elements of the orbits of those minor planets discovered during 1904 of which the paths have been computed at the Berlin Astronomischen Recheninstitut. The list contains the orbits of 28 minor planets, 24 (523–549) of which are referred to the epoch 1904.0, and 4 (550–553) to 1905.0, and is followed by a series of remarks which name the observations on which the computations were based, and the corrections to some of the orbits as obtained from subsequent observations. A note concerning (526) NQ says that that object is probably identical with 1901 HA.

An additional list of five asteroids discovered during November and December, 1904, and to which the permanent numbers 549–553 are now allotted, brings the total number discovered during last year up to thirty-two.

EFFECT OF AUTUMNAL RAINFALL UPON WHEAT CROPS.[1]

BY autumn, in this note, is to be understood the period from the thirty-sixth to the forty-eighth week, both inclusive, of the year, as represented in the *Weekly Weather Report* of the Meteorological Office; it covers the months of September, October, and November, approximately. The rainfall to be referred to is the average amount in inches, for the "Principal Wheat Producing Districts," for the period mentioned, in successive years. The amounts are taken from the summaries of the *Weekly Weather Report.*

The yield of wheat is that given for successive years in the annual summaries of the Board of Agriculture and Fisheries as the average yield in bushels per acre for England, since 1884, or more strictly since 1885, as that is the first year for which the figures for England are given separately. In 1884 the figure for Great Britain, which generally differs but little from that for England, is used.

These are the only figures in the official publications which are immediately available for the purposes of comparison. The totals of rainfall for the thirteen weeks have been compiled from the weekly amounts, otherwise the figures are taken as they stand in published returns. The areas referred to are not exactly coterminous, but they are more nearly so than if the rainfall values had been taken for the whole of England, or the wheat yield for Great Britain.

When the autumn rainfall and the yields of wheat for successive years from 1884 to 1904, as thus defined, are plotted, the rainfall curve being inverted, *i.e.* rainfall being measured downward on the paper while yield is measured upward, there is a very striking similarity between the curves, so much so as to suggest that if the scales were suitably chosen the two curves would superpose and show general consonance, with exceptions, more or less striking, in a few of the years. In other words, the yield of wheat in any year seems to depend mainly on the absence of rainfall in the previous autumn, and but little on any other factor.

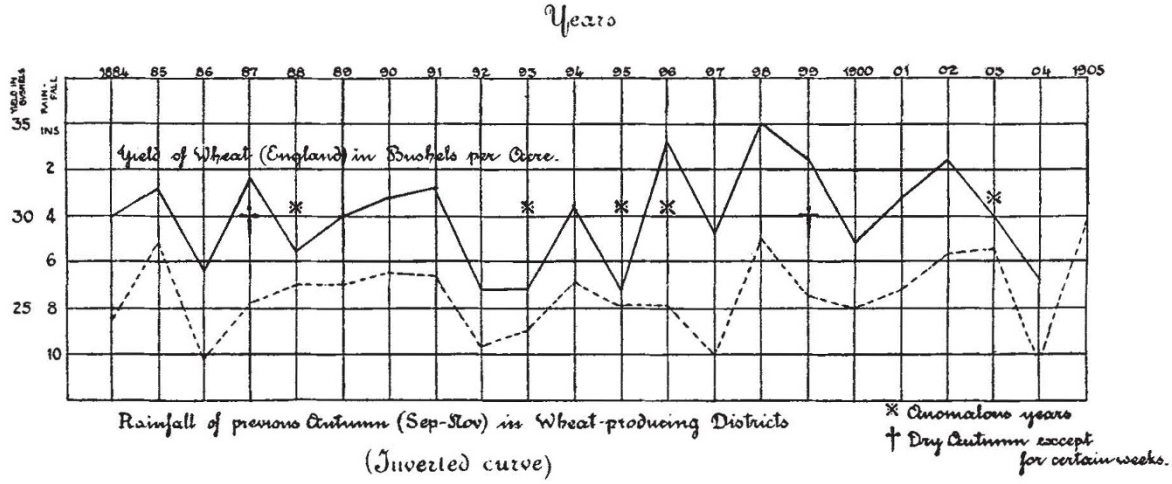
The obvious algebraical expression for such a condition as the curves represent is a linear equation, and the equation which represents the relation between yield of wheat for England and the previous autumn rainfall is :—

Yield = 39.5 bushels per acre − 5/4 (previous autumn rainfall in inches).

If we call the yield obtained from the rainfall by this equation the "computed yield," a comparison with the actual yield for the twenty-one years shows that the computed yield agrees with the actual yield within half a bushel in seven years out of the twenty-one. In fourteen years the agreement is within 2 bushels; in the remaining seven years the difference between computed and actual yield exceeds 2 bushels. The extreme variation of yield in the twenty-one years is 9 bushels, from 26 bushels per acre in 1892 and two other years to 35 bushels per acre in 1898.

