IV.—On the Microscopic Structure of the Pitchstones and Felsites of Arran.

By S. Allport, F.G.S.

In my last communication[1] I gave some account of all the varieties of Arran pitchstones then known to me, and referring to other closely allied rocks, intimated an intention of describing them on another occasion.

A second visit to the island during the past summer has not only enabled me to collect the requisite materials, but has also supplied me with a few additional varieties of pitchstone; some remarkable for their microscopic structure, others of considerable interest to the petrologist, as they exhibit a transition from the true glassy texture to that of the dull compact "hornstones" and felsites.

Intimately associated with the pitchstones, there frequently occur dykes and other intrusive masses of light-grey rocks of a felsitic or trachytic character; they are all quartziferous, and present several well marked varieties. As these rocks have not been previously described, I purpose giving some account of their structure and mode of occurrence, but will, in the first place, complete my description of the pitchstones.

In my former paper I described the pitchstones on the east and west coasts as occurring in intrusive veins and dykes, and subsequent examination has not only confirmed this view, but has also shown that the sandstones are greatly altered along the line of junction. Prof. Zirkel, on the other hand, states that the vein on the Corriegills shore has not produced the slightest change on the sandstones, and that it is regularly interbedded with them.[2] It became necessary, therefore, to make another careful examination of the locality. The result was, that the sandstone in contact with, or in close proximity to, the pitchstone, is greatly indurated in places, while in others it is comparatively soft; but in these instances there is invariably an escape of water at the junction of the two rocks, and a partial disintegration has been the result; an examination, therefore, of such places only, might easily mislead an observer. As regards the relative positions of the two rocks, I have nothing to add to the previous account; in all the localities examined the pitchstone is clearly intrusive.

In order to insure a tolerably complete investigation of the rocks described in this and the former paper, specimens exhibiting any variations in structure or appearance were taken from each locality; and of these I have prepared forty-one thin sections for microscopic examination.

[1] See Geol. Mag. Vol. VIII. pp. 448–450.

[2] Zeits. d. d. geol. Ges., xxiii., p. 1.

Specimens of pitchstone collected in Monamore Glen and Birk Glen, near the old Lamlash road, afford beautiful varieties of the rock represented in Plate I., Fig 1, combined with the structure of Fig. 2. A dark green pitchstone from Invercloy contains numerous crystals of quartz and felspar, which give it a porphyritic character; the base is a clear colourless glass, thickly crowded with very short, straight belonites, which wind in streams round the larger crystals, but there is no arrangement in groups. Some of the quartz crystals contain remarkable cavities inclosing small fern-like groups of belonites, although there are none whatever in the surrounding matrix.

A specimen of black pitchstone deserves special mention. It was taken from a boulder on the high ground near West Benan; two other boulders of the magnificent porphyritic pitchstone previously described, together with many others of the coarse-grained granite, were lying near it; the whole assemblage being evidently derived from the Goatfell granitic range.

It may be well to observe here, that of the hundreds of boulders scattered over this part of the country, I did not see one of any rock foreign to the island. The specimen in question is quite black, of irregular brittle fracture, and contains a few crystals of felspar and brown augite. The microscopic structure is highly remarkable, and differs considerably from any previously described. With a low power, the colourless glassy base appears to be crowded with numerous groups of slender black prisms, exhibiting the following singular arrangement. A long acicular prism forms an axis, to which are attached, on opposite sides, two rows of similar shorter prisms, projecting from it at right angles, like the teeth of a double comb. With a higher power, the prisms are easily recognized as the usual pyroxenic belonites thickly studded with extremely minute grains of magnetite; the rock itself is rather strongly magnetic. Well formed crystals of orthoclase and plagioclase are imbedded in the base, together with many distinct characteristic crystals of augite. Quartz appears to be absent from this rock.

One of the porphyritic pitchstone boulders just referred to is also of great interest, as it contains a considerable proportion of fine-grained basalt included in it. Under the microscope, the pitchstone itself is seen to be quite the same as that previously described (p. 7), but it contains, in addition, small isolated fragments of basalt, while the basaltic part of the rock incloses quartz crystals, which have included in their cavities portions of the basaltic matrix in which they are imbedded. The basalt is very fine-grained, and consists almost entirely of small, clear, felspar crystals, and very minute grains of magnetite. A few small grains of augite may also be detected.

