AGATES

THE following letter was addressed by the writer in 1871 to Mr. Joseph John Murphy, and though not originally intended for publication, is now published with the writer's consent :—

St. Andrews, November 4, 1871

DEAR SIR,—I have on my return found your note as to agates. Though I have been at work on the subject in different ways for many years, I have not found myself in a position yet to publish. In fact I cannot yet say that I *know* much as to how they have been formed, though I do know, or rather am able to show, that they have not been made in the manner usually supposed.

The late Principal Forbes conceived that they had been formed by concentric deposition round a central nucleus :—this I showed him to be untenable. Others conceive that siliceous matter in a state of fusion has been poured into cavities through an opening, such opening being called the "point of infiltration." I am able to show that this so-called point of infiltration is an orifice of escape or exit of something.

Fully to state how (from examination of their mode of occurrence, experiments upon the decomposibility of trap rocks under the action of carbonated water, section of agates in every conceivable direction, experiments upon their powers of absorbing liquids, and from microscopic examination) I conceive agates to be formed would call for indeed a long statement.

I will attempt briefly to put it thus :—

Igneous rocks are being poured forth from a volcanic vent, in perfectly fluid or at least plastic flow ; some are dense, some scoriaceous, some frothing, and so when solidified are vesicular, or perchance even hold in suspension bubbles of included water, this latter holding in solution (red-hot solution) solids afterwards to separate as rheolites. Should the air-bubbles of the vesicular rocks arise through the plastic mass while it is motionless, these bubbles will be more or less rounded or pear-shaped. Should the solidifying rock, however, become crystalline or porphyritic, as generally is the case with amygdaloids, the separating crystals of labradorite, &c., will more or less roughen the sides, and so destroy the smooth and rounded figure of the cavity ; while, if the lava-flow continues its motion while the bubbles are still rising, their shape will be more or less flattened or altered :—try bubbles in flowing treacle.

Stage the first.—An empty cavity of any shape.

Stage the second.—The rock, while solidifying, may contain an excess of a magnesian mineral, which is exuded into the cavity ; or this excess of magnesian compound (magnesia not being, to any large extent, a *natural* constituent of the mass of a trap) may be held as vapour in the cavity, to be, on cooling, deposited on its sides. This forms in Scotland, Faroe, Iceland, &c., the layer of celadonite or delessite ; at Giant's Causeway, of chlorophœite, which, on the extraction of the afterwards filled-up cavity, forms the "skin of the pebble."

Stage the third.—One of two processes, the first very doubtful.

The cooling and shrinking rock holds in a state of *liquidity, from heat,* an excess of colloidal silica which is exuded into the cavity forming a chalcedonic druse. But, admitting the process, it must here stop, and a *solid* agate could not thus be formed. This seems to have been the view of Sir George Mackenzie.

The other process I pin my faith to. The thoroughly solidified—indeed the now *old*—rock is having its felspar (labradorite or other) decomposed by water holding carbonic acid in solution. I have proved that this process is rapid and continuous, and agate-holding traps are all rotten ; the colloidal silica, with a certain quantity of *tridamyte* is taken up by this water, and transfuses into the cavity; the silica is there solidified—probably the layer of delessite is the coagulation. We have now a cavity slightly lined with chalcedonic matter, containing, within, water more or less pure, while without (that is outside of the now double skin, delessite and first layer) we have a strong solution of colloidal silica constantly supplied. Endosmose and exosmose are set up with all their resistless force. The *strong* solution finds its way through the two or any number of increasing skins : the *weak* water is forced out through the "point of infiltration," and so in its passage out thins all the successively deposited layers *at that place.* By this continuous flow of colloidal silica (held in solution by liquid) through the already coagulated or deposited layers, continuous coagulation of the silica in the yet hollow agate, and continuous extrusion of the residual water, we have the ultimate filling up of the cavity, and a solid agate formed.

The adhesion of agates to the containing rock is slight in most cases from the so-called "skin" being magnesian and soapy.

The "point of infiltration," instead of being at once filled up, as would result from the inflow of coagulable silica, is in reality the last point filled up, being truly the point of escape : indeed it frequently is not altogether filled up, *remaining an open tube.*

The microscope shows on a cross section the concentric layers of coagulated silica, soluble in alkalies ; the crystals or fibres of *tridamyte* cross these layers at right angles, radiating like a rheolite from the skin, and it is always along the sides of these crystals that intruding and staining liquids find a way ; probably, therefore, along their sides also did the ingress of chalcedonic fluid find entrance. I remain very truly yours,

M. FORSTER HEDDLE

THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[1]