Of the seven years for which the formula gives yields differing from the actual by upwards of 2 bushels, 1896 is the most conspicuous; its actual yield exceeds the computed yield by 4.5 bushels.

These seven years all show anomalous seasons. Taken *seriatim,* they are 1887, 1888, 1893, 1895, 1896, 1899, and 1903.



In 1888 and 1903 the crops were washed away by 10 inches of rain in the summer; 1893 is the year of phenomenal drought, and the crop was below the computed figure by 2.5 bushels. The years 1892 and 1899 are interesting, because though the amounts of rain were up to the average, the former had eight dry weeks and the latter ten dry weeks out of the thirteen included in the conventional autumn. They were thus dry autumns, the average amount of rainfall being made up by a few exceptionally wet weeks. The yields correspond with dry autumn values. They are above the average and above the computed figures by some 2 or 3 bushels per acre.

There remain 1895 and 1896. 1895 was the year of remarkably cold weather, and in that year the yield fell short, but in the following year the deficiency was made up by a yield as much above the computed value as the previous one fell short. It would appear that in this instance the productive power not utilised in the year of the great cold was not lost, but stored. On the other hand, it must be remarked that 1896 had the advantage of a specially dry winter.

It appears from these considerations that the dryness of autumn is the dominant element in the determination of the yield of wheat of the following year. The averages of yield and of rainfall are taken over very large areas, and it may be taken for granted that the investigation of the question for more restricted areas would introduce some

[1] "On a Relation between Autumnal Rainfall and the Yield of Wheat of the following Year.—Preliminary Note." By Dr. W. N. Shaw, F.R.S., Secretary of the Meteorological Council. Read before the Royal Society on February 2.

modification in the numerical coefficients, if not in the form of the relation.

The data for making such an investigation are not yet in an available form. A comparison has been made between autumnal rainfall for "England, East," and the average yield for the counties of Cambridge, Essex, Norfolk, and Suffolk, which shows a similar relation but a magnified effect of autumnal rainfall upon the crop, and also two exceptional years which have not yet been investigated.

GEOLOGICAL NOTES.

FROM the Geological Survey we have received a memoir on the water supply of Lincolnshire from underground sources, with records of sinkings and borings, edited by Mr. H. B. Woodward, with contributions by Mr. W. Whitaker, Dr. H. F. Parsons, Dr. H. R. Mill, and Mr. H. Preston. In the introduction a description is given of the various geological formations with especial reference to the water-bearing strata. The bulk of the work is taken up with records of borings, among which we note particulars of a new boring in progress at Boultham for the supply of Lincoln; many records from the prolific locality of Bourn, where from one bore-hole five million gallons of water a day have been obtained; and other records from Scunthorpe, Skegness, Woodhall Spa, &c. Many analyses of water are given, and Dr. Mill contributes a useful section on rainfall, with a colour-printed map.

The Geological Survey has issued a memoir on the geology of West-Central Skye, with Soay, in explanation of sheet 70 of the geological map of Scotland. The memoir is written by Mr. C. T. Clough and Mr. Alfred Harker. The area is mainly occupied by the Tertiary igneous rocks of the Cuillin Hills, but it includes also some Torridonian rocks, and small tracts of Trias, Lower Lias, and Cretaceous. The occurrence of Cretaceous strata, probably of Upper Greensand age, is of especial interest. The Glacial and post-Glacial accumulations, the physical features and scenery are duly described. The memoir, in short, is in a handy form (pp. 59, and price 1s.), well suited as a guide on the ground, and as an introduction, as regards the volcanic rocks, to the larger work by Mr. Harker (lately noticed in NATURE) on the Tertiary igneous rocks of Skye.

Another memoir issued by the Geological Survey is on the geology of the country around Bridgend, being part vi. of the "Geology of the South Wales Coal-field," by Mr. A. Strahan and Mr. T. C. Cantrill, with parts by Mr. H. B. Woodward and Mr. R. H. Tiddeman. The district here described includes the Vale of Glamorgan, for the most part an area of Lias with irregular scatterings of Drift; an agricultural district, famed also for its Blue Lias lime, so well known in old times at Aberthaw, and now largely manufactured at Bridgend. The basement portions of the Lias at Sutton and Southerndown, conglomeratic in character, are duly described, as well as the littoral portions of the Keuper and Rhætic Beds. A small tract of the main coalfield enters the area, bounded by Millstone Grit and Lower Carboniferous Rocks, and the Old Red Sandstone appears in inliers. The bulk of the work is taken up with a description of the Keuper, Rhætic Beds and Lias, which furnish many points of interest.