It has already been explained that the characteristic base of pitchstone is a *homogeneous glass without a trace of double refraction*, and therefore remaining dark between crossed Nicols; the base of felsites, porphyrites, and other allied rocks, is, on the other hand, characterized by a *felsitic* structure, and a felsitic base *invariably*

exhibits double refraction. In ordinary light, there are seldom any distinct indications of individual forms, the appearance being rather that of a confused imperfectly blended mass of glassy materials. Its true character is, however, well seen in polarized light; the axes of the Nicols being parallel, there are still comparatively few sharp outlines, but as either of the prisms is rotated, the mass appears to break up into variously coloured little patches, which gradually assume a more definite form as the axes approach to a right angle; in that position it has the appearance of a granular compound of crystalline fragments, among which there may be seen, in most cases, a few more or less perfectly formed crystals. It is not, however, a granular compound in the proper meaning of the term: it is evidently a mass which has been consolidated whilst in an incipient stage of crystallization; or, in other words, an originally homogeneous mass has undergone a certain amount of molecular change, insufficient for the development of crystalline forms, but sufficient for the production of double refraction.

It would appear from these facts, that in the case of pitchstone, the conditions under which the consolidation of the matrix took place were altogether unfavourable to crystallization; but that in the case of a felsitic base, the process of crystallization had commenced, and had been arrested, possibly by the act of consolidation. But it is by no means obvious in what way the conditions differed, for it is quite certain, that in both cases, felspar and quartz crystallized out from the mass, and in doing so caught up portions of the surrounding glassy or felsitic matrix. The explanation may however lie in the fact, that there is more silica in the felsitic than in the vitreous parts of these rocks. Concurrently with an incipient crystallization there has also been a partial formation of distinct constituents; for in most cases, if not in all, quartz may be distinctly recognized. Although the peculiar texture just described may be regarded as the chief characteristic of a large class of rocks, it is only in typical specimens that it exclusively prevails, for it will be seen, that by a gradual increase in the quantity of granular and crystalline particles, it passes into a more or less perfectly crystallized structure. It will shortly be shown that felsitic substances frequently occur in pitchstone, and in the following descriptions the term will always be used to indicate the structure just explained.

On the west coast, between Drumadoon Point and the headland called Cleitadh nan Sgarbh, the cliffs round the bay consist of red sandstones traversed in places by veins of pitchstone and red jaspery "hornstone." One of them near King's Cove is a brown pitchstone, forming a vein high up in the cliff, and is a rock of special interest, as it is very variable in structure, and shows clearly that ordinary pitchstone, and the compact red "hornstone," are simply modifications of one and the same mass. Four specimens taken from this vein exhibit the following varieties:—

1. A yellowish-brown pitchstone, full of small round grains and narrow bands, differing slightly in colour from the glassy base.

2. A brown pitchstone, of duller aspect than No. 1, containing spheroidal nodules of light brown compact "hornstone," having a bluish-grey nucleus; the nodules are from 1 to 2 inches in diameter, and contain many crystals and grains of quartz, with some of felspar.

3. A specimen, containing the two former varieties, with a little red "hornstone."

4. A compact red "hornstone," with crystals of quartz and felspar; a portion of one specimen also exhibits a minute spherolitic structure.

Under the microscope a section of No. 1 exhibits, in ordinary light, a pale yellow glass, full of well-defined circular aggregations of a reddish-yellow substance, which appears indistinctly granular; these are the grains seen in the specimen; they will be described as spherolites. Great numbers of short green belonites are scattered through the base, and there are many crystals of quartz, orthoclase and plagioclase, the latter are beautifully striated. A crystal of quartz or felspar sometimes forms the nucleus of a spherolite, numbers of belonites radiate from it, and the group is surrounded by one or more concentric coloured bands; frequently, however, the spherolites have no distinct nucleus. The true character of the rock is better seen in polarized light; between crossed Nicols the glassy base of course remains dark, and on this black ground numerous spherolites and small patches of felsitic matter are very well seen. The spherolites invariably exhibit double refraction, but no felsitic structure; in ordinary light many are quite clear, and the only indication of a radial structure is the direction in which the belonites lie. Between crossed Nicols, however, a black cross is seen, and on rotating either of the prisms the arms of the cross also rotate; this is of course indicative of a minute radial crystallization.

The dull brown pitchstone, No. 2, which contains the nodules, exhibits many spherolites like No. 1, aggregations of felsite, and also characteristic groups of belonites.

