

crystalline sandstone, granite, clayslate, agate, tourmaline, iron pyrites, garnet, garnet spinel, &c., which compose this alluvium, are all roundedly polished and waterworn, and are imbedded at Klipdrift in a brownish, fatty earth.

"The question arises, Is this alluvium of recent or ancient formation? Did the majority of the pebbles exist in the form of a conglomerate, aggregated from the alluvium of a former age? Or have the Kopjes at no very late period been the bed of the river?

"It is my opinion that the water-worn gravel has been under the influences of running water prior to the last great changes which formed the present landscape. The greater number of the water-worn pebbles and boulders are of the basalt of the Kopjes. Many of them are a crystalline sandstone, others are water-worn fragments of clayslate, sandstone, &c., of the sedimentary rocks which exist in the Kopjes. The agates, tourmalines, and garnets are undoubtedly from some supercumbent conglomerate sandstone which has yielded to denudation and no longer exists at Klipdrift, and also to a considerable extent from the amygdaloidal trap everywhere prevalent. I have in my possession from the Vaal a single fragment of red sandstone containing garnets, but I have not succeeded in tracing this to its source.

"It will, therefore, be sufficiently apparent that there must have existed, at a remote geological period, a series of metamorphic and sedimentary rocks which lay above the present rock system of the region, and that, through successive disturbances and persistent denudation, these have been worn away, forming in great part the alluvial soil of the present surface. In some few spots remnants of this series still exist, as in the clay-slaty crystalline sandstone and conglomerate of Sitlacomies Valley, in the thin layers of claystone, sandstone, and micaceous sandstone of some of the Kopjes now worked for diamonds, and generally in the fragments of sedimentary rocks scattered over the surface along the whole Vaal Valley.

"I am decidedly inclined to think that the diamonds have not been washed down from some higher region. I hope to show in another article that the Free State possesses an independent diamondiferous centre, and that there no river has existed at any time, for there is no evidence of water-wearing, and the soil is not alluvial. Diamonds have been discovered two hours' distance from Potchefstroom, and all down the Vaal to its junction with the Orange River, and thence to ten hours' distance below Hope Town. This is a stretch of at least 500 miles. I believe the diamonds have come from some rock which may now have vanished, but which existed formerly throughout the whole region.

"In concluding at present, I have to make some observations on the position of the gravelly soil which is now being washed for diamonds. The old diggers are in favour of the summits of the Kopjes. They have tested this belief, or rather formed it, from their experience of the old Kopje. How can it be explained that the soil is alluvial and yet deposited far above the influences of the river? For two or three miles inland, which I investigated, there is everywhere on the heights the same deposit.

"There are certain facts which enable me to point out the geological history of these Kopjes. The summits are all basalt. This has been protruded through the

amygdaloidal and conglomerate traps. At a subsequent period, however, there must have been another elevation for the blocks and columns radiate from a centre, so that the crevices are wedge-shaped, or expanding outwards to the surface. This subsequent upheaval was evidently not simultaneous throughout the whole region, but successive, and therefore the bed of the stream was changed from place to place. The present bed of the Vaal cannot be an old one, and the whole surface of the country as far as the alluvial soil extends was, at different previous times, under the wearing and breaking influence of the river. Granting, then, a series of rocks such as have been described undergoing water-wearing by the ancient Vaal, which by intermittent and successive upheavals was compelled continually to change its course, and the presence of alluvial gravel on the summits of the Kopjes far and wide is easily explained.

"In the hollows no gravel is apparent, because a thick covering of sand, the accumulation of present denudation, lies over the gravel. Diggers do not care to undertake the labour of carrying off the surface sand at present. In time this will be done, and I am convinced there will be found more diamonds than on the Kopjes. And when the day comes when the bed of the stream shall be searched by deflecting the water in canals through the many flats which abound in the Valley of the Vaal, a superior diamondiferous gravel will be worked. From all I saw and for the reason I have now advanced, the present diamond digging of South Africa is only trifling in comparison to what it should and will ultimately be."

#### THE QUARTERLY WEATHER REPORT

*Quarterly Weather Report of the Meteorological Office, with Pressure and Temperature Tables for the Year 1869. Part I. January—March, 1869.*

IT is an arduous undertaking to establish and work a system which shall give us a perfectly full, trustworthy, and continuous account of the meteorology of even so small a part of the globe as the British Isles. The Meteorological Committee of the Royal Society are therefore deserving of credit in the systematic effort which they have made to establish the weather records of these isles upon a scientific foundation. Nor must we forget that our Government has been very liberal in this matter, and that a grant of 10,000*l.* a year devoted to meteorology represents a very handsome contribution from that national purse which is, alas! so often shut when it ought to be open, and so often open when it ought to be shut.

Let us now consider how far the Committee have succeeded in advancing our knowledge of British Meteorology, and in what respect, if any, they have fallen short of that which they might have been expected to accomplish. For this purpose let us divide the labours of the Committee into three heads, and consider separately their system of obtaining information, their system of discussing it, and, in the last place, their system of publication.