THE Lakes of Britain present us with some of the most interesting problems in our topography. It is obvious that the existence of abundant lakes in the more northern and more rocky parts of the country points to the operation of some cause which, in producing them, acted independently of and even in some measure antagonistically to the present system of superficial erosion. It is likewise evident that as the lakes are everywhere being rapidly filled up by the daily action of wind, vegetation, rain, and streamlets, they must be of geologically recent origin, and that the lake-forming process, whatever it was, must have attained a remarkable maximum of activity at a comparatively recent geological epoch. Hardly any satisfactory trace is to be found of lakes older than the present series ; perhaps Lough Neagh, which from its thick deposits and their fossils, has been referred back to Pliocene times, is the solitary exception. How then have our lakes arisen ? Several processes have been concerned in their formation. Some have resulted from the solution of rock-salt or of calcareous rocks and a consequent depression of the surface. The "meres" of Cheshire, and many tarns or pools in limestone districts, are examples of this mode of origin. Others are a consequence of the irregular deposit of superficial accumulations. Thus, landslips have occasionally intercepted the drainage and formed lakes. Storm-beaches, thrown up by the waves along the sea-margin, have now and then ponded back the waters of an inland valley or recess. The various glacial deposits—boulder-clays, sands, gravels, and moraines—have been thrown down so confusedly on the surface that vast numbers of hollows have thereby been left which, on the exposure of the land to rain, at once became lakes. This has undoubtedly been the origin of a large proportion of the lakes in the lowlands of the north of England, Scotland, and Ireland, though they are rapidly being converted by natural causes into bogs and meadow-land. Underground movements may have originated certain of our lakes, or at least may have fixed the direction in which they have otherwise been produced. A very large number of British lakes lie in basins of hard rock, and have been formed by the erosion and removal of the solid materials that once filled their sites. The only agent known to us by which such erosion could be effected is land-ice. It is a significant fact that our rock-basin lakes occur in districts which can be demonstrated to have been intensely glaciated. The Ice Age was a recent geological episode, and this so far confirms the conclusion already enforced, that the cause which produced the lakes must have been in operation recently, and has now ceased. We must bear in mind, however, that it is probably not necessary to suppose that land-ice excavated our deepest lake-basins out of solid rock. A terrestrial surface of crystalline rock, long exposed to the atmosphere, or covered with vegetation and humus, may be so deeply corroded as, for two or three hundred feet downward, to be converted into mere loose detritus, through which the harder undecomposed veins and ribs still run. Such is the case in Brazil, and such may have been also the case in some glaciated regions before the glaciers settled down upon them. This superficial corrosion, as shown by Pumpelly, may have been very unequal, so that when the decomposed material was removed, numerous hollows would be revealed. The ice may thus have had much of its work already done for it, and would be mainly employed in clearing out the

[1] Abstract of fourth lecture given at the Royal Institution, February 26, by Archibald Geikie, F.R.S., Director-General of the Geological Survey of the United Kingdom. Continued from p. 397.

corroded debris, though likewise finally deepening, widening, and smoothing the basins in the solid rock.

The Hills and Hill-groups of Britain have all emerged during the gradual denudation of the country, and owe their prominence to the greater durability of their materials as compared with those of the surrounding lower grounds. They thus represent various stages in the general lowering of the surface. In many cases they consist of local masses of hard rock. Such is the structure of the prominent knobs of Pembrokeshire and of Central Scotland, where masses of eruptive rock, formerly deeply buried under superincumbent formations, have been laid bare by denudation. In connection with such eruptive bosses attention should be given to the "dykes" so plentiful in the north of England and Ireland, and over most of Scotland. In numerous instances, the dykes run along the crests of hills and also cross wide and deep valleys. Had the existing topography existed at the time of their protrusion, the molten basalt would have flowed down the hill-slopes and filled up the valleys. As this never occurs, and as there is good evidence that the dykes are not of higher antiquity than the older Tertiary periods, we may conclude that the present configuration of the country has, on the whole, been developed since older Tertiary time—a deduction in harmony with that already announced from other independent evidence.

Escarpments are the steep edges of hills in retreat. The British Islands abound in admirable examples of all ages from early Palæozoic rocks down to Tertiary deposits, and of every stage, from the almost unbroken line of cliff to scattered groups of islet-like fragments. The retreat of our escarpments can be well studied along the edge of the Jurassic belt from Dorsetshire to the headlands of Yorkshire, likewise in the course of the edge of the Chalk across the island. Not less suggestive are some of the escarpments of more ancient rocks, such as those of the older Palæozoic limestones, the Old Red Sandstone of Wales, the Carboniferous Limestone and Millstone Grit of Yorkshire, and the Coal Measures of the Irish plain. Our volcanic escarpments are likewise full of interest—those of the Lower Old Red Sandstone along both sides of the Tay, of the Carboniferous system in Stirlingshire, Ayrshire, Bute, and Roxburghshire, and of the Tertiary series in Antrim and the Inner Hebrides.