The "hornstone" nodules consist of the usual glassy base, nearly filled with a fine brown dust, which renders it dull and semi-opaque; a very thin section exhibits however a somewhat similar structure to No. 2; but the belonites are longer, and there are very few fern-like groups; larger portions of the base are felsitic, quartz crystals are more abundant, and there are several small masses of amorphous quartz.

The grey nucleus of the nodules exhibits a characteristic felsitic texture, together with imbedded crystals of quartz and felspar.

The red "hornstone," No. 4, consists of a very compact felsitic base, with much colouring matter disseminated through it, and it also contains crystallized quartz and felspar.

I am fortunate in being able to give the results of a very careful analysis of two of these rocks by Mr. J. Arthur Phillips, who kindly undertook the examination, and made a double analysis of each. No. I. is the "hornstone" nodule. II., the red felsite or "hornstone." III., a globular felsite, to be presently described; also analyzed by Mr. Phillips:—

	I.		II.		III.	
	1.	2.	1.	2.	1.	2.
Water[1]	8·23	8·14	3·58	3·59	1·47	1·47
Silica	73·90	73·78	78·05	77·92	78·32	78·02
Alumina	10·12	10·08	11·12	11·21	11·39	11·46
Ferric Oxide	trace		trace		—	—
Ferrous Oxide	1·23	1·25	1·08	1·17	1·67	1·61
Manganous Oxide[2]	1·19	1·15	0·15	0·17	—	—
Lime	—	—	0·98	0·88	0·13	0·13
Magnesia	trace		trace		trace	
Potassa	2·42	2·44	trace		0·20	0·20
Soda	2·64	2·66	4·94	4·92	7·62	7·72
	99·73	99·50	99·90	99·86	100·80	100·61

Felsites.—On the east and west coasts of the southern half of the island there are several dykes of a light grey felsite, which cut through the Carboniferous sandstones in precisely the same way as the pitchstones and basalts; and sometimes even form portions of the same dykes. These are the rocks frequently mentioned by Dr. Bryce as claystones; they appear to have been but very imperfectly understood, and as they are far more common than the pitchstones, it is singular that Zirkel should have given no description of them in his account of the Arran rocks.

These felsites vary considerably in appearance, some being distinctly spherolitic, while others can scarcely be distinguished from the so-called quartz porphyries; it will, in fact, shortly appear that they possess an intermediate character between the latter and the pitchstones. Referring to the preceding account of their general microscopic structure, it will be convenient to describe, in the first place, a rock of very different appearance, but of essentially the same structure and composition.

Near the small pitchstone vein on the Corriegills shore, there is an intrusive vein of a very remarkable character.

Globular Felsite.—The rock was described by MacCulloch, and has been frequently mentioned by subsequent writers as globular pitchstone, perlitic pitchstone, claystone, and hornstone. It is not mentioned by Zirkel in the paper previously quoted. Dr. Bryce observes: "Mineralogists have long regarded this curious rock with much interest, and various opinions have been held respecting its true relations, some considering it as allied to claystone, and others to pitchstone."[3] It will soon be evident that a microscopic examination of one or two thin sections is quite sufficient to establish its true character.

It is a hard, tough rock of dull greenish-grey colour, full of

[1] In No. I. 2·37 was lost in water bath.
„ II. 1·32 do. do.
„ III. 0·65 do. do.

[2] The whole of the iron in No. I. was found "to be in the state of ferrous oxide, and that fact is sufficient evidence that the manganese exists as manganous oxide." It is worthy of remark, that the felsitic portion of the rock contains more silica than the pitchstone, a result quite in accordance with that obtained by microscopic examination.

[3] Geol. of Arran, p. 77.

spherical concretions, set in a compact matrix. The spheres have a distinct fibrous radial structure, and are frequently coated with a white film. In a very thin section, in ordinary light, the spheres exhibit a well-defined circle, bounded by a line of minute grains of iron oxide, but the fibrous structure is not so distinct; in fact, it then appears to be simply a radial arrangement of the particles of a fine dust scattered through a dull uniform base; dark greenish aggregations of this substance sometimes form an irregular nucleus, throwing off rays towards the circumference; frequently, however, the centre is free from them, and there is then no appearance of any sort of structure. These green patches also occur in the matrix, and both spheres and matrix appear to be composed of precisely the same substance. Placed between crossed Nicols the appearance is completely changed, and it is at once seen that the matrix has a felsitic structure, and that some of the spheres are also composed of portions of the same substance, which have, however, undergone a process of aggregation and radial arrangement in globular masses; but the felsitic structure is still quite as evident as in the base. Many of the spheres are, however, composed of two or more concentric layers; in some there is a felsitic nucleus surrounded by radiating groups of the green dust; in others the nucleus consists of grains of quartz only. The globular concretions here described differ entirely in structure and appearance from the spherolites occurring in the pitchstones, and it is quite evident that the rock is a felsite. Some specimens may, at first sight, be readily taken for a dull perlitic pitchstone, but a microscopic examination shows very clearly that it is not a pitchstone, and that the structure is not perlitic.

