m. the western half faded away gradually, and at 11.30 p.m. the eastern half vanished.

THE SAKURA-JIMA ERUPTION OF JANUARY, 1914.

PROF. OMORI has recently published a second valuable memoir on the eruption of Sakura-jima, which occurred on January 12, 1914.[1] The volcano lies in Kagoshima Bay, in South Japan, a few miles to the east of the city of Kagoshima. Until the last eruption Sakura-jima was an island. It is now connected by a lava-stream with the east side of the bay. The part of the bay lying to the north of Sakura-jima ranges in depth from 70 to 107 fathoms, and is apparently of the same origin as the deep lakes which are found behind the sea-coast volcanoes of Usu-san and Tarumai-san.

Displacements of the Ground.—Soon after the eruption it was noticed that the sea-level had undergone an elevation relatively to the adjoining coast. At high tides the low districts at the south end of Kagoshima were flooded. Along the north-west and north coasts of Kagoshima Bay the rise of the water was still greater, embankments and stone walls being damaged and extensive rice-fields devastated. The amount of the sea-level elevation was nearly a metre at Kagoshima and two metres or more in Sakura-jima. The apparent sea-level elevation was greatest at the end of 1914, after which it began to decrease.

Prof. Omori attributes this change to the depression of the ground in the neighbourhood of Sakura-jima in consequence of the great eruption. This depression was revealed with greater precision by a renewal of the Military Survey levelling of the district and of the levelling along the railway lines near Kagoshima Bay. Prof. Omori has represented the results on a map on which are drawn the curves of 50, 100, 300, and 500 mm. depression. The curves of 300 and 500 mm. run close to the coast of the northern portion of Kagoshima Bay. The axes of these curves, which are directed north and west respectively, intersect in a point lying off the north coast of Sakura-jima, and Prof. Omori regards this point as indicating the centre of the area of greatest depression of the ground. The total depression-volume within the 100-mm. curve is 1·35 c. km. The aggregate volume of lava flows and pumice and ash ejection during the recent explosion is about 2·2 c. km.

It is important to notice that the point of maximum depression, which probably coincides with the principal centre of the lava reservoir, lies, not under Sakura-jima, but in the region between it and the active volcano of Kirishima.

The triangulation surveys of 1898 and 1914 also reveal considerable displacements, both horizontal and vertical, in Sakura-jima, while the coast of the island is everywhere depressed. Three points in the interior have been raised 0·14 and about 9·7 and 10·4 metres. The horizontal displacements in the north-west of the island vary from 2·04 to 3·62 metres towards the south, and in the west and north by amounts from 1·08 to 4·52 metres towards the north and north-east. The north and south portions of Sakura-jima have thus been displaced outwards in contrary directions.

[1] "The Sakura-jima Eruptions and Earthquakes." II. Bull. Imp. Earthq. Inv. Com., vol. viii., 1916, pp. 35–179. The first memoir was noticed in NATURE, vol. xciv., p. 289; see also vol. xcii., pp. 716–17.

Moreover, displacements of 0·53 to 0·95 metre along the west coast of Kagoshima Bay converge with those in the west and north of Sakura-jima towards an elliptical area which agrees roughly with the area of greatest depression.

Propagation of Sound-Waves.—Prof. Omori divides the sounds which accompanied the eruption into three groups: (1) the early sounds heard from about 10 a.m. to the afternoon of January 12; (2) the strong detonations from 6.30 p.m. on January 12 to 6 a.m. on January 13; and (3) the much weaker sounds of the after-explosions for about ten days following the great eruption. All these sounds were heard within two entirely detached areas, and it is remarkable how similar these areas are in form and to some extent in magnitude. The area which includes the volcano extends in each case in an easterly direction, the mean radius of the boundary being 111, 114, and 102 km. for the above three classes of sounds. The second area lies to the north of the other, and is elongated from west to east, the mean radial distance of its central line from the volcano being 195, 177, and 196 km. The width of the silent zone was 40–50 km. for the strong detonations and about 108 km. for the after-explosions, the axis of the silent zone, in both cases, being at a distance of about 120 km. from Sakura-jima. The greatest distance to which the detonations were heard is about 500 km. (or 310 miles) towards the north-east, but the air-vibrations were strong enough to shake houses and doors for about 85 km. farther in the same direction.