SUN-GLOWS AND VOLCANIC ERUPTIONS IN ICELAND

IN reply to the inquiry despatched to me by NATURE with last mail, whether any remarkable sun-glow had been observed recently in Iceland, and which, I learn, has been observed in nearly all parts of the world, and whether any volcanic eruption had lately taken place in the island to which the same might be attributable, I beg to relate, as regards the first of these points, that on November 23, between 5 and 6 p.m., I noticed for the first time an unusual and striking purple intensity of the sky, a phenomenon which was also observed on the subsequent mornings and nights. I did not attach much importance to this phenomenon at the time, through the circumstance that I was told that sunrises and sunsets were generally attended by very intense auroræ here, and since then I have had so few opportunities of seeing the sky free from clouds that I have not observed any similar phenomenon. I learn, however, on inquiry here, that the same glow was observed once or twice before Christmas by several persons. On one occasion, January 30, the sky was perfectly clear several hours after sunset, but there was no unusual glow.

With regard to the second point, as to recent volcanic eruptions in the island, I have not much new information to transmit (NATURE, vol. xxix. p. 343). The only thing we know as to this is that a man has written a letter to an Iceland paper stating that on October 8 and 9 last year he was at a farm about three geographical miles east-north-east inland from the well-known fishing village Seydisfjord, on the east coast, when he saw, on the first-mentioned day, in the direction of the unexplored gigantic volcanic mountain, the Vatnajökull, about 130 geographical miles in extent, in the south-eastern corner of the island, two columns of fire, and on the following morning, in the same direction, two columns of smoke. He adds that a similar phenomenon was observed on the farm two days previously. It is also reported to us here that ashes have fallen in Seydisfjord.

It is most probable that these eruptions have occurred in the same place where similar phenomena have been observed several times in recent years, viz. in the neighbourhood of the Kverk Mountains on the north side of the Vatnajökull, and that there are, in all probability, several volcanoes in activity in this district, which is utterly unapproachable to explorers.

There is, however, no reason to assume that eruptions of any magnitude have recently taken place in any other part of the island, as such an occurrence would soon have been reported by some means or another to us here.

If, therefore, the remarkable sun-glows of which I read are attributed to terrific volcanic eruptions, the latter must be sought in other localities than Iceland.

SOPHUS TROMHOLT

Reykjavik, Iceland, February 1 (by mail February 8)

COMPOSITE PORTRAITURE ADAPTED TO THE REDUCTION OF METEOROLOGICAL AND OTHER SIMILAR OBSERVATIONS

IT has often been remarked that one of the main, if not the chief, of the difficulties the meteorologist has to contend with, is the enormous amount of preliminary labour which has to be expended in the not very pleasing task of forming the observations he may wish to discuss into tables, casting the columns of figures so obtained, and then computing the means. Should, as in many cases nowadays, his original material be in the shape of curves, *e.g.* barograms, thermograms, or anemograms, he has first to reduce these to figures by tabulation, before he can attempt any step towards their reduction.

The deterrent nature of these preliminary operations not unfrequently forms a complete bar to the entering upon most interesting investigations with a view to the advancement of the science, in the case of persons unable to devote sufficient time to such labour, which may almost be termed drudgery. To cite examples, a glance at the recently published papers in the *Proceedings of the Royal Society*, by Prof. Balfour Stewart (vol. xxv. p. 577) and by Mr. C. Chambers (vol. xxxiv. p. 231), in which they endeavour to trace a possible intimate connection between solar and terrestrial phenomena, will show the immense amount of calculation they had to perform in order to arrive at their results—how, for instance, preliminary means had to be taken of three days' observations and the result assumed to be a corrected value for the middle day of the three, then, after the whole series had been so treated, a second or even a third set of averages computed. The author has also a lively recollection of the excessively tedious calculations required to eliminate in a somewhat similar manner the effect of disturbances in the discussion of the Kew magnetic observations for the late Sir E. Sabine. With the view of arriving at results by a shorter cut, the author has been led to consider the possibility of employing a method suggested by an examination of the highly ingenious system of composite portraiture invented by Mr. Francis Galton, F.R.S., and utilised in his anthropological studies.

Mr. Galton's method of experiment is based upon the fact that certain groups of people possess certain physiognomical features in common. This agreement of feature is usually characterised by the term "family likeness." In order, therefore, to select this particular element from the others, and to obtain a picture in which it is most strongly defined; or, in other words, to form a characteristic portrait of the group of individuals, Mr. Galton employs a series of photographs. These, representing a large number of men or women, are first reduced to the same scale, and then projected successively upon a sensitised photographic plate, having been previously so arranged that the eyes or other salient feature shall always fall on the same portion of the plate.

In this manner a negative is eventually obtained which gives a print depicting a countenance which, although resembling but partially any one of the component portraits, gives a fair typical picture of the group of individuals. Among other results Mr. Galton has detected the likeness existing in various classes of criminals, and also in patients suffering from the same disease, as well as the more marked features transmitted through the different members of a family.

Since in meteorological investigations the desire is to select and to identify the one particular variable running through a group of phenomena, it has appeared to the author, arguing by analogy, feasible to perform this operation by a method somewhat resembling that just described. Supposing, for example,

[1] By G. M. Whipple, B.Sc., F.R.Met.Soc., F.R.A.S., Superintendent of the Kew Observatory, Richmond (from the *Quarterly Journal of the Meteorological Society*, vol. ix. No. 48).