On the shore south of Tormore there is a compound dyke about 20 feet wide, the two sides consist of basalt, while the central part, 12 feet in width, is composed of a hard light grey felsite, containing crystals of quartz and a few of felspar; the latter are chiefly orthoclase, but plagioclase is also present. The base is felsitic, and contains many perfectly clear spherolites with radiating belonites; this is the only indication of structure in ordinary light, but between crossed Nicols there is a well-defined black cross. The larger quartz crystals are surrounded by a continuous clear band, containing tufts of radiating belonites, and between crossed Nicols the tufts are seen to mark the places of imperfectly formed spherolites, more or less complete black crosses being then visible. Many belonites, and small opaque grains, are scattered through the base, and they assume a stream-like arrangement round the sides of the larger crystals.

In Monamore Glen, about a mile above the mill, there is a small quarry worked for road metal. The rock is a hard felsite, varying in colour from greenish-grey to light brown; it contains a little felspar, and numerous crystals of quartz; the latter being surrounded by a green border, give the rock an unusual appearance. The base is felsitic, contains many green belonites, and is quite as distinctly spherolitic as the specimen just described. In addition to many clear spherolites, there are others of a dull green substance, having a radial arrangement, but not distinctly crystallized. The quartz

crystals contain many cavities inclosing portions of the base, and are invariably surrounded by a band of green spherolites so closely packed together as to interfere with their full development. The felspar is much altered, but a few crystals still display coloured bands and striæ.

A spherolitic felsite appears to form an intrusive vein on the south slope of Dun Fion above the Corriegills shore. It is a rather hard yellowish-grey rock, full of small spherical grains, without imbedded crystals. Under the microscope, with ordinary light, the felsitic base appears to be full of brown dust, with many imperfect belonites scattered through it; there are also many clear circular spaces, which exhibit no structure whatever. Between crossed Nicols, however, a spherolitic structure is at once evident; the clear spaces then display one or more circular disks traversed by a black cross. This kind of latent, or crypto-spherolitic texture, is the same as that previously described in the pitchstones. There are many small spherolites of distinctly fibrous structure.

We have previously seen that the brown pitchstone from King's Cove passes into a felsite, and in the rocks just described we have examples of typical felsites containing spherolites and belonites, differing in no respect from those common in pitchstones.

On the Lamlash road, about a mile from the Brodick Hotel, there is a mass of spherolitic felsite in connexion with the vein of pitchstone, which is well exposed in the bed of the stream below. It is the bed of "claystone" mentioned by Dr. Bryce, who describes the relative positions of the two rocks, and observes, that "the relations of the two beds lend countenance to the idea that these claystones are but altered sandstones." It is by no means easy to understand how any one who had given some attention to igneous rocks could entertain such an idea. In external appearance the rock is not unlike a nearly white Oolitic limestone, full of small yellowish grains. Under the microscope a thin section shows the grains to be spherolites of fibrous radial texture, thickly scattered through a felsitic base containing many distinct grains of quartz. The rock is somewhat decomposed, but a few of the spherolites still exhibit traces of belonites.

A crystalline felsite from Auchenhew Hill, about a mile and a half N.W. of Kildonan Castle, is an interesting rock, as it exhibits a composition and structure combining the characters of the felsites with those of the more perfectly crystallized dolerites, and may, therefore, be compared with the well-known trachy-dolerites. It is of a light grey colour, distinctly crystalline in texture, and contains a few crystals of orthoclase. The felsitic base contains grains of quartz, and many spherolites, like the preceding rocks; but there are in addition numerous small felspar crystals, and long prisms of a brown pyroxenic mineral, too much altered for determination: it is probably altered hornblende. There are also many black grains of magnetite; the larger felspar crystals are twins of orthoclase. This rock occurs high up among the sandstones on the south side of the hill; the latter being capped by a thick sheet of columnar dolerite.