In the first place, and with respect to their observational system, it is hardly necessary to state that they have established seven observatories in which the various meteorological elements are registered continuously by means of photography, or that the Kew Observatory has

undertaken to examine the records from these various outlying observatories before they are sent to the central office. Nor is it necessary to detail the other steps which have from time to time been taken by the Meteorological Committee to insure instrumental and observational accuracy; for men of science have only to examine the various publications of the office to be convinced that a large amount of accuracy has been already achieved.

In addition to the observations from self-registering instruments, other records of a less complete nature come to the office in continually-increasing quantity; for, evidently, the records from only seven stations, however completely equipped, are insufficient to give us a true view of the very complicated meteorology of these isles. It is, therefore, an important duty of the chief officer of the Committee so to increase this stock of observations as to obtain in time a complete and trustworthy meteorological record. There seems reason to believe that this will ultimately be done, and it will be a great boon to meteorological science when it is accomplished.

But, if the observational system is important, the method of reducing observations is a point of equal importance. The condensed account of the quarter's weather, and of its easterly storms, by Mr. Scott, are exceedingly useful summaries, and form, as it were, the first step of the ladder which leads from facts to laws, and it is hardly necessary to state that such summaries have a practical as well as a theoretical importance.

We pass on from these to consider next the tables of averages for the year 1869, which have been given in this Quarterly Report. As far as the air-temperature and pressure are concerned, there can be no objection to tables giving average results. These are two meteorological elements of a nature sufficiently simple to render averaging desirable; and the five-day means of those elements given in page 41 form, perhaps, the best way of accomplishing this. But surely the readings of the wet-bulb thermometer do not represent any simple meteorological element! The moisture is best represented by ascertaining the mass of vapour present in a cubic foot of air, this forming its legitimate expression in terms of *mass* and *volume*, which are fundamental physical conceptions. On the other hand, the temperature of the wet bulb, while it forms the easiest and best observational method of obtaining continuous information regarding moisture, is yet in reality a very complicated joint function of the temperature of the air, of its pressure, and of the mass of vapour present in one cubic foot. To give five-day readings of the wet-bulb thermometer cannot, therefore, we think, lead to any good result.

We are just beginning to know a little about the motions of the atmosphere and its variable components, and if we wish to extend our knowledge in this direction, it seems perfectly essential that the physical meteorologist should choose proper methods of reduction. His method ought not to be one which, when accomplished, *may possibly* increase our knowledge, but one which, from its very nature, *must necessarily* do so. He ought to seek to have the same certainty which the astronomer possesses, that in treating his observations after a particular method, the results will infallibly extend his knowledge of celestial motions.

We have dwelt so long upon this part of the labours

of the Meteorological Committee, that we can only briefly allude to their system of publication. The reduced graphical representations of the observatory records given at the end of the volume, while hardly enough for the wants of meteorologists, are yet extremely valuable and useful. It is impossible to say what benefit to science may not result from bringing before the public such a speaking epitome of weather, and we owe many thanks to Mr. Francis Galton, the member of the Meteorological Committee who invented the instrument which has given us these admirable plates.

BALFOUR STEWART

### BEET-ROOT SUGAR

*On the Manufacture of Beet-Root Sugar in England and Ireland.* By William Crookes, F.R.S., &c., Editor of the *Chemical News*. Illustrated with ten engravings. Pp. 290. (London: Longmans, 1870.)

THIS work is founded on a series of articles by M. Julien M. Deby, C.E., published about a year ago in the *Scientific American*; these articles have, however been very much extended, and much new matter added, in order to bring the subject down to the present date, and so increase its usefulness in assisting those who may wish to establish beet-root farms and sugar factories in this country. The experiences obtained abroad, and investigations made in England and Ireland, show that it would be quite possible to grow sugar-beets with profit in the United Kingdom. The beets might be used as fallow crop and cultivated, instead of the roots grown in such great quantities as food for cattle, since the beet-root pulp after the extraction of sugar is even more valuable for this purpose.

During the year 1867, beet-root sugar of the value of 1,600,000*l.* was imported into this country, and it would appear that this might readily have been produced here. In the first chapter we have a description of the beet, and of the qualities that can most profitably be used for sugar making; the weight of each root should not be less than 1½*lb.*, nor more than 2*lbs.*; smaller roots are frequently woody, while larger ones are watery and poor in sugar. The juice should have a specific gravity between 1·060 and 1·070, though sometimes, when very rich in sugar, it rises to 1·075 or 1·078. The percentage of sugar in the roots varies considerably, the minimum quantity given in a long list of analyses being 3·62, while the maximum is 13·47. The next number below this maximum is 13·19, and is interesting as representing the amount of sugar found in red beet manured with London sewage. Peligot obtained as much as 18 per cent. from some French beets, and some American specimens have produced 17·6 per cent. It has been found in Ireland that from 16 to 40 tons of roots may be grown on one acre, so that satisfactory results might be anticipated in that country. Chapter II. treats of the culture of the beet, the climate, kinds of soil, manure, and all the necessary directions to the agriculturist to ensure a profitable return. Chapters III. to VII. contain a detailed description of the mode of extraction of the sugar, and a very useful statement of the cost of the different pieces of apparatus required for working up 150,000*lbs.* of beet-root per twenty-four hours during five months, which