C. DAVISON.

THE BRITISH ASSOCIATION AT NEWCASTLE.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS (ABRIDGED) BY EDWARD A. REEVES, F.R.A.S., F.R.G.S., PRESIDENT OF THE SECTION.

THE surveying equipment of the pioneer explorer of early days, say, of from twenty to sixty years ago, usually consisted of a sextant and artificial horizon, a chronometer or watch, prismatic compass, boiling-point thermometers, and aneroid. With the sextant and artificial horizon the astronomical observation for latitude and longitude were taken, as well as those for finding the error of the compass. The route was plotted from the compass bearings and adjusted to the astronomically determined positions. The latitudes were usually from meridian altitudes of the sun or stars, and longitudes from the local mean time derived from altitudes east or west of the meridian, compared with the times shown by the chronometer, which was supposed to give Greenwich Mean Time.

The sextant, in the hands of a practical observer, is capable of giving results in latitude to within 10″ or 20″, provided it is in adjustment, but the difficulty is that the observer has no proper means of testing for centring and graduation errors.

The great drawback to the sextant for survey work is that it is impossible to take accurate rounds of horizontal angles with it, since, unless the points are all on the same level, the angles must be too large. It is essentially a navigator's instrument, and nowadays has been almost entirely superseded by the theodolite for land-surveying.

As regards the longitude, the difficulty was always to obtain a steady rate for the chronometer, owing principally to the unavoidable oscillations and concussions met with in transit. Formerly it was customary to observe lunar distances for getting the Greenwich Mean Time instead of trusting to the chronometers, but these, even with the utmost care, are very unsatisfactory.

In more recent years the occultation of a star method of finding the Greenwich Mean Time superseded almost entirely the lunar distance, but all these so-called "absolute" methods of finding longitude are fast becoming out of date since the more general introduction of triangulation and wireless telegraphy.

Heights of land were usually obtained by the boiling-point thermometer or aneroid.

This, then, was the usual equipment of the pioneer. With such an outfit the greater part of the first mapping of Africa and other regions of the world was carried out, with results that were more or less trustworthy according to the skill of the explorer and the time and opportunities at his disposal.

In recent years considerable improvement has been made in the instruments and methods of the geographical surveyor; the introduction of the invar tape for the measuring of the base lines, the more general application of triangulation, the substitution of the theodolite for the sextant, the use of the plane-table for filling in the topographical details of the survey, the application of wireless telegraphy to the determination of longitudes, these and other improvements have all tended to greater accuracy and efficiency in geographical and topographical mapping, so that in many respects the rough approximate methods of the earlier explorers are fast being superseded by instruments and methods more in keeping with modern requirements in map-making.

Still, the principle underlying all surveying is the same, and the whole subject really amounts to the best and most accurate methods of measurement with a view of representing on a plane, on a greatly reduced scale, the leading features of a certain area of the earth's surface in their relatively correct positions; and so it resolves itself into geometrical problems of similar angles and proportional distances. This being the case, it is clear that it becomes in the main a question of correct angular and linear measurements, and all the improvements in survey methods have had for their object the increased accuracy of accomplishing this, together with greater facility for computing the results.

What we do now is exactly what was attempted by the early Greek geometricians and others in ancient times, only we have far more accurate instruments. If, for instance, we compare our modern micrometer theodolite with the old scaph of the Greeks the contrast is striking, although both had the same object in view as regards taking altitudes of heavenly bodies. Many of the old instruments, in spite of their great size, were extremely rough, and the angles could only be read with approximation or to a great extent by estimation, while the theodolite, which is now generally used on geographical surveys, although it has circles of only five inches in diameter, can, by means of the micrometers, be read to 2″ of arc, or even to 1″ by careful estimation. This, when one comes to think of it, is a triumph of refinement, since it really means that we can measure to within about 1/80,000 part of an inch, which is something like the space occupied by 1″ on the arc of a circle of 5-in. diameter. At least this is the theoretical accuracy, but in practice there are, of course, errors in sighting, setting the micrometer wires, and those arising from other sources which have to be taken into consideration.

The continued striving after greater accuracy of measurement applies not only to angular measuring instruments, but to linear distance measurement as well; and the improvements in apparatus for this purpose, could we follow them in detail, would be most interesting. From the rough methods that would suggest themselves naturally to early intelligent men,