The felsites just described all form dykes or veins in the sandstones; but there is a rock, of similar appearance, which occupies a considerable area in the vicinity of Lagg. It nowhere reaches the coast, but is first seen a few hundred yards south of Clauchog farm, and extends in a northerly direction for at least two miles; and from Sliddery Water, on the west, to the Cloined burn, near the well-known shell-bed, on the east, a distance of a mile and a half; how much further it may extend in both directions is uncertain, as I had no opportunity of tracing it. In Sliddery Water it is first seen in the bed of the river, about 700 yards above the bridge, where there is a fine junction with the sandstones. The side of the felsite is vertical, with the ends of the sandstone strata abutting against it, and dipping away at an angle of 30°; the felsite here crosses the river, and occupies both banks as far as Glenrie Mill. It appears to be continuous within the limits observed, and in the Cloined burn the relations of the two rocks are the same as in Sliddery Water. In this instance a mass has probably flowed over the sandstone, and has been brought into its present position by faults.

The rock is very uniform in character, generally of a light-grey colour, but often marked with reddish-brown bands and concentric rings. The base is finely granular, and contains many small crystals of felspar and quartz, with numerous grains of magnetite. Under the microscope the base appears distinctly granular, and contains much quartz; orthoclase and plagioclase are both present, though much altered; the quartz is well crystallized, sometimes exhibiting short prisms doubly terminated.

Porphyritic Felsites, or quartz porphyries, as they have generally been called, occur in many places in Arran, frequently as dykes in the Carboniferous sandstone, or forming extensive overlying masses. The best localities on the west coast are Drumadoon Point, Leac a breac between Blackwater foot and Sliddery Water, and Benan Head; and on the east coast, Dun Dhu between Brodick and Lamlash. As Zirkel has given an account of these rocks in the paper cited above, a brief description of two varieties will now suffice. Benan Head is formed entirely of a mass of various intrusive rocks, of which a beautiful "quartz porphyry" forms the greater part. It is a pale-grey rock, containing numerous large crystals of orthoclase and quartz in a compact base; the orthoclase is clear and glassy, like sanidine; the quartz is well crystallized in short prisms doubly terminated.

Under the microscope, in polarized light, the base exbibits a perfectly characteristic felsitic structure, with a very few imperfectly formed felspar crystals, and a little quartz; there are also many small black grains of magnetite. Nearly all the felspar is orthoclase, but Zirkel's statement that there is no trace of plagioclase requires to be modified, as one of my sections contains a crystal which exhibits well-defined coloured striæ. The larger crystals of quartz and felspar contain many cavities, with included portions of the base.

The columnar "porphyry" at Drumadoon Point is of a darker colour than the preceding rock, and some of the orthoclase crystals

are quite opaque; others are glassy in the middle, with an opaque coating. The dark colour is due to the presence of a great number of grains of magnetite and a little chloritic mineral scattered through the base; there are also a few crystals of a pyroxenic mineral altered to the same green substance. The base exhibits a more crystallized structure than the rock from Benan Head, and in this respect resembles the felsite from Auchenhew Hill previously described.

It should be distinctly understood that in calling these rocks felsites or quartz porphyries, nothing is implied thereby as to their age; they might with equal propriety be called trachytes, and would certainly be placed in the trachytic group, if they were known to be of Tertiary age; there is no mineralogical or structural difference between them and the recent trachytes, nor on the other hand is there anything to distinguish them from much older rocks. If any petrologist thinks he can determine the age of such rocks by their chemical or mineralogical composition, he might try his skill on these Arran felsites before their age is ascertained by other means. So far as is yet known with certainty, they may have been intruded at any time between the close of the Carboniferous and the close of the Tertiary Periods; there is here, therefore, an excellent opportunity of solving a difficult problem, and any one who has discovered a criterion for determining the age of eruptive rocks would render great service to science by making it known. Although there is at present great confusion in petrological nomenclature, a partial alteration, or introduction of new terms, would only make matters worse; and as more exact methods of observation are now being employed, it will not be very long before the composition and structure of most rocks will be known. Petrologists will then be able, for the first time, to adopt a nomenclature founded on a knowledge of facts; for it should be remembered that most of the names by which the fine-grained rocks are known were given in complete ignorance of their true composition. In the meanwhile no harm can be done by discontinuing the use of a number of terms which have lost, or never had, any definite meaning; for example, the names 'porphyry' and 'porphyrite' may be dismissed as quite unfit for generic terms, the structure to which they are applied being frequently found in all kinds of igneous rocks, and therefore characteristic of none. It should be restricted to its proper use as a varietal character only, and such names as 'felspar-porphyry,' 'pitchstone-porphyry,' etc., should give way to 'porphyritic felsite,' 'porphyritic pitchstone,' etc. Another step would be to ignore the distinction now made between rocks of different ages, when there is really no essential difference between them; we should then get rid of *melaphyr*, *aphanite*, *anamesite*, *diabase*, and *greenstone*. The three former are but varieties of 'dolerite,' 'diabase' is simply an altered 'dolerite,' while 'greenstone' has now no definite meaning whatever, having been applied to diorites, dolerites, felsites, or in fact to any rock which a collector or writer could not make out. An indefinite term is of course frequently useful in the field, and perhaps none could be better for the purpose than *trap*.