The fifteenth report by Prof. W. W. Watts on photographs of geological interest in the United Kingdom (Brit. Assoc., Cambridge, 1904) is of a most satisfactory character. A clear profit of 130*l.* has been made. This shows that the work of collecting and storing typical photographs of geological features and phenomena, and of supplying copies to teachers and others in various parts of the world, has proved a great success, and a distinct service to geological and perhaps also to geographical science. This success is due to the indefatigable energy of Prof. Watts.

In his address to the Liverpool Geological Society, Mr. T. H. Cope took as his subject types of rock-flow in the Ceiriog valley and their analogies with river structure (*Proc.* Liverpool Geol. Soc., vol. ix., part iv.). The author points out the evidence of flow structures and other terrestrial movements in igneous and metamorphic rocks, and compares them with the known movements of water.

We have received No. 37 of vol. v. of "Spelunca" (*Bulletin* and *Mémoires* de la Société de Spéléologie). This contains a number of articles on caves and on underground waters, on prehistoric remains from caves, on the present subterranean flora, on contamination of waters, and on the use of fluorescence in detecting the flow of underground streams. A report on the sources of the water of Arcier, with special reference to the water-supply for the town of Besançon, is contributed by Prof. E. Fournier to the same periodical (No. 38), and he concludes that the supply from Arcier must at all costs be abandoned. The subject has excited much controversy owing to the fact that the probable sources of contamination through porous and fissured limestones are at a distance from the outlet of the stream at Arcier.

In the ninth report of the periodic variations of glaciers by Dr. H. F. Reid and M. E. Muret (*Arch. des Sc. phys. et nat. Genève,* xviii., 1904), the general record is one of decrease.

The records of the Geological Survey of India (vol. xxxi. part iii.) contain an article by Mr. R. D. Oldham on the glaciation and history of the Sind Valley, Kashmir, a subject illustrated by six excellent photographic views, which exhibit features produced respectively by glaciers and by rivers, and afford support to the view of the author of a diversion of the drainage since the glaciers attained their greatest dimensions.

A report on the Jammu coal-fields has been written by Mr. R. R. Simpson, mining specialist to the Geological Survey of India (*Mem.* Geol. Surv. India, vol. xxxii. part iv.). The coal-fields lie in a mountainous country, varying from three thousand to nine thousand feet above sea-level, and the strike of the coal-bearing rocks does not conform to any of the main natural features. The prospects of working the coal with profit are not considered good, in present circumstances, as the expenses would be great on account of the inclined and broken character of the rocks, the possibility of landslips, and of trouble from water. Otherwise a fairly good steam-coal may be obtained.

A geological map of Cyprus, by Mr. C. V. Bellamy, has been issued by Mr. Stanford (price 6s.). It is accompanied by a key or short explanation, in which the author describes the physical features and the various geological formations which range from Cretaceous to Pliocene and Pleistocene. Between the Oligocene and Pliocene there is a break, marked by the occurrence of basic igneous rocks, which have baked and altered the Oligocene (Idalian) limestones. These igneous rocks, which comprise serpentine, variolite, gabbro, &c., form a broad belt of mountainous ground in the south-central portion of the island. The map, which is produced on a scale of $5\frac{1}{2}$ English miles to one inch, is printed in colours, and clearly shows the extent of the main geological divisions. It will be a useful guide to those interested in the geology, whether from a scientific or practical point of view. The economic products include building stones, marble, pottery clay, gypsum, &c.

Our knowledge of the geology of South Africa proceeds apace. We have received vol. vii., part iii., of the *Transactions* of the Geological Society of South Africa, which contains among other articles an essay by Dr. F. H. Hatch and Dr. G. S. Corstorphine on the petrography of the Witwatersrand conglomerates, with special reference to the origin of the gold. The original explanation was that the Rand conglomerates were ancient placer deposits, in which the gold was as much a product of denudation as the pebbles which accompany it. The authors show that the theory of the subsequent infiltration of the gold is most in accordance with the facts. The gold is practically confined to the matrix of the conglomerate, and occurs there in crystalline particles in association with other minerals of secondary origin.

Mr. E. Jorissen, in the same *Transactions,* deals with some intrusive granites in the Transvaal, the Orange River Colony and in Swaziland. These old granites, mostly grey in colour, penetrate the crystalline schists which are regarded as of Archæan age, but they do not intrude into the Witwatersrand series. Mr. J. P. Johnson contributes further notes on some pigmy stone implements from Elandsfontein No. 1. They are regarded as scrapers belonging to the Neolithic stage of culture.

In his address to the South African Association for the Advancement of Science (Johannesburg meeting, 1904), Dr. Corstorphine took for his subject the history of strati-