I would observe, in conclusion, that, although much has been written on the geology of Arran, comparatively little is accurately known, especially as regards the rocks in the southern half of the island. A few rambles along the shore and among the hills should surely teach a geologist that there are igneous rocks of different ages, presenting various modes of occurrence; yet such important distinctions as those between interbedded sheets and intrusive dykes have been generally overlooked or completely misunderstood. What is now wanted is a good geological map and memoir, a work which could not be in better hands than in those of Prof. Geikie and his staff, and with which it is to be hoped geologists may soon be favoured.

V.—On the Temperature and other Physical Conditions of Inland Seas, in their Relation to Geological Inquiry.[1]

By William B. Carpenter, M.D., LL.D., F.R.S., F.G.S.

THE researches in which the Author has been personally engaged during the last four years into the Temperature and other Physical conditions of the Deep Sea, combined with the information he has obtained from other sources, have led him to the knowledge of certain remarkable differences in regard to these conditions, which prevail between Inland Seas and the open Ocean. As these differences have a most direct and important bearing upon the distribution of Animal life, and as it would seem highly probable that similar differences have existed in all Geological periods, he thinks it important that Geologists, by being made aware of them, should be in possession of a key that seems likely to open the way to a rational interpretation of many Palæontological phenomena which are at present obscure.

The *general facts* in regard to Ocean Temperature, which have been determined by recent observations, are briefly as follows:—

1. In high Northern latitudes, the Temperature of the *surface* of the sea, near the border of the ice barrier, is but little above 32°; and at small depths below the surface, according to the recent observations of Payer and Weyprecht, it falls below 32°. Making allowance for the known influence of pressure upon the thermometers with which temperature-observations at great depths have been made in these regions, there is every reason to believe that—save in cases in which the temperature of the upper stratum may be modified by local causes—there is a progressive descent from 32° to 29°, or even lower; so that the average temperature of the *entire column of Polar water* may be considered to be not above 30°.

2. In lower latitudes, the Temperature of the surface of the sea is greatly influenced by solar radiation; but the *superheating* thus produced does not generally extend in a marked degree much below 100 fathoms. Beneath this, in the Atlantic, is a stratum of which the temperature may be said to range from about 52° to 45°, in all but the highest latitudes; but the depth of this stratum varies considerably, extending downwards to about 500 fathoms near the Faroe Banks, to about 700 fathoms off the coast of Portugal, and to 1,000 or 1,200 fathoms nearer the Equator.

3. Beneath this stratum is a "stratum of intermixture" in which the thermometer falls rapidly, sometimes as much as 10° in 200 fathoms; and below this the temperature again becomes more uniform, sinking very gradually from 39° or 38°, to 36° or 35°, at depths of 2,000 fathoms or more, near the Eastern border of the North Atlantic. It is probable that Temperatures yet lower than these will be found to prevail over the deep bottom of the Mid-Atlantic; the recent Temperature-soundings of Captain Chimmo in the Eastern Seas, made with 'protected' Thermometers, having now fully demonstrated that, *even under the Equator*, the bottom-temperature at great depths of the Ocean may be as low as 32°.

4. Thus the Intertropical column may be considered as consisting of (1) a *superheated stratum*, of which the temperature ranges from 84° at the surface to 52° at

[1] Extracted from *The English Mechanic and World of Science*, for September 20-27, 1872, with additions and corrections by